Lithiation and Trapping of Acyclic Sulfoximines:

Scope and Diastereoselectivity

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MSc by Research

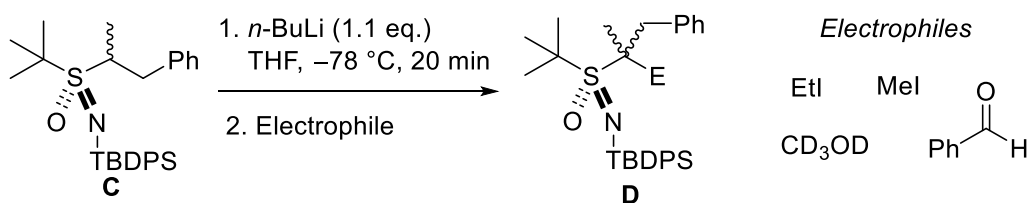**University of York**

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Abstract

This thesis describes the diastereoselective synthesis of a wide range of α-functionalised acyclic sulfoximines *via* lithiation-trapping methodology. The diastereoselective synthesis of some tetrasubstituted sulfoximines is also presented.

Chapter 2.1 describes the synthesis of a range of *N*-TBDPS acyclic sulfoximines **A** bearing different aliphatic and aromatic substituents at sulfur. A range of lithiation-trappings with different electrophiles is presented in Chapter 2.2. *N*-TBDPS acyclic sulfoximines **A** generally showed high diastereoselectivity and yields of **B**, particularly when the sulfoximine was substituted with a bulky group (R^1 = *t*-butyl and adamantyl). Across most examples, the *anti*-diastereomer *anti*-**B** was produced as the major product and a model for this is proposed. Benzylic sulfoximines **A** (R^2 = Ph) (Chapter 2.2.3) were also explored and exhibited different and unpredictable diastereoselectivity.

Electrophiles
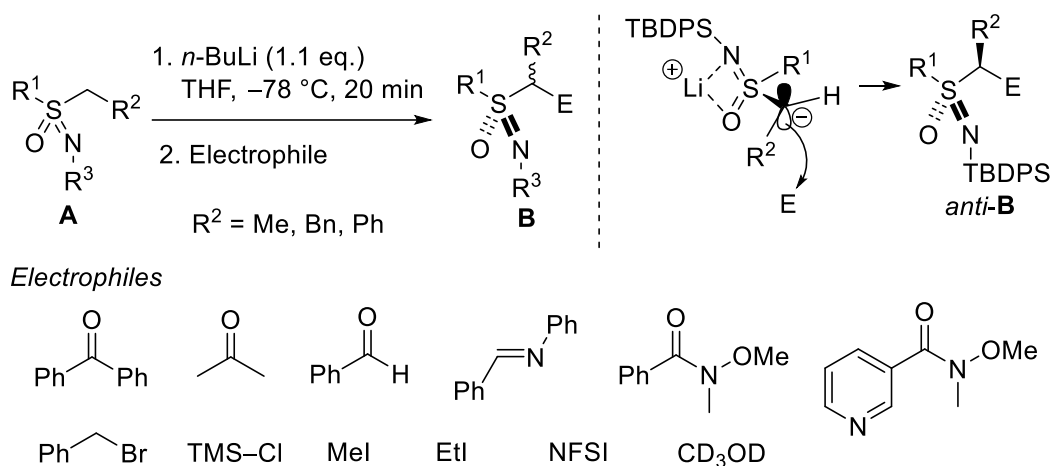
The synthesis of tetrasubstituted sulfoximines **D** by lithiation-trapping is presented in Chapter 2.3 using *t*-Bu-substituted sulfoximines **C**. High yields and diastereoselectivity were obtained for some examples and the same outcome was observed with benzaldehyde when employing either diastereomeric starting sulfoximine. The best results were obtained when small, reactive electrophiles were used, presumably due to the sterically demanding substrate. It was not possible to assign the stereochemistry of the major diastereomers.

List of Contents

List of Tables

List of Figures

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Finally, I would like to thank my family and my partner; Aaron, for their unconditional love and support in everything that I do.

Author's Declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

Alexandra Hindle

Abbreviations

Ac	acetyl
Ad	adamantyl
Ar	argon
ATR	ataxia telangiectasia and Rad3-related
Bn	benzyl
Boc	*tert*-butoxycarbonyl
BSA	bistrimethylsilylamide
Bu	butyl
Bz	benzoyl
CDK	cyclin dependent kinase
d	doublet
DMAP	4-dimethylaminopyridine
DMF	dimethylformamide
DMSO	dimethyl sulfoxide
dr	diastereomeric ratio
DSCG	disodium chromoglycate
E	electrophile
eq.	equivalent
Et	ethyl
h	hour
HMPA	hexamethylphosphoramide
Hz	Hertz
IR	infra-red
J	coupling constant in Hz
LDA	lithium diisopropylamide
LiTMP	lithium tetramethylpiperidine
m	multiplet
M	molar
M^+	molecular ion
Me	methyl
min	minute
MP	melting point

MS	mass spectrometry
m/z	mass to charge ratio
NFSI	*N*-fluorobenzenesulfonimide
NMR	nuclear magnetic resonance
NOE	nuclear Overhauser effect
Ph	phenyl
Pr	propyl
PIDA	(diacetoxyiodo)benzene
q	quartet
rt	room temperature
s	singlet
t	triplet
TBAF	tetrabutylammonium fluoride
TBDMS	*tert*-butyldimethylsilyl
TBDPS	*tert*-butyldiphenylsilyl
TFA	trifluroracetic acid
THF	tetrahydrofuran
TMS	trimethylsilyl
tol	tolyl
Ts	tosyl
X-Phos	2-dicyclohexylphosphino-2′,4′,6′-triisopropylbiphenyl

1. Introduction

1.1 Introduction to Sulfoximines

In the last few years, sulfoximines have been a focus of interest in synthetic chemistry due to their applications in the pharmaceutical[1] and agrochemical[2] industries. As a result, attention in this interesting functional group is continuously expanding. Sulfoximines share similarities with the related sulfone and sulfoxide functionalities and are isoelectronic with sulfones (Figure 1.1).[1] The synthesis and reactions of sulfones and sulfoxides are far more explored than sulfoximines and therefore research efforts regarding the synthesis and functionalisation of sulfoximines is a current focus.
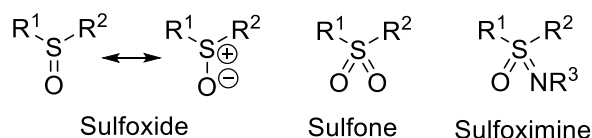
Figure 1.1 Structure of the sulfoxide, sulfone and sulfoximine

The structural differences between the sulfoximine and sulfone units consist of the presence of a nitrogen atom replacing one of the oxygen atoms of the sulfone, which leads to unique physicochemical properties. Sulfoximines demonstrate a desirable spectrum of properties including high stability, a hydrophilic core and the ability to undergo hydrogen bonding.[1] Furthermore, they demonstrate better 'drug-like' features over their corresponding sulfone analogues by being more polar and readily soluble in water which is likely to be due to the solvation of the sulfoximine.[3] These factors collectively showcase the potential of sulfoximines as viable candidates for drug discovery.

As sulfoximines have beneficial 'drug-like' properties and good bioactivity, they have been employed in various pharmaceuticals over recent years. This is best illustrated by enantiopure nanomolar pan-CDK inhibitor BAY 100394 (Figure 1.2), developed by Bayer, currently undergoing clinical trials.[4] BAY 100394 was investigated following the failure and termination of sulfonamide ZK 304709 (Figure 1.2) during phase 1 clinical trials due to poor thermodynamic solubility in water (8 mg L^{-1} at a pH of 7.4) and low lipophilicity.[5] Sulfoximine-containing BAY 100394 allowed Bayer to overcome these issues by having much higher solubility in water (182 mg L^{-1}). The use of the sulfoximine pharmacophore within BAY 100394 has sparked and directed further attention towards utilising this unit within other drug discovery programmes at Bayer.[1] Another example is

AZD6738 (Figure 1.2), developed by AstraZeneca, an enantiopure ATR kinase inhibitor which has shown potential as an anticancer treatment. AZD6738 is currently undergoing clinical trials and has provided promising results in terms of its effectiveness against gastric cancer cells.[6]
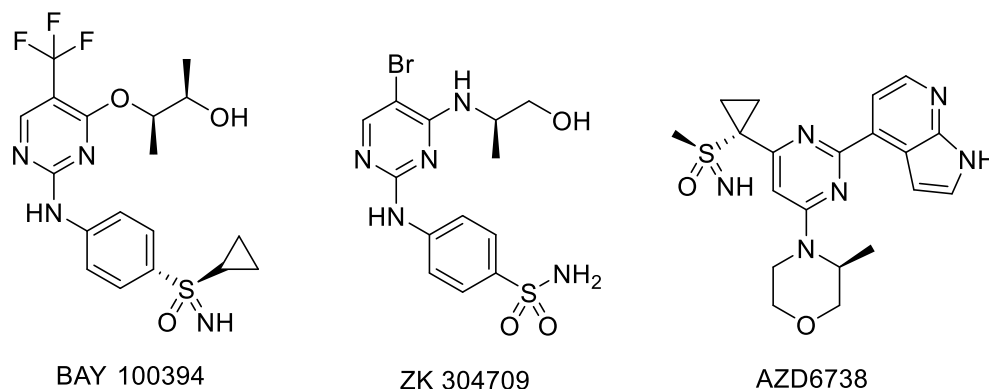
Figure 1.2 Sulfoximine-containing pharmaceutical candidates

An earlier example is racemic antiasthmatic drug candidate RU 31156 (Sudexanox) that has been selected to undergo clinical trials (Figure 1.3). Disodium chromoglycate (DSCG) is an effective asthma treatment but is not orally active. Therefore, xanthone-2-carboxylic acid was selected as a template for an orally active antiasthmatic agent, as it displays activity similar to that of DSCG when dosed orally. This lead structure then enabled the development of Sudexanox through a series of structural modifications which showed an increase in potency and intravenous and oral activity when compared to DSCG.[1,7]
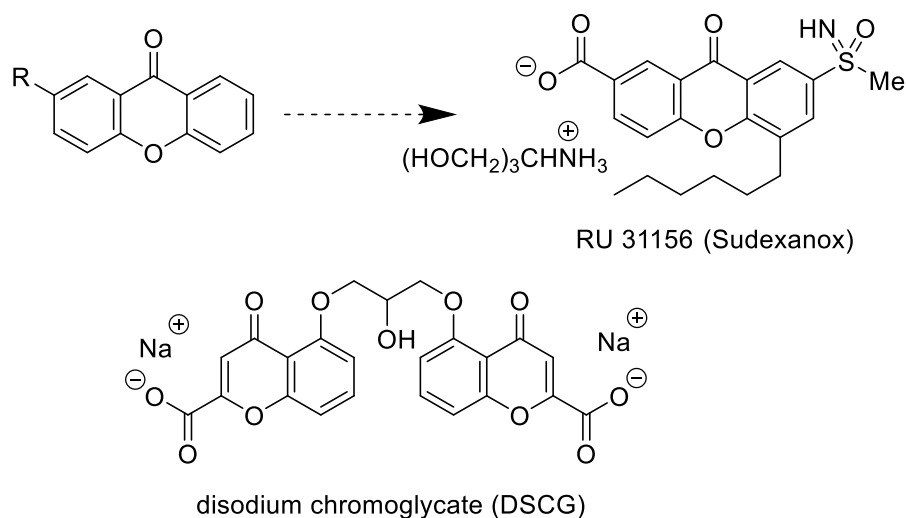
Figure 1.3 Details of the lead optimisation of Sudexanox

The electron withdrawing nature of sulfoximines and the presence of the mildly basic amine group allows for further diversification *via* installation of a variety of substituents. *N*-H, or 'free', sulfoximines are often the focus of research, but alternative nitrogen substituents have also been investigated. Some common examples include alkyl (*N*-R), aryl (*N*-Ar), silyl (*N*-SiR₃) and cyano (*N*-CN) substituents. The electronic properties of the group on nitrogen has a significant effect on the properties of the sulfoximine and therefore its applications. For example, electron donating substituents such as alkyl, aryl and silyl containing groups decrease the polarity of the sulfoximine. Conversely, functional groups with electronic withdrawing capabilities such as cyano and sulfonyl increase the polarity.[8]

The installation of different groups at nitrogen allows for different applications of sulfoximines. For example, *N*-CN functionalised sulfoximines have shown potential to act as insecticides. Sulfoxaflor (Figure 1.4) was developed as an insecticidal compound that is effective against a range of sap-feeding insects.[9] Sulfoxaflor is racemic and exists as a mixture of four stereoisomers, two of which are diastereomers.[10] It was shown that the *N*-CN substituent was an important feature required for its activity when compared to the previously investigated *N*-nitro sulfoximine. Other related examples also describe the incorporation of the *N*-CN functionality further highlighting its necessity.[11] Prior to the development of Sulfoxaflor, the sulfoximine scaffold had not been extensively investigated within the agrochemical industry.[9]
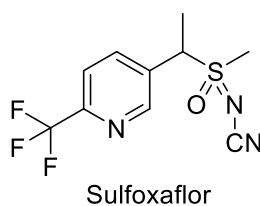
Figure 1.4 The structure of Sulfoxaflor

When the two carbon substituents attached to sulfur are not identical, the sulfoximine centre is stereogenic and applications in asymmetric synthesis as chiral ligands and auxiliaries have been described.[12] For example, Pyne[13] and co-workers have described the asymmetric synthesis of cyclopropanes and Harmata[14] has reported the enantioselective synthesis of benzothiazines. Work by Johnson also showed the potential of chiral sulfoximines as reagents for the optical resolution of ketones.[15]

The enantioselective borane reduction of ketones to alcohols using β-hydroxysulfoximines has been described by Bolm.[16] Langner and Bolm have also investigated sulfoximines as chiral ligands and described their application in Cu-catalysed Mukaiyama-type aldol reactions.[17] Bisulfoximines such as **1** have been used in asymmetric Pd-catalysed allylic alkylation reactions. For example, bisester **2** was formed in 94% ee, although the absolute stereochemistry was not established (Scheme 1.1).[18] Studies have also reported the use of sulfoximines as directing groups in various C-H activations, including the Rh-catalysed synthesis of 1,2-benzothiazines.[19,20]
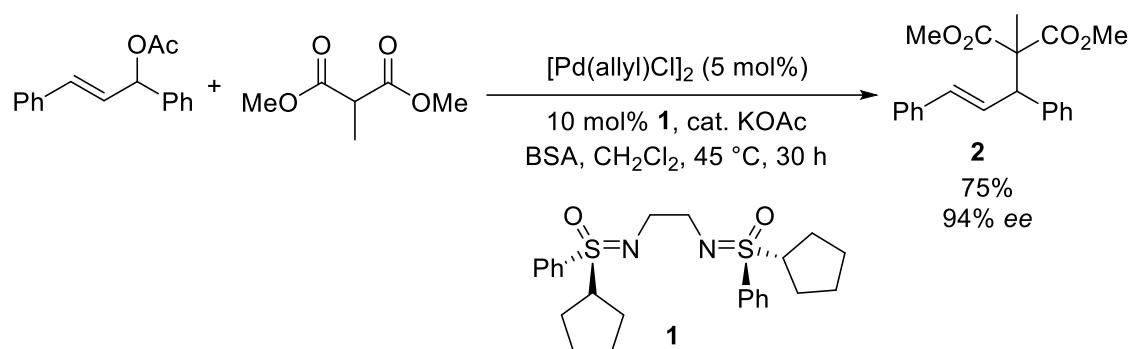
Scheme 1.1

1.2 α-Functionalisation of Sulfoximines by Lithiation-Trapping

It is possible to functionalise at the α-position of alkyl substituents of *N*-functionalised sulfoximines *via* deprotonation of the α-protons and subsequent trapping with an electrophile. The ease of such α-carbanion formation depends on the functionality attached to the amino group. Bordwell and co-workers experimentally measured the associated pK_a values of the α-protons in sulfoximine, sulfone and sulfoxide functional groups. The phenyl methyl derivative of each sulfur-containing compound was used in these studies and the pK_as of the methyl protons were measured (Figure 1.5). *N*-Me sulfoximine **3** was shown to have a pK_a ~33 in DMSO at 25 °C. This was equal to the measured pK_a of the corresponding sulfoxide **4** and higher than that of the corresponding sulfone **5** (pK_a ~29) presumably due to the greater electron withdrawing ability of the sulfone functional group. Bordwell's studies also highlighted the effect of the nitrogen substituent on the sulfoximine since the pK_a of the *N*-Ts sulfoximine analogue **6** was 24.5. This is significantly lower than the *N*-Me sulfoximine **3** presumably due to the electron withdrawing ability of the tosyl functionality which is better at stabilising the resulting α-carbanion.[21]

| **3** | **4** | **5** | **6** |
| pK_a ~ 33 | pK_a ~ 33 | pK_a = 29 | pK_a = 24.5 |
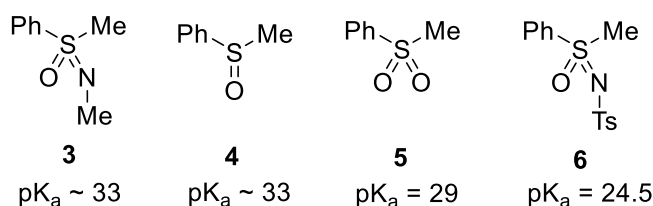
Figure 1.5 pK_as of sulfoximines, sulfones and sulfoxides

Since the α-protons of sulfoximines generally have pK_a values of ~23-33,[8,21] strong bases such as *n*-BuLi and LDA are typically used for deprotonation. There has been significant research exploring the α-functionalisation of various acyclic sulfoximines using lithiation-trapping, where a range of *N*-substituents and electrophiles have been explored. This chapter will provide a selection of key examples of the lithiation-trapping of acyclic sulfoximines to demonstrate the scope and diastereoselectivity which is possible with this methodology.

The reaction conditions used for the lithiation-trapping of acyclic sulfoximines usually consist of a deprotonation step using *n*-BuLi in THF at low temperatures, typically at −78 °C. This is followed by addition of the electrophile under the same conditions. Often, the trapping step is performed at −78 °C but it is common for higher temperatures to be

used.[22] Using these typical conditions, the lithiation-trapping of *N*-TBDPS sulfoximine **7** with 1-bromo-2-bromomethylbenzene gave α-substituted sulfoximine **8** in 70% yield (Scheme 1.2).[23]
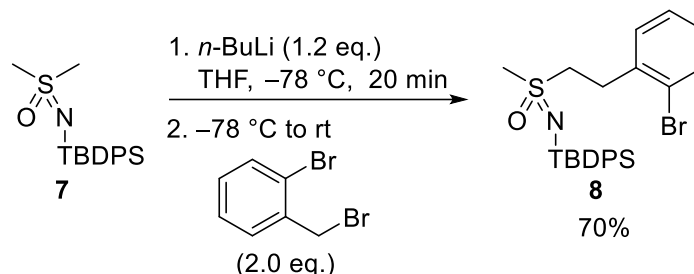
Scheme 1.2

The study also employed other alkylating agents and the electron rich 2-bromo-5-methoxybenzyl bromide gave benzylated sulfoximine **9** in 72% yield (Scheme 1.3). Trapping with a secondary alkyl bromide such as **10** resulted in the formation of α-alkylated products *anti*-**11** and *syn*-**11** due to the formation of an additional stereocentre at the β-position. In this example, a 67:33 mixture of *anti*-**11** and *syn*-**11** was obtained (isolated yields of 39% and 17% respectively). The diastereoselectivity presumably arises from the different rates of trapping of the lithiated sulfoximine with the chiral electrophile.[23]
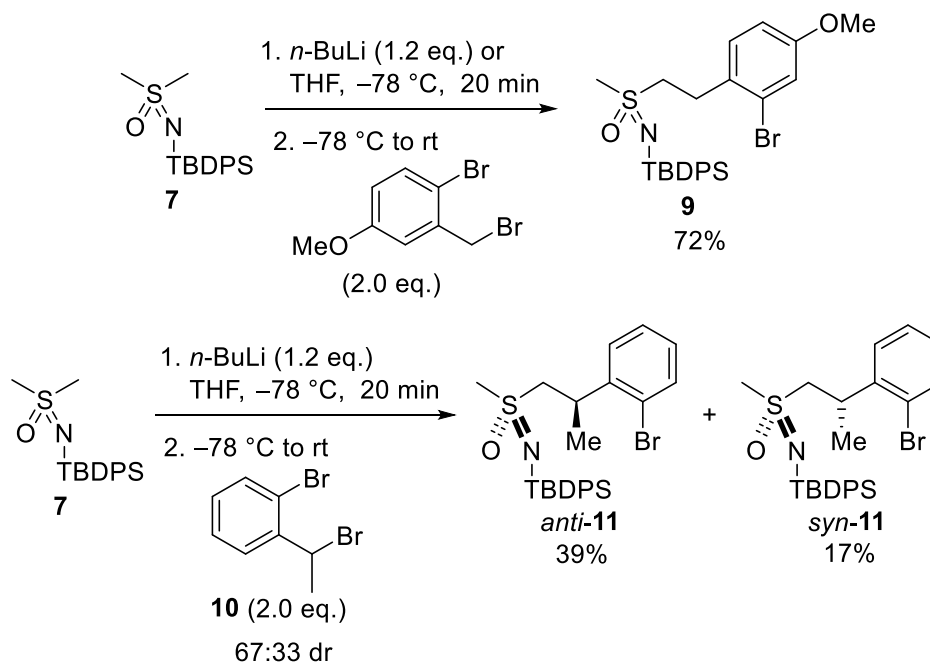
Scheme 1.3

The lithiation-trapping methodology has also been applied to the synthesis of some complex molecules such as sulfoximine-containing vitamin D analogues which were being studied as potential chemotherapy agents. Lithiation-trapping of *N*-TBDMS sulfoximine **12** with alkyl iodide **13** gave a 50:50 diastereomeric mixture of sulfoximines **14** in 55% yield (Scheme 1.4). The HMPA was probably used to increase the reactivity of the lithiated sulfoximine in its reaction with the sterically hindered alkyl iodide. The lithiated sulfoximine was presumably used in excess to ensure consumption of the complex alkyl iodide.[24]
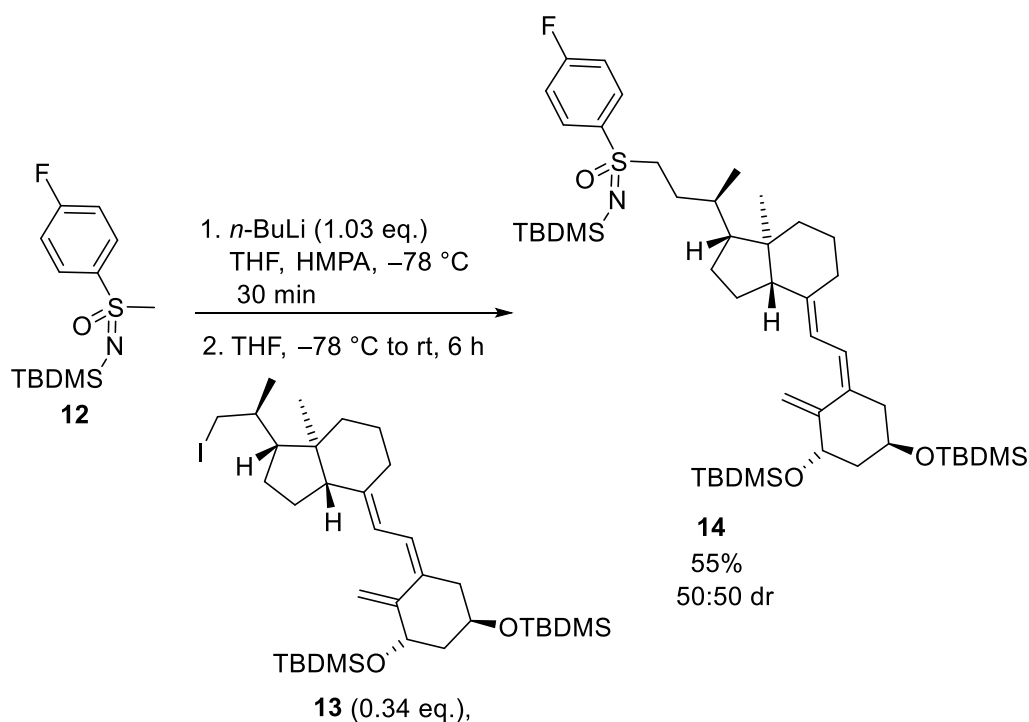
Scheme 1.4

Füger and Bolm have carried out lithiation-trappings with a range of allyl bromides, an example of which is shown in Scheme 1.5. It was reported that upon slow addition of the alkenyl bromide, double trapping at the α-position was observed to give disubstituted sulfoximine **17**. This is presumably due to the ability of unreacted lithiated sulfoximine to deprotonate at the α-position of the trapped sulfoximine which will enable another trapping reaction. The double alkylation was minimised *via* either fast addition of an excess of the electrophile to the lithiated sulfoximine or slow transfer of the lithiated sulfoximine to the electrophile. The chosen method was not reported, but a 67% yield of *N*-H sulfoximine **16** was obtained over two steps, after removal of the *N*-TMS group using NH₄Cl/MeOH (Scheme 1.5).[25]
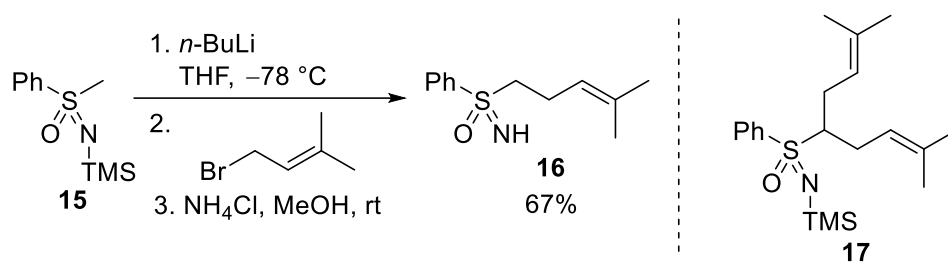
Scheme 1.5

The lithiation-trapping of sulfoximines with carbonyl-containing compounds as electrophiles has also been investigated. A range of examples using ketones, aldehydes, CO_2, esters, acid chlorides and Weinreb amides have been reported. For example, lithiation of *N*-Me sulfoximine **3** was carried out using *n*-BuLi in THF at -78 °C. Subsequent trapping with cycloalkanones of various ring sizes gave 83-97% yields of the corresponding alcohols (Scheme 1.6).[26] In related work, *N*-Me sulfoximine **3** was deprotonated using *n*-BuLi at -5 °C and then an acyclic ketone was added at -78 °C. This gave sulfoximine **18** in good yield (80%) but, unfortunately, the diastereoselectivity was not commented on in this study (Scheme 1.6).[27]
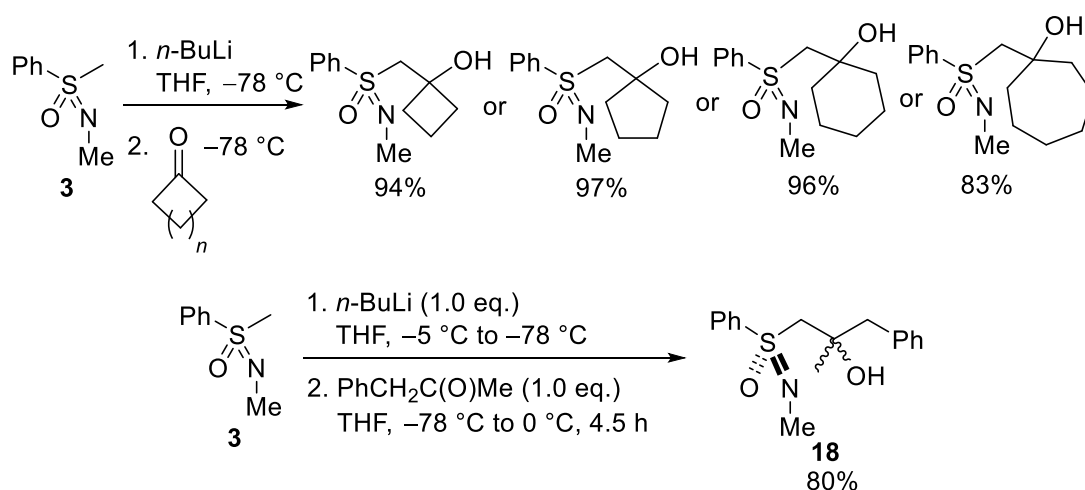
Scheme 1.6

Lithiation of *N*-TBDPS sulfoximine **19** and trapping with *i*-PrCHO gave a 93:7 mixture of diastereomeric alcohols *syn*-**20** and *anti*-**20** in 74% yield (Scheme 1.7).[28] Trapping with linear or aryl aldehydes provided similar diastereoselectivity to branched aldehydes. Furthermore, the use of sterically smaller *N*-silyl substituents led to lower diastereoselectivity.[29] Lithiation of the corresponding *N*-Ts sulfoximine **6** and trapping with *i*-PrCHO gave an 87:13 mixture of diastereomeric alcohols **21** in 70% yield although the relative stereochemistry was not assigned.[30]
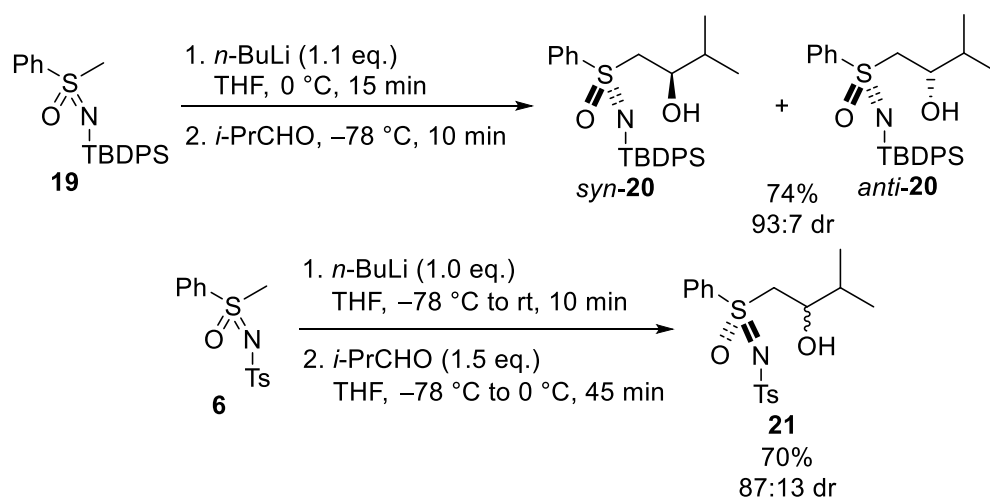
Scheme 1.7

To rationalise the preferred formation of *syn*-alcohols such as *syn*-**20** from the lithiation of *N*-TBDPS sulfoximine **19** and trapping with aldehydes, two chair-like transition states were proposed (Figure 1.6). In each one, the sulfoximine and aldehyde oxygens would be chelated to the lithium. When the aldehyde substituent is pseudo-axial, severe 1,3-diaxial-like interactions with the bulky *N*-TBDPS group would occur. Hence, the major products would arise from the transition state with the more favourable pseudo-equatorial orientation.[28] No explanation for the diastereoselectivity of the lithiation-trappings of *N*-Ts sulfoximine **6** with aldehydes was provided although it is conceivable that it proceeds *via* a similar transition state.
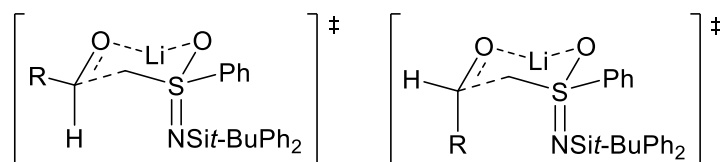
Figure 1.6 Transition states for trapping a lithiated sulfoximine with aldehydes

Esters and chloroformates have also been used as electrophiles in related lithiation-trappings. One example is the lithiation of *N*-Me sulfoximine **3** using LDA and subsequent trapping with ethyl isobutyrate, followed by heating at reflux for 12-35 h to give ketone **22** in 69% (Scheme 1.8).[31] In a related example, the lithiation-trapping of *N*-benzoyl sulfoximine **23** was performed with ethyl chloroformate enabling the installation of an ester functionality. This was carried out using LiTMP (generated from *n*-BuLi and tetramethylpiperidine) for the lithiation and subsequent trapping gave ester **24** in a high yield (89%) (Scheme 1.8).[32] In both examples, two equivalents of base were employed

presumably due to the acidity of the α-proton present in both the ketone and ester products.
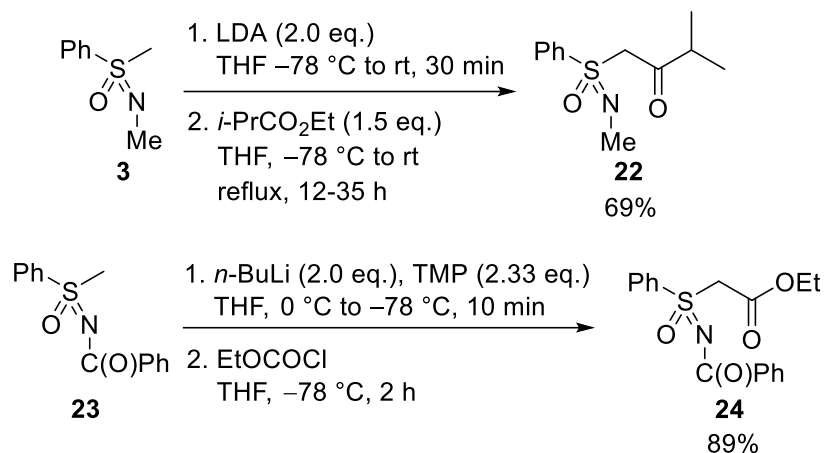
Scheme 1.8

Weinreb amides can also be used as electrophiles to install a ketone functionality into the product of the lithiation-trapping process. For example, lithiation of *N*-TBDPS sulfoximine **19** and trapping with Weinreb amide **25** gave ketone **26** in 84% yield (Scheme 1.9). The ketone product results from a nucleophilic addition to the carbonyl functionality. A substitution reaction displacing the bromide could also be expected to give the α-alkylated product, but this was not observed.[33]
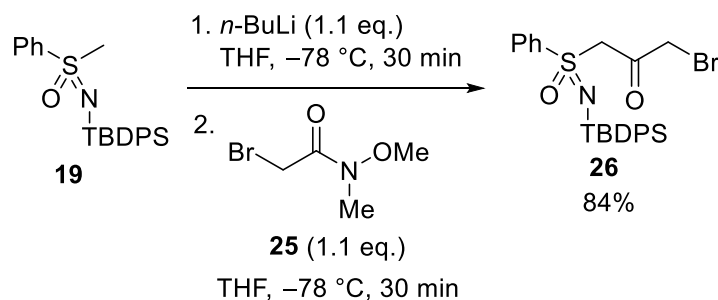
Scheme 1.9

Carboxylic acids can also be accessed *via* lithiation-trapping reactions with gaseous CO_2. For example, *N*-tolyl sulfoximine **27** underwent lithiation and trapping with CO_2 to give carboxylic acid **28** in 79% yield (Scheme 1.10). Changing the phenyl substituent to a mesitylene or pyridyl substituent gave respective yields of 42% and 61%.[34] Epoxides can also be used as electrophiles. Hwang reported the lithiation of *N*-TMS sulfoximine **15** using *n*-BuLi and trapping with gaseous ethylene oxide to give alcohol **29** in 75% yield (Scheme 1.10).[22]
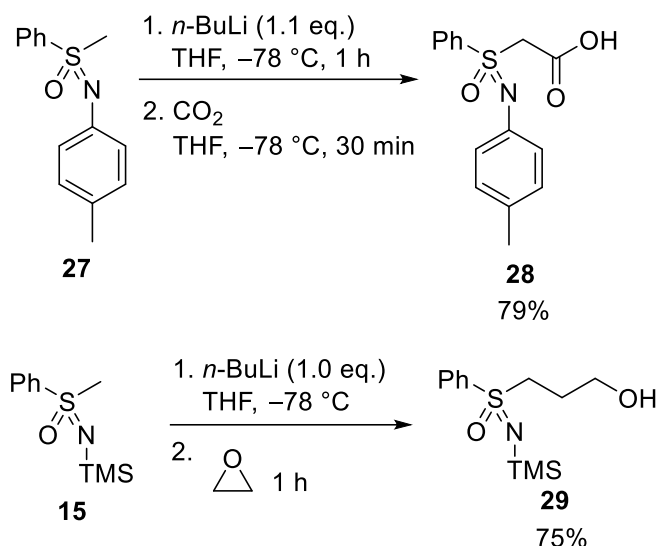
Scheme 1.10

It is also possible to install an enone functionality into the lithiation-trapping product. For example, the lithiation of *N*-Ts sulfoximine **6** and trapping with β-sulfonyl-enone **30** gave enone **31** in 83% yield (Scheme 1.11).[35] Presumably, conjugate addition of the lithiated sulfoximine to the Michael acceptor takes place to give intermediate **32**, followed by elimination of the benzenesulfinate group.
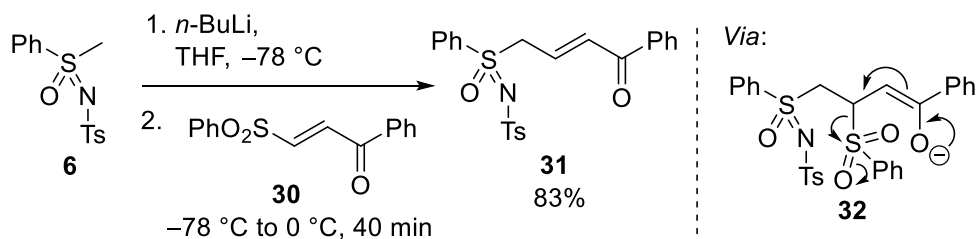
Scheme 1.11

Lithiation-trapping can also lead to diastereomeric products if the starting sulfoximine has a CH$_2$R substituent. For example, lithiation of *N*-Ts sulfoximines **33**, **34** and **35** and subsequent trapping with enones **36** and **37** gave Michael adducts **38**-**42** as reported by Pyne (Table 1.1). Lithiation of allylic sulfoximine **33** and trapping with enone **36** gave a 93:7 mixture of diastereomeric ketones *syn,anti*-**38** and **38** of unidentified stereochemistry in 90% yield (Entry 1). Similarly, trapping with enone **37** provided a 94:6 mixture in 69% yield (Entry 2). X-ray crystallography was used to determine the structure of the major diastereomeric ketone *syn,anti*-**38**, but that of the minor product was not reported. Lithiation of alkyl sulfoximine **34** and trapping with enone **36** gave a 98:2 mixture of diastereomeric ketones *syn,anti*-**40** and **40** in 68% yield (Entry 3). Similarly,

trapping with enone **37** gave a 96:4 mixture of *syn,anti*-**41** and **41** in 62% yield (Entry 4). Benzylic sulfoximine **35** yielded a 99:1 mixture of diastereomeric ketones *syn,anti*-**42** and **42** in 72% yield after lithiation and trapping with enone **36** (Entry 5). Preferential lithiation was observed at the benzylic position due to the increased stability of the resulting carbanion *via* delocalisation into the phenyl group. X-ray diffraction was also used to assign the relative stereochemistry of the major diastereomeric ketones *syn,anti*-**40** and *syn,anti*-**42**.[13]

Table 1.1 Lithiation-trapping of *N*-Ts sulfoximines **33**, **34** and **35** with various enones
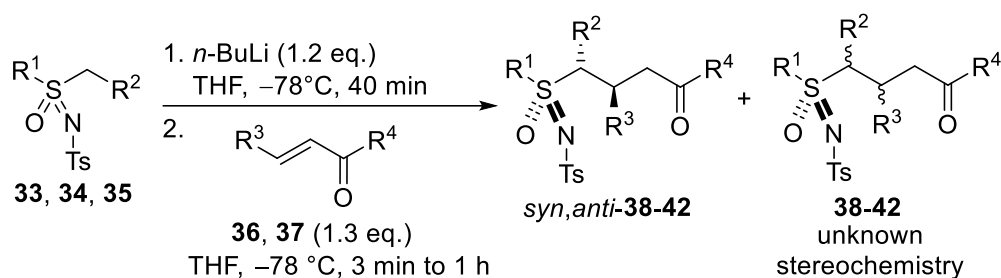
Entry	R^1	R^2	Starting material	R^3	R^4	Electrophile	dr	Product/%
1	Ph	CH=CH$_2$	**33**	Ph	Ph	**36**	93:7	**38**, 90
2	Ph	CH=CH$_2$	**33**	Me	Ph	**37**	94:6	**39**, 69
3	Ph	*n*-Pr	**34**	Ph	Ph	**36**	98:2	**40**, 68
4	Ph	*n*-Pr	**34**	Me	Ph	**37**	96:4	**41**, 62
5	Me	Ph	**35**	Ph	Ph	**36**	99:1	**42**, 72

To explain the observed *syn,anti*-stereochemistry of the major product, a transition state structure was proposed (Figure 1.7). The transition state describes the orientation of the R^2 and bulky Ts substituents of the lithiated sulfoximine as *anti*. The approach of the electrophile then takes place from the top face of the lithiated sulfoximine, and subsequent chelation of the sulfoximine nitrogen and oxygen atoms as well as the enone oxygen by lithium occurs. R^4 and the sulfonimidoyl are depicted in an *anti*-orientation to minimise steric hindrance.
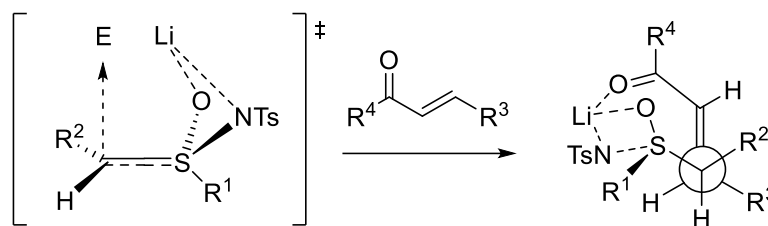
Figure 1.7 Proposed transition state for the lithiation-trapping of *N*-Ts sulfoximines **33**, **34** and **35** with enones **36** and **37**

Pyne also described the addition of both ketones and imines to lithiated *N*-TBDPS sulfoximines to yield the corresponding alcohol and amine products.[36,37] For example, *N*-TBDPS sulfoximine **43** was lithiated and trapped with benzaldehyde giving a 48:26:10:16 mixture of diastereomeric alcohols *syn,syn*-**44**, *anti,anti*-**44**, *anti,syn*-**44** and *syn,anti*-**44** in a 95% yield (Scheme 1.12). When benzaldehyde was precomplexed with boron trifluoride-diethyl ether prior to its addition to the lithiated sulfoximine, better diastereoselectivity (67:28:1:4 dr) was obtained. Trapping with imine **45** gave a 60% yield of a 79:21 mixture of diastereomeric amines *syn,anti*-**46** and **46**. Precomplexing the imine with boron trifluoride-diethyl ether provided a higher diastereoselectivity (95:5) and high yield (86%). Lithiation-trappings of the analogous *N*-TBDMS sulfoximines were shown to give lower diastereoselectivity.
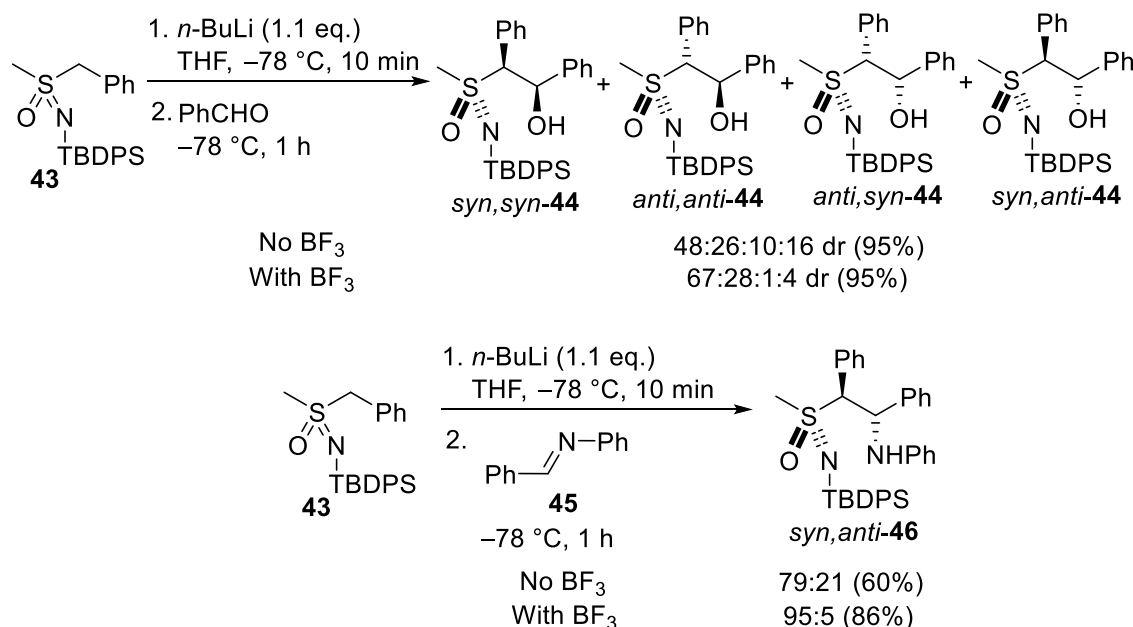
Scheme 1.12

The observed stereochemistry for the major diastereomeric alcohol *syn,syn*-**44** was explained by the transition state model shown in Figure 1.8. The benzylic position was

depicted as close to planar, and the phenyl substituent was shown as *anti* to the bulky TBDPS group. The aldehyde would then add to the top face to minimise steric hindrance in which the aldehyde substituent is orientated *anti* to the phenyl substituent. It was speculated that the minor diastereomeric alcohols *anti*,*syn*-**44** and *syn*,*anti*-**44** could arise from a chelated chair transition state. The yield of these diastereomers decreased when benzaldehyde was precomplexed with boron trifluoride-diethyl ether, supporting this theory. A similar transition state was proposed for the formation of major diastereomeric amine *syn*,*anti*-**46**, where the approach of imine **45** was dictated by unfavourable interactions between the *N*-Ph and sulfoximine Ph substituents. An alternative model for amine *syn*,*anti*-**46** was presented by Pyne in the literature initially,[36] however this was updated later in a review.[37] This thesis discusses the model and subsequent stereochemistry reported in the review. The resulting stereochemistry of alcohol *syn*,*syn*-**44** and amine *syn*,*anti*-**46** differed at the β-position. However, the stereochemistry at the α-position was consistent with that obtained for major diastereomeric *N*-Ts sulfoximines *syn*,*syn*-**38-42** in a related example (see Table 1.1).
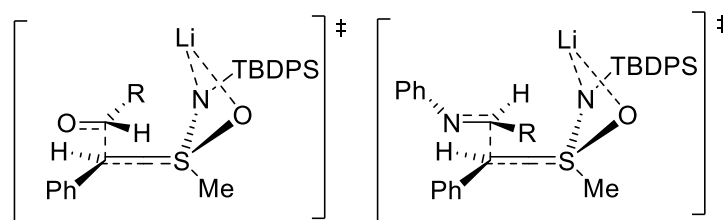
Figure 1.8 Proposed transition states for the addition of benzaldehyde and imine **45** to the lithiated *N*-TBDPS sulfoximine

Zhang investigated the lithiation of *N*-Ts α-fluoro sulfoximine **47** and subsequent trapping with MeI which formed a single diastereomeric sulfoximine **48** (Scheme 1.13).[38] The fluorination of *N*-Ts sulfoximine **49** was also carried out *via* lithiation-trapping with NFSI to give fluorinated sulfoximine **48** in 69% but, unfortunately, the diastereoselectivity was not reported in this case.[39]
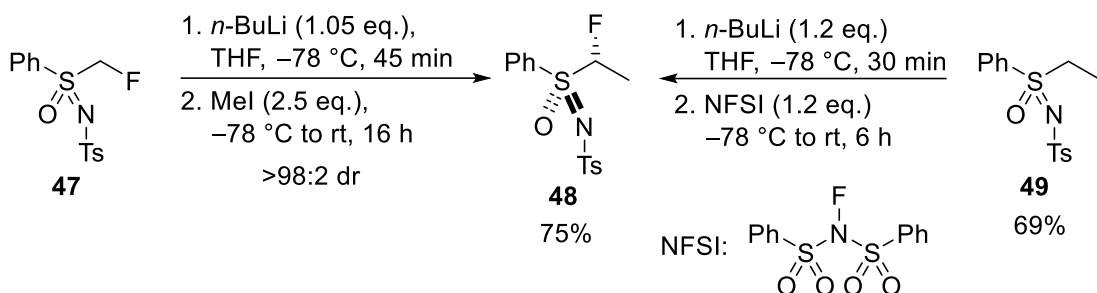
Scheme 1.13

In a related example, the lithiation-trapping of *N*-Ts sulfoximine **50** with MeI gave a mixture of diastereomeric alcohols **51** in 55% yield (Scheme 1.14). Two equivalents of *n*-BuLi were required due to the presence of the hydroxyl group. Unfortunately, no explanation of the diastereoselectivity or assignment of stereochemistry was provided.[35] Gais and Mahajan carried out the lithiation-trapping of *N*-Me sulfoximine **52** with allyl bromide to give the α-functionalised product as a 77:23 mixture of diastereomeric sulfoximines **53** in 80% yield. Similarly, no comment was made regarding the stereochemistry in this example.[40]
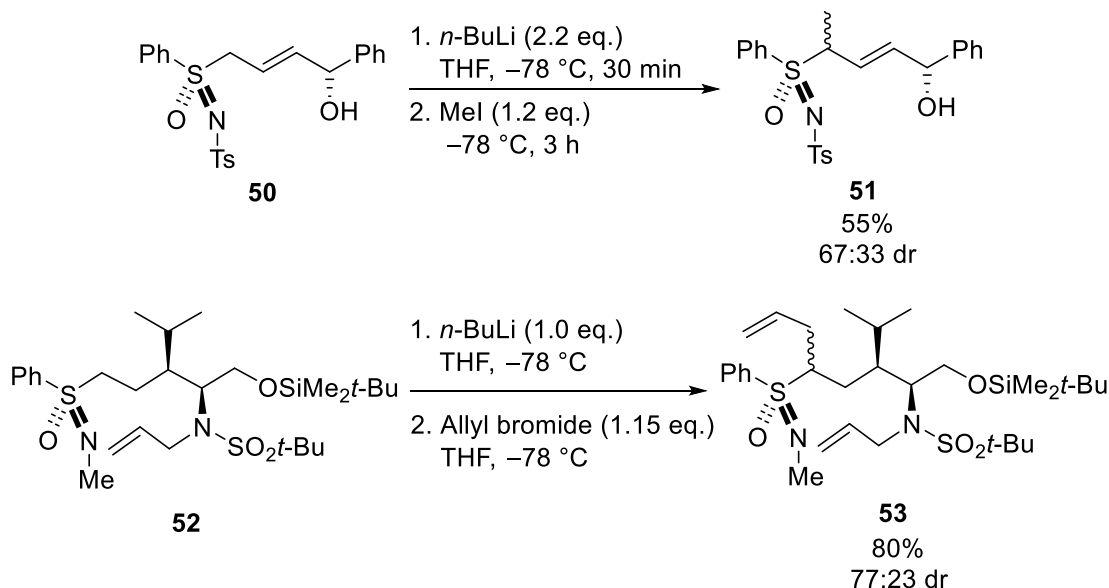
Scheme 1.14

In a similar example, *N*-Me sulfoximine **54** was lithiated and trapped with MeI which gave an 83:17 mixture of diastereomeric sulfoximines *syn,syn,anti,anti*-**55** and *anti,anti,anti,anti*-**55** (Scheme 1.15). Two equivalents of *n*-BuLi were employed to ensure the production of the dilithiated sulfoximine. Purification afforded *syn,syn,anti,anti*-**55** in 75% yield and a mixture of *anti,anti,anti,anti*-**55** and starting material **54**.[41]
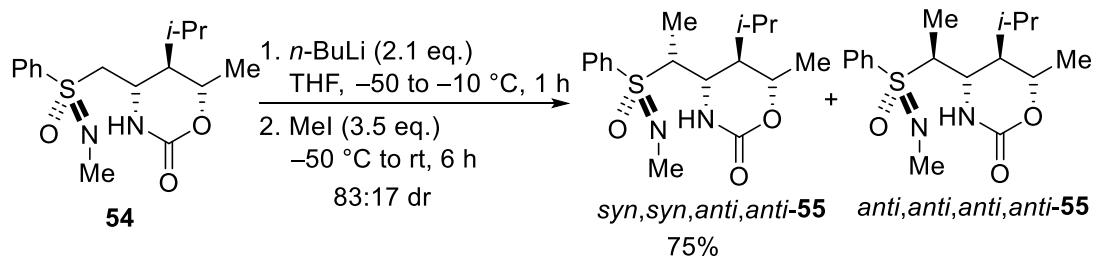
Scheme 1.15

The stereochemistry of *syn,syn,anti,anti*-**55** was assigned by X-ray crystallography. By analysis of the ^{1}H NMR spectrum and NOE experiments, it was determined that the adopted structure of the lithiated sulfoximine in solution was similar to that in the solid-state. Therefore, to explain the stereochemical outcome, a transition state structure was proposed where the phenyl sulfoximine substituent adopted a pseudoaxial orientation (Figure 1.9). The diastereoselectivity is thought to arise from the sterically demanding *i*-Pr substituent encouraging a preferential electrophilic attack from the opposing face.
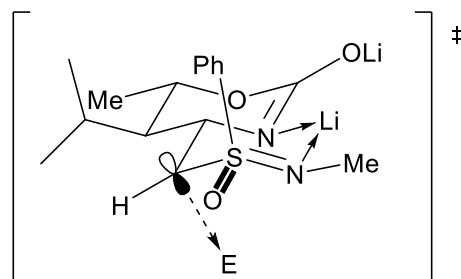
Figure 1.9 Proposed transition state for the lithiation-trapping of *N*-Me sulfoximine **54**

Lithiation of *N*-Me sulfoximine **56** and trapping with tosylate **57** gave sulfoximine **58** in 68% yield and a high dr (>98%) (Scheme 1.16). Trapping of the same lithiated sulfoximine with ditosylate **59** gave cyclised sulfoximine **60** in 75% and >98% dr. An excess of *n*-BuLi was presumably employed due to the acidic NH proton within the starting sulfoximine and the high diastereoselectivity was controlled by the bulky α-substituent within this starting sulfoximine.[42]
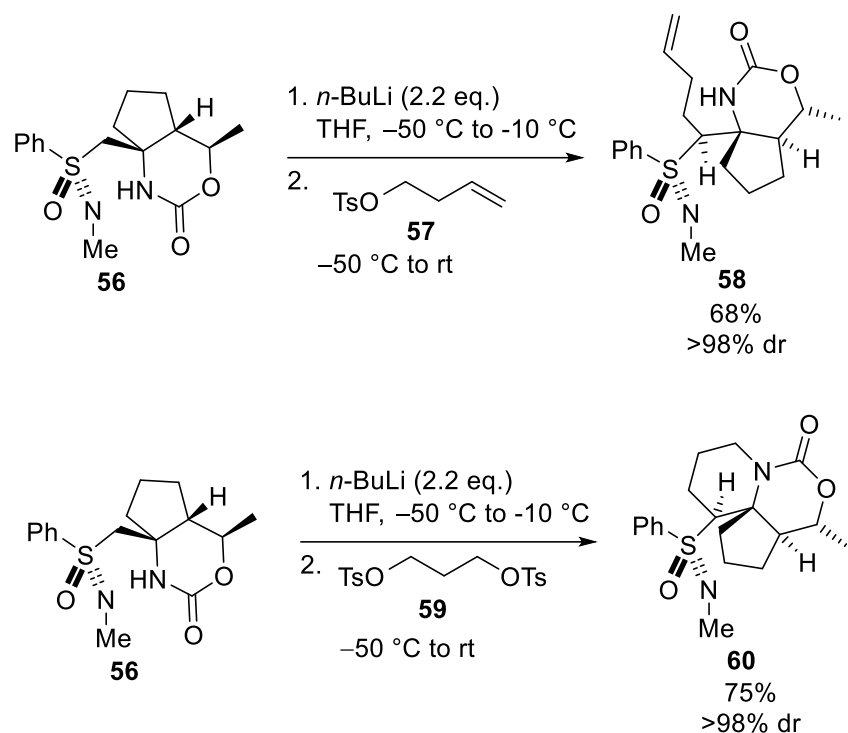
Scheme 1.16

To summarise, the lithiation-trapping reactions of a range of acyclic sulfoximines have been well explored and established, with the examples described in this chapter employing a range of substrates, electrophiles and *N*-substituents. Some diastereoselective lithiation-trappings have been carried out and, in many of these examples, the starting sulfoximine contains at least one additional stereogenic centre, which will no doubt influence the diastereoselectivity. Zhang and Pyne have reported three highly diastereoselective reactions (see Table 1.1 and Scheme 1.12), but only a few electrophiles and substrates were employed. In addition, Pyne has proposed different transition state models to explain the diastereoselectivity of these reactions (see Figures 1.7 and 1.8).

1.3 α-Functionalisation of Sulfoximines by Lithiation-Trapping – Previous Work within the Group

Previous work on the α-functionalisation of *N*-functionalised sulfoximines *via* lithiation-trapping has been performed in our group[43] and has inspired many of the project aims detailed in this thesis. The 5-membered and 6-membered cyclic sulfoximines were chosen due to limited associated research. *N*-TBDPS sulfoximines were selected due to their frequency in similar studies,[23,24,28,36,37] but other *N*-functionalised sulfoximines were investigated including those containing *N*-Boc, *N*-CN and *N*-Me groups.

It was found that *N*-TBPDS functionalised 5- and 6-membered cyclic sulfoximines **61** and **62** exhibited high yields and diastereoselectivity from lithiation-trappings with a range of electrophiles. Two examples, each trapping with benzophenone, are shown in Scheme 1.17. *n*-BuLi was used to deprotonate sulfoximines **61** and **62** in THF at −78 °C for 20 min. Then, benzophenone was added and reacted for 1 h to yield the α-functionalised sulfoximines *cis*-**63** (66%) and *cis*-**64** (59%) (Scheme 1.17). These experimental conditions used were adapted from various literature procedures[23,33,36] and were employed for most lithiation-trappings of sulfoximines within the group.
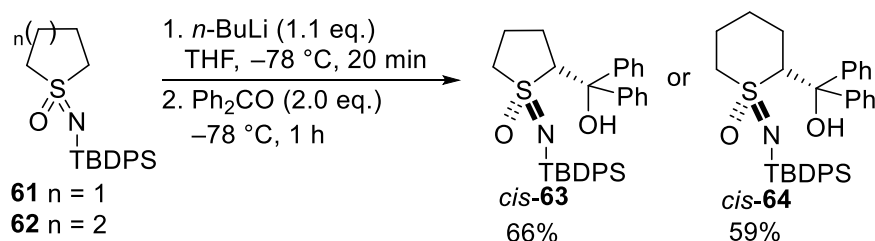
Scheme 1.17

The associated stereochemistry of *cis*-**63** and *cis*-**64** was assigned using X-ray crystallography, where the new α-substituent was shown to be *cis* to the sulfoximine oxygen. The proposed model for the high diastereoselectivity is shown in Figure 1.10. It is believed that the bulky TBDPS group blocks one face from electrophilic attack of the sp^2 hybridised carbanion and, as a result, the newly formed α-substituent forms *cis* to the sulfoximine oxygen atom.
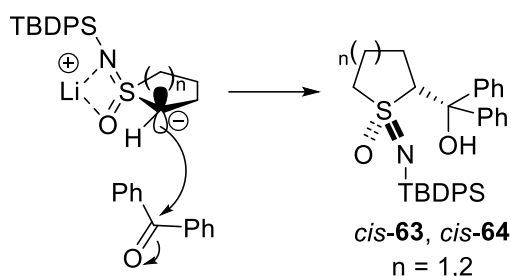
Figure 1.10 Proposed model for electrophilic trapping of cyclic sulfoximines

Lithiation-trapping of 5-membered sulfoximine **61** with benzyl bromide gave benzyl sulfoximine *cis*-**65** in 65% yield and disubstituted sulfoximine *cis,cis*-**66** in 13% yield.[44] The analogous reaction with 6-membered sulfoximine **62** provided *cis*-**67** in only 31% yield. This was because a significant amount (33%) of double-trapped sulfoximine *cis,cis*-**68** was formed (Scheme 1.18).
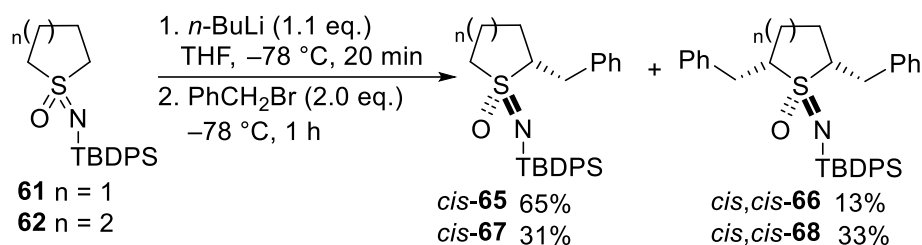
Scheme 1.18

These double-trapped products are proposed to be a result of the slow trapping process with alkyl halides, therefore allowing a second deprotonation and trapping. An example of the proposed mechanism is shown in Scheme 1.19 for the lithiation-trapping of sulfoximine **62**. It is thought that initially the reaction proceeds as expected to give mono-trapped sulfoximine *cis*-**67**. Sulfoximine *cis*-**67** can then be deprotonated at the other, less sterically hindered, α-position by residual lithiated sulfoximine **69**. Finally, lithiated monosubstituted sulfoximine *cis*-**70** can react with another molecule of benzyl bromide to yield disubstituted sulfoximine *cis,cis*-**68**. A similar effect was reported by Füger and Bolm (see Scheme 1.5), where disubstitution took place at the α-position with an alkenyl bromide.[25]

19
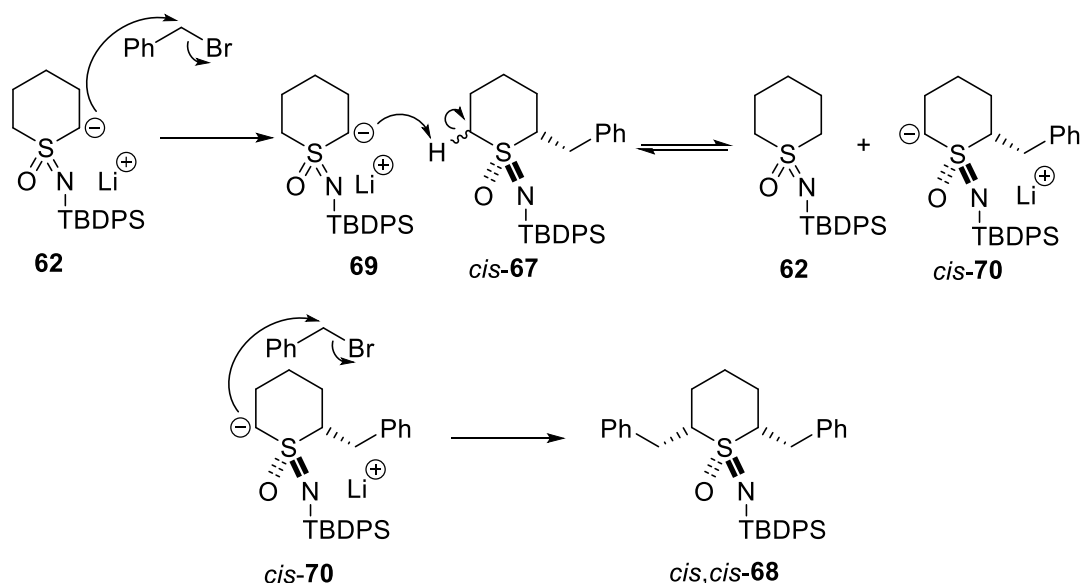
Scheme 1.19

Benzaldehyde was employed as the electrophile in some examples. For example, lithiation-trapping of 5-membered *N*-TBDPS sulfoximine **61** gave full stereocontrol at the α-position and an 85:15 dr corresponding to the β-position (Scheme 1.20). Both diastereomeric alcohols were separated in good yields (66% for *cis,anti*-**71** and 10% for *cis,syn*-**71**). Lithiation-trapping of 6-membered *N*-TBDPS sulfoximine **62** gave *cis,anti*-**72** and *cis,syn*-**72** (isolated as an 85:15 mixture in 73% yield).
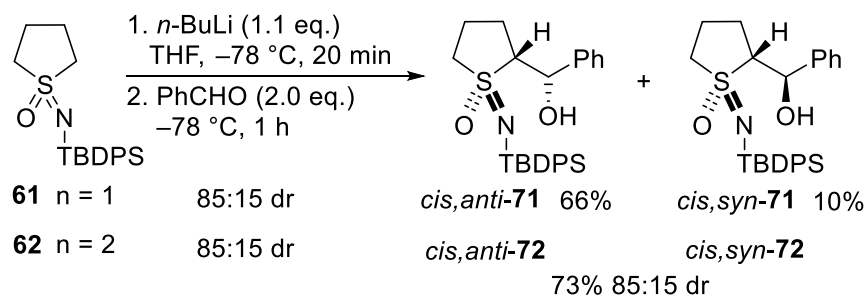
Scheme 1.20

Weinreb amides were used as the electrophile to install a ketone functionality. Examples included the lithiation-trappings of *N*-TBDPS sulfoximines **61** and **62** with Weinreb amide **73** to give the corresponding diastereomeric ketones **74** and **75**, both in a 75:25 dr (Scheme 1.21). The low diastereoselectivity was unexpected and repeats of the reaction with 5-membered sulfoximine **61** gave varying diastereomeric ratios (55:45 dr and 65:35 dr). This was rationalised by proposing that during the work-up and/or the chromatographic purification, epimerisation occurred *via* enolisation due to the acidity of the α-proton in the ketone products.
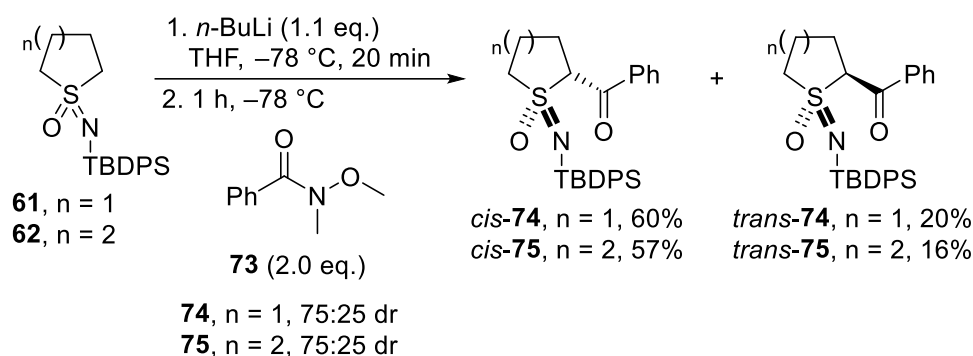
Scheme 1.21

In some cases, it was shown that further functionalisation of the lithiation-trapping products could be carried out on the less sterically hindered α-position to afford disubstituted sulfoximines. For example, lithiation of α-methyl functionalised sulfoximines *cis*-**76** and *cis*-**77** and trapping with benzophenone gave disubstituted sulfoximines *cis*,*cis*-**78** and *cis*,*cis*-**79** in yields of 71% and 81% (Scheme 1.22).
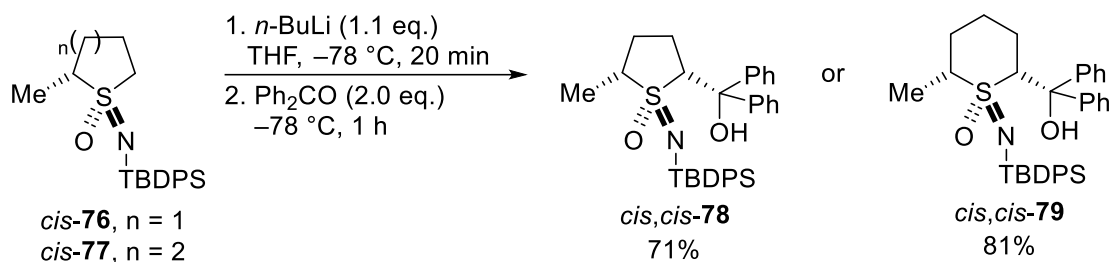
Scheme 1.22

As part of the study, some other *N*-functionalised sulfoximines were investigated including those with *N*-Boc, *N*-Me and *N*-CN groups attached. The results with *N*-Me and *N*-CN sulfoximines were less successful. Some examples of lithiation-trappings of cyclic *N*-Boc sulfoximines **80** and **81** are summarised in Table 1.2. Lithiation of *N*-Boc sulfoximines **80** and **81**, followed by trapping with benzophenone gave single diastereomeric alcohols *cis*-**82** and *cis*-**83** respectively (isolated in 71% and 75% yields) (Entries 1 and 2). Lithiation-trappings with benzyl bromide gave 85:15 and 65:35 mixtures of diastereomeric alcohols *cis*-**84** and *trans*-**84** (isolated in 85% yield) and **85a** and **85b** (isolated in 45% yield) (Entries 3 and 4). This diastereoselectivity with benzyl bromide was lower than that observed for analogous *N*-TBDPS sulfoximines *cis*-**65** and *cis*-**67** (≥95:5).

Table 1.2 Synthesis of α-functionalised *N*-Boc sulfoximines
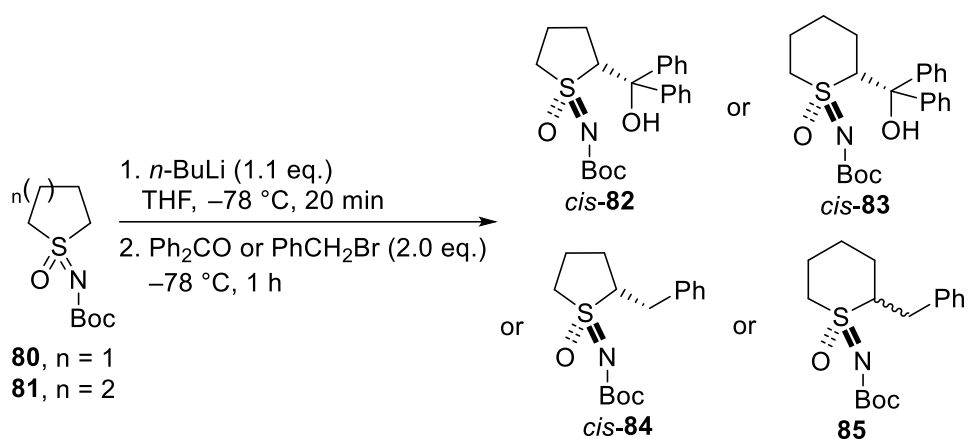
Entry	n	Starting material	Electrophile	dr	Product/%
1	1	**80**	Ph₂CO	≥95:5	*cis*-**82**, 71
2	2	**81**	Ph₂CO	≥95:5	*cis*-**83**, 75
3	1	**80**	Benzyl bromide	85:15	*cis*-**84**, *trans*-**84**, 85[a]
4	2	**81**	Benzyl bromide	75:25	**85a**, **85b**, 45[b]

[a] Isolated as an 85:15 mixture of *cis*-**84** and *trans*-**84**. [b] Isolated as a 75:25 mixture of diastereomers.

Two *N*-TBDPS acyclic sulfoximines (**86** and **87**) were also lithiated and trapped with benzophenone to give alcohols **88** and **89** in 73% and 70% yields respectively (Scheme 1.23). Lithiation-trapping of *N*-TBDPS diethyl sulfoximine **86** gave a single diastereomer, whereas *N*-TBDPS phenyl ethyl sulfoximine **87** gave an 85:15 dr, although the minor diastereomer was not isolated during column chromatography. The stereochemistry of these products was not determined.
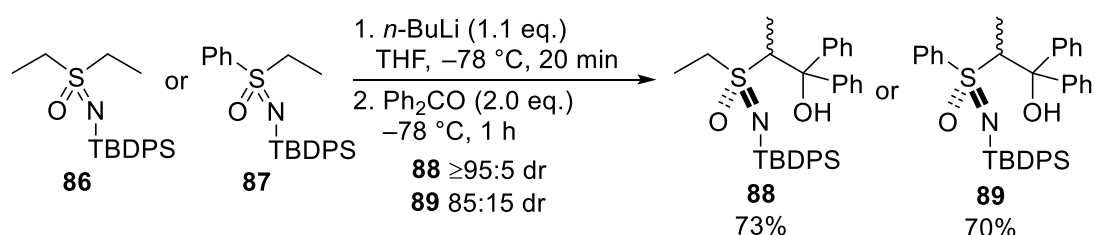
Scheme 1.23

1.4 Project Outline

Over recent years, sulfoximines have received increased attention as potential medicinal and pesticidal compounds. Therefore, it is important to develop effective and selective methodology for the installation of the sulfoximine unit and its subsequent functionalisation. Novel methodology for the diastereoselective α-functionalisation *via* lithiation-trapping of some cyclic sulfoximines has been developed previously within our group.[43] It was planned that this project would focus on the diastereoselective lithiation-trappings of acyclic sulfoximines **90**, to give the corresponding α-substituted products **91**, *via* reactions that have received limited attention previously. It was decided that a range of acyclic sulfoximines and electrophiles would be used and their effect on the yield and diastereoselectivity would be investigated (Scheme 1.24). Previous work within the group had shown that *N*-TBDPS cyclic sulfoximines provided high diastereoselectivity, and, therefore, *N*-TBDPS acyclic sulfoximines would be the main focus of this work. It was also planned that some other nitrogen substituents would be investigated including *N*-TBDMS and *N*-Boc groups. The results of these investigations are presented in Chapters 2.1 and 2.2.

R^1 = Me, Et, Ph, *i*-Pr, *t*-Bu
R^2 = Me, Bn, Ph
R^3 = TBDPS, TBDMS, Boc
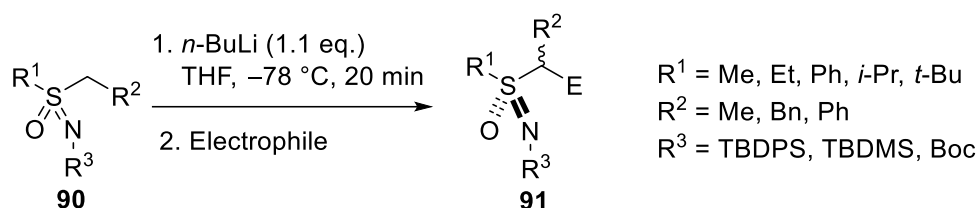
Scheme 1.24

It was thought that some of the α-functionalised sulfoximines **91** could provide a scaffold for the synthesis of some tetrasubstituted sulfoximines. Therefore, we planned to further functionalise α-functionalised sulfoximines **92** to give tetrasubstituted products **93** using similar lithiation-trapping conditions (Scheme 1.25). This would be carried out with a range of electrophiles to investigate the yield and diastereoselectivity. The results of these studies are presented in Chapter 2.3.
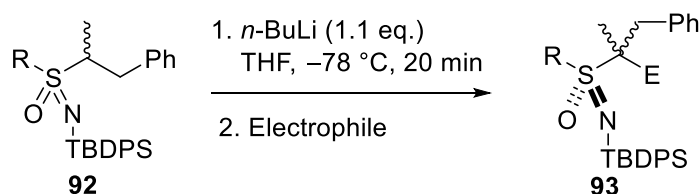
Scheme 1.25

2. Results and Discussion

2.1 Synthesis of Sulfoximines

To enable the planned lithiation-trapping investigations, it was necessary to synthesise several acyclic sulfoximines. The majority of examples contained the *N*-TBDPS group but one *N*-Boc and *N*-TBDMS example were also included. For these syntheses, based on the route used previously in the group for the synthesis of cyclic sulfoximines, a two-step approach was chosen (Scheme 2.1). The first of these two steps, as reported Luisi, Bull and co-workers,[45,46] is a one-pot synthesis of NH sulfoximines **95** from the corresponding sulfides **94**. Following this, the desired nitrogen protecting group would be installed.
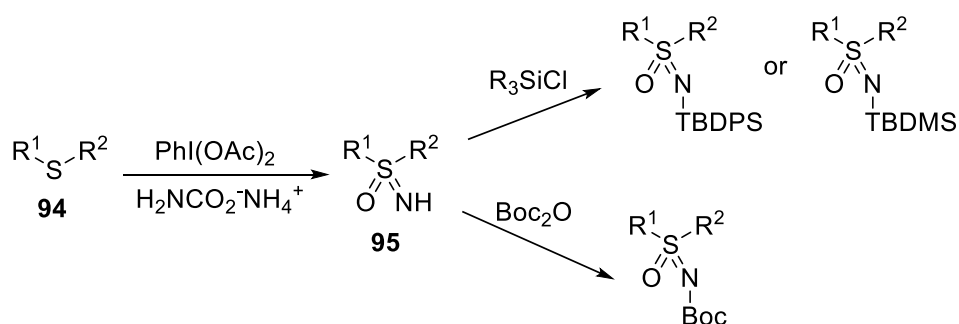
Scheme 2.1

In 2017, Luisi, Bull and co-workers reported a convenient method for the synthesis of NH sulfoximines from sulfides.[46] This methodology presents much milder experimental conditions and better safety aspects, by avoiding metal-containing or explosive reagents, e.g. azides, than the previous methods.[47-49] The conditions utilise PIDA (2.5 eq.) as the oxidising agent and ammonium carbamate (2.0 eq.) as the source of ammonia. Three representative examples are shown in Scheme 2.2. Methanol was found to be a better solvent than toluene and acetonitrile, giving the shortest reaction time (3 h) whilst also maintaining good yields. Subsequently, Reboul *et al.* carried out mechanistic studies on this reaction and they proposed several mechanistic pathways proceeding *via* an iodonitrene species.[50]
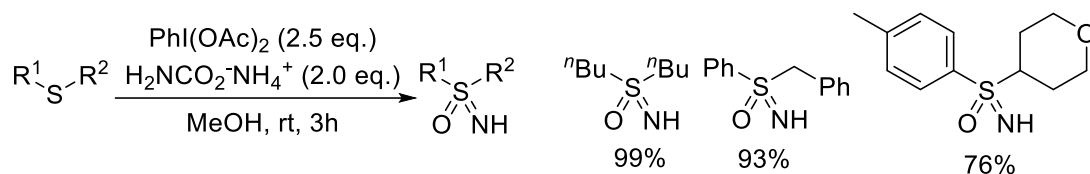
Scheme 2.2

As a starting point, the synthesis of *N*-TBDPS diethyl sulfoximine **86** was performed using this two-step approach. Treatment of diethyl sulfide **96** with PIDA (2.5 eq.) and ammonium carbamate (2.0 eq.) in methanol at rt for 3 h gave NH sulfoximine **97** in 92% yield after purification (Scheme 2.3). ^{1}H NMR spectroscopy showed the expected signals of the ethyl substituents alongside a 1H broad singlet at δ_H 2.42 indicating the presence of the newly formed NH group. NH sulfoximine **97** was reported in the literature and the data obtained matched the NMR spectroscopic data reported.[51] Using a literature procedure,[52] subsequent treatment with TBDPSCl (1.25 eq.) and imidazole (2.0 eq.) in DMF initially at 0 °C and then at 90 °C for 48 h, followed by column chromatography, gave *N*-TBDPS sulfoximine **86** in 80% yield (Scheme 2.3). The incorporation of the TBDPS group was confirmed by ^{1}H NMR spectroscopy, in which a 9H singlet was observed at δ_H 1.07.
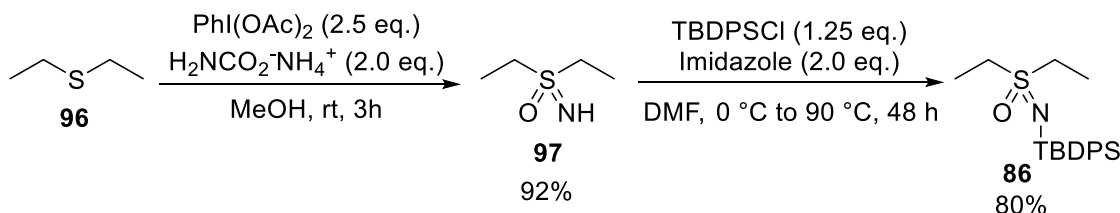
Scheme 2.3

A series of *N*-TBDPS sulfoximines were then produced using this methodology (Scheme 2.4, yields reported for each step). The range of examples illustrates the broad scope of this methodology, where different alkyl and aryl containing substrates are tolerated. For the TBDPS protection, the literature method reports the addition of TBDPSCl to the reaction mixture at 0 °C and sulfoximines **87**, **19**, **104** and **105** were synthesised using these conditions. To investigate whether the cooling step was required, the synthesis of sulfoximines **104** and **105** was repeated with the addition of all reagents at rt, giving higher yields (91% and 76%) than previously (46% and 73% respectively). *N*-TBDPS sulfoximines **106** and **107** were therefore synthesised using these modified conditions.
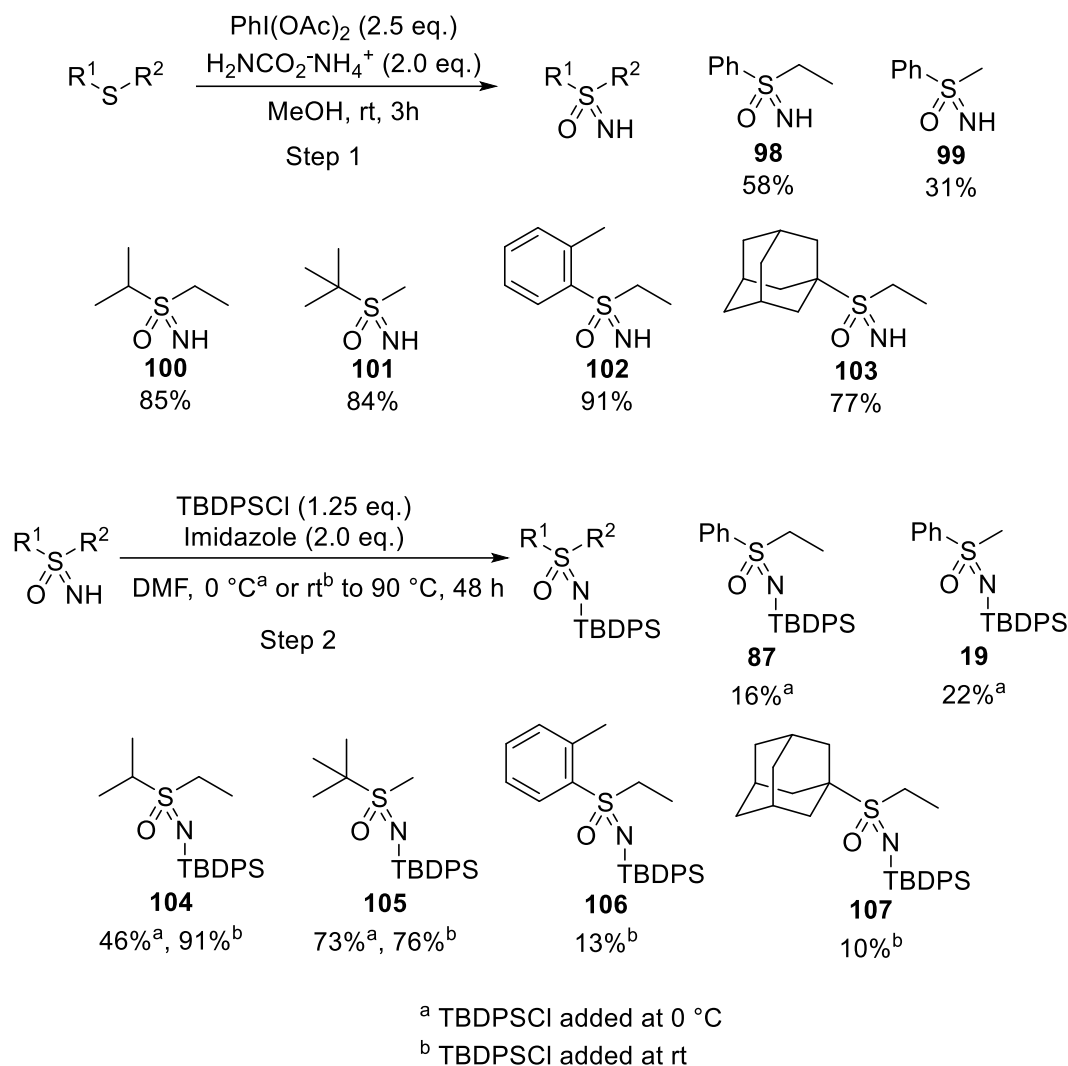
Scheme 2.4

The yields in Scheme 2.4 were variable and substrate-dependent. For some sulfoximines, low yields arose due to difficult separation of the product from either TBDPSCl or TBDPSOH. To try to combat this, TBDPSCl was used as the limiting reagent (0.9 eq.) and, as previously discussed, added to the reaction mixture at rt, in the synthesis of *N*-TBDPS sulfoximines **110** and **43** (Scheme 2.5). However, this did not significantly improve the purification in these cases and unreacted TBSPSCl or TBDPSOH was still observed in the ^{1}H NMR spectra of the crude products.
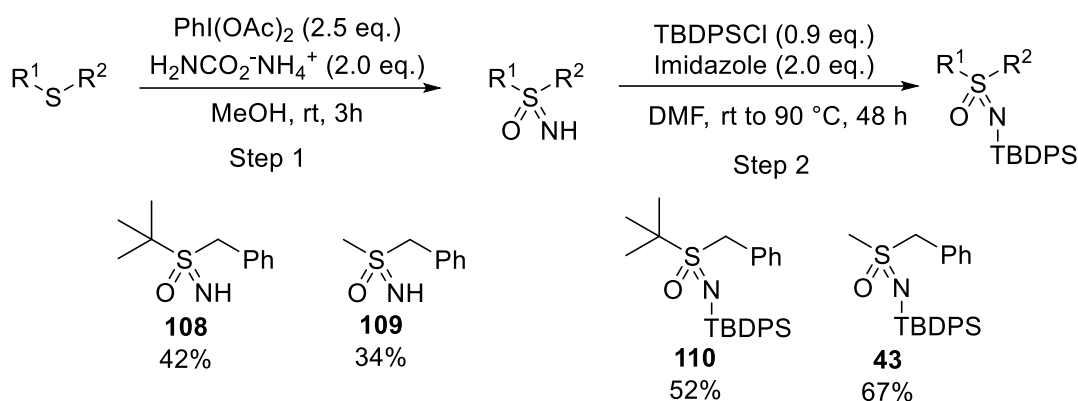
Scheme 2.5

NH sulfoximines **98**, **99**, **101** and **109** were known and the NMR spectroscopic data matched those reported in the literature.[50,53] ^{1}H and ^{13}C NMR spectroscopic data of *N*-TBDPS sulfoximine **19** were also consistent to those reported in the literature.[54] *N*-TBDPS sulfoximine **43** was synthesised by Pyne, but no spectroscopic data was provided.[37] All of the other NH and *N*-TBDPS sulfoximines had not been reported previously (see Schemes 2.4 and 2.5).

For sulfoximines **106**, **107** and **110**, the sulfides required to synthesise the desired *N*-TBDPS sulfoximines were not commercially available and, therefore, they were prepared from their corresponding thiols. Sulfides **113** and **114** were synthesised using a literature procedure employing KOH, ethyl bromide and Aliquat 336® as a phase transfer catalyst. High yields were obtained (Scheme 2.6).[55] For sulfide **113**, the ^{1}H and ^{13}C NMR spectroscopic data were reported in the literature[56] and for sulfide **114**, the ^{1}H NMR data was provided.[57] In both cases, the obtained spectroscopic data was consistent to the literature data. Sulfide **116** was prepared using a similar approach from the literature.[58] *t*-Butyl thiol **115** was treated with KOH and benzyl bromide followed by heating at reflux for 16 h to give sulfide **116** in 99% yield (Scheme 2.6). The ^{1}H NMR spectroscopic data of sulfide **116** matched that reported in the literature.[58,59]
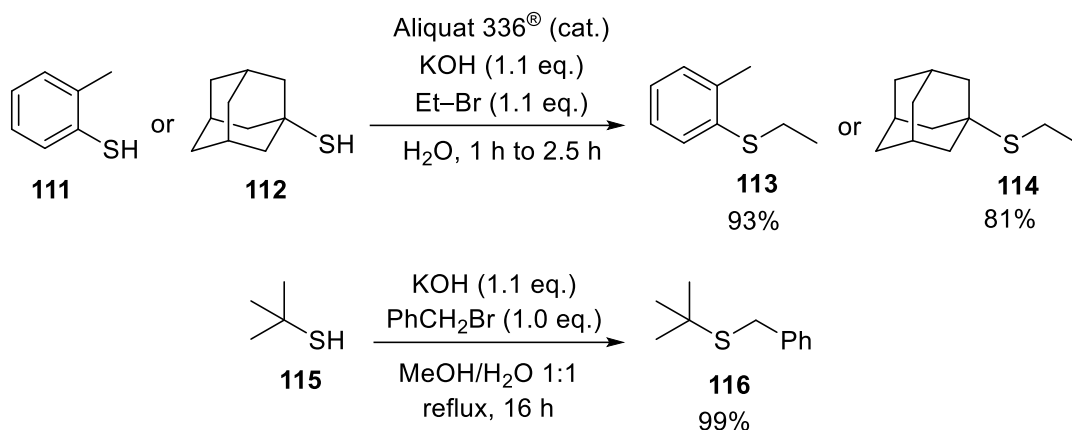
Scheme 2.6

In some cases, the required sulfide was not commercially available and the best approach was to synthesise the desired starting sulfoximine *via* functionalisation of an existing *N*-TBDPS sulfoximine using lithiation-trapping. This was performed for the synthesis of sulfoximines **117**, **118** and **119**. Sulfoximines **19** and **105** were initially treated with *n*-BuLi (1.1 eq.) in THF at −78 °C followed by the addition of either methyl iodide or benzyl bromide and stirred for 1 h. This delivered yields of 82–93% (Scheme 2.7).
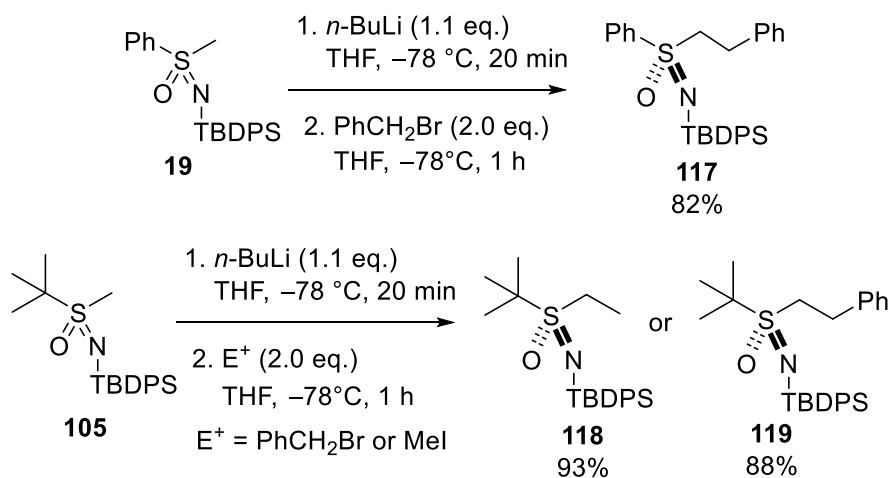
Scheme 2.7

Previous results within the group suggested that the TBDPS group offers good control on the diastereomeric outcome. However, compounds with two other protecting groups (*N*-Boc and *N*-TBDMS) were also synthesised for comparison. Sulfoximine **97** was treated with KO*t*Bu and then Boc₂O, using a literature procedure,[60] to give *N*-Boc sulfoximine **120** in low yield (14%) (Scheme 2.8). A repeat provided a consistently low yield (12%) indicating that further optimisation is necessary.
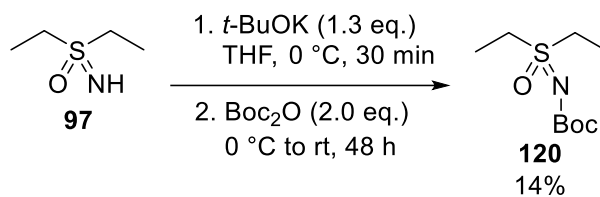
Scheme 2.8

A TBDMS group was installed onto sulfoximine **98** in an attempt to improve the yields obtained when synthesising *N*-TBDPS sulfoximines from some aromatic sulfides. Two reactions were employed from the literature for acyclic sulfoximines.[24,61] Reaction of NH sulfoximine **98** with TBDMSCl in pyridine or in DMF with added imidazole, both at rt for 12 h, gave *N*-TBDMS sulfoximine **121** in the same high (87%) yield (Scheme 2.9). These yields improved on the analogous reactions for *N*-TBDPS installation (see Scheme 2.4) and required milder reaction conditions and shorter reaction times.
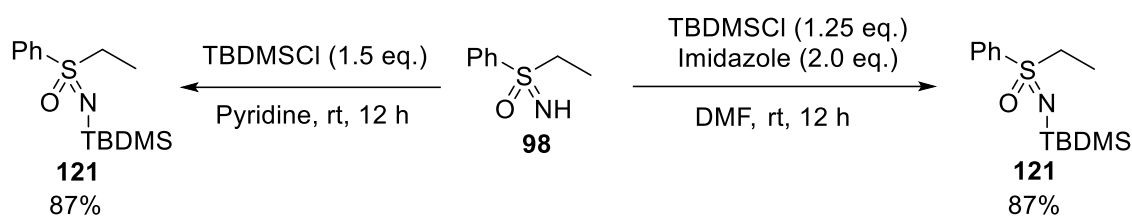
Scheme 2.9

To summarise, a range of NH sulfoximines were synthesised from their corresponding sulfides using a convenient one-pot procedure. A series of *N*-functionalised sulfoximines were then prepared with *N*-TBDPS, *N*-TBDMS and *N*-Boc groups. When the desired sulfide was commercially unavailable, the corresponding thiol was employed in its synthesis, or alternatively, the *N*-TBDPS sulfoximine was functionalised at the α-position *via* lithiation-trapping with *n*-BuLi and an electrophile.

2.2 Lithiation-Trapping of Sulfoximines

Following the synthesis of a range of acyclic *N*-TBDPS sulfoximines and some examples of *N*-TBDMS and *N*-Boc sulfoximines, a variety of lithiation-trapping reactions were then carried out to yield the α-functionalised products. A range of electrophiles would be explored for these lithiation-trapping reactions and the impact on the associated yields and diastereoselectivity would be investigated.

2.2.1 Lithiation and Trapping of Sulfoximines with Carbonyl-Containing Electrophiles

Initially, the lithiation-trapping of *N*-TBDPS diethyl sulfoximine **86** was explored using benzophenone as the electrophile, as this had previously been performed within the group. The selected methodology was therefore carried out as per the previous work in the group (see Chapter 1.3). *N*-TBDPS diethyl sulfoximine **86** was initially treated with *n*-BuLi in THF at −78 °C for 20 min, and then trapped with benzophenone to give α-functionalised *N*-TBDPS sulfoximine *anti*-**88** in a high yield (71%) following purification by column chromatography (Scheme 2.10). The result agrees with previous work,[43] where *anti*-**88** was obtained in a similar yield (73%) (see Scheme 1.23).
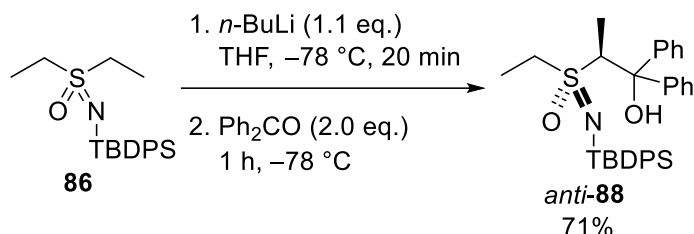
Scheme 2.10

The ^{1}H NMR spectra of both the crude and purified product demonstrated that only one diastereomer was produced since only one set of signals was observed. The 1H signal at δ$_H$ 4.20 (q, *J* = 7.0 Hz) was assigned to the α-proton next to the newly installed alcohol unit and exhibited a much higher chemical shift than the two diastereotopic α-protons at δ$_H$ 2.19 (dq, *J* = 14.0, 7.0 Hz) and δ$_H$ 1.69 (dq, *J* = 14.0, 7.0 Hz) (Figure 2.1). The 1H singlet at 6.31 was assigned to the OH environment. These spectra and subsequent analysis were consistent with those obtained from the previous work in the group.[43] The stereochemistry of *N*-TBDPS sulfoximine *anti*-**88** was assigned by an independent synthesis from a compound of known stereochemistry (*vide infra*).
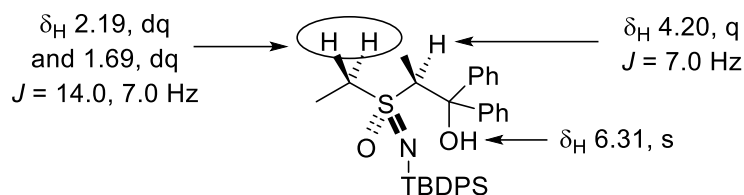
Figure 2.1 ^{1}H NMR spectroscopic data for *N*-TBDPS diethyl sulfoximine **88**

Due to this high observed diastereoselectivity and yield, other *N*-TBDPS acyclic sulfoximines were investigated to explore the scope of this methodology (Table 2.1). Lithiation of *t*-Bu-substituted sulfoximines **118** and **119** and trapping with benzophenone provided single diastereomeric alcohols *anti*-**122** and *anti*-**123** in 92% and 87% yields respectively (Entries 1 and 2). A similar outcome was obtained with adamantyl ethyl sulfoximine **107** which gave alcohol *anti*-**124** in 76% yield (Entry 3). Phenyl-substituted sulfoximines **87** and **117** and *i*-Pr-substituted sulfoximine **104** all gave a crude product which contained an 85:15 mixture of *anti* and *syn*-alcohols (Entries 4-6). The major phenyl-substituted sulfoximine *anti*-**89** was isolated in 58% yield and the minor product was not isolated, whereas *anti*-**125** and *syn*-**125** were isolated in 91% yield as an 85:15 mixture (Entries 4 and 5). The major and minor *i*-Pr-substituted sulfoximines *anti*-**126** and *syn*-**126** were isolated in 80% and 3% yields respectively (Entry 6). A 65:35 mixture of diastereomeric alcohols *anti*-**127** and *syn*-**127** (isolated in 64% and 20% as an 80:20 mixture of benzophenone and *syn*-**127**) were obtained from the analogous reaction of *o*-tolyl-substituted sulfoximine **106** (Entry 7). Both *syn*-**126** and *syn*-**127** were isolated in low yields as they were difficult to separate from 1,1-diphenylmethanol (a side-product from lithiation-trappings with benzophenone).

Table 2.1 Lithiation-trapping of different sulfoximines with benzophenone
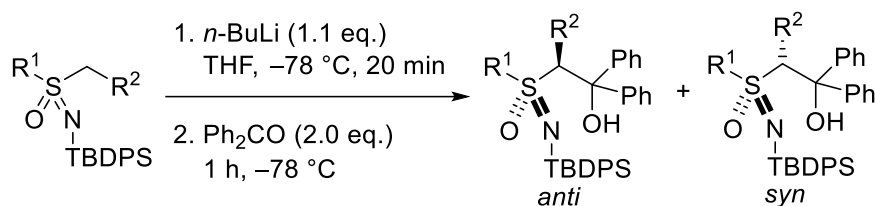
Entry	R^1	R^2	Starting material	*anti*:*syn*[a]	Major (%)[b]	Minor (%)[b]
1	*t*-Bu	Me	**118**	>98:2	*anti*-**122**, 92	-
2	*t*-Bu	Bn	**119**	>98:2	*anti*-**123**, 87	-
3	Ad	Me	**107**	>98:2	*anti*-**124**, 76[c]	-
4	Ph	Me	**87**	85:15	*anti*-**89**, 58	*syn*-**89**[d]
5	Ph	Bn	**117**	85:15	*anti*-**125**, 77[e]	*syn*-**125**, 14[e]
6	*i*-Pr	Me	**104**	85:15	*anti*-**126**, 80	*syn*-**126**, 3[f]
7	*o*-tol	Me	**106**	65:35	*anti*-**127**, 64	*syn*-**127**, 20[f,g]

[a] Ratio determined by ^{1}H NMR spectroscopy of the crude product. [b] Yield after purification by chromatography. [c] Isolated as an inseparable 95:5 mixture of *anti*-**124** and starting sulfoximine **107**. [d] The minor diastereomer was not isolated. [e] Isolated as an inseparable 85:15 mixture (by ^{1}H NMR spectroscopy). [f] Yield after two purifications by chromatography. [g] Isolated as an inseparable 80:20 mixture of benzophenone and *syn*-**127** (by ^{1}H NMR spectroscopy).

For these lithiation-trapping results, the ^{1}H NMR spectra of the crude products were used to determine the ratio of diastereomeric alcohols. In particular, the signal corresponding to the α-CH environment adjacent to the newly formed α-substituent was the most useful. In the case of isolated alcohols *anti*-**127** and *syn*-**127**, broad singlets were observed for the α-CH and α-methyl positions. We suspected that this was due to slow rotation around the S-Ar bond resulting in atropisomers. Upon changing the solvent from CDCl$_3$ to d_6-DMSO for *anti*-**127**, a ^{1}H NMR spectrum was obtained which presented signals δ_H 4.70 (q, J = 7.0 Hz) and δ_H 1.44 (d, J = 7.0 Hz) for the SCH and SCH*Me* environments respectively. For *syn*-**127**, changing the solvent to d_6-DMSO and additionally heating to 80 °C gave signals at δ_H 4.90 (q, J = 7.0 Hz) and δ_H 1.43 (d, J = 7.0 Hz) for the SCH and SCH*Me* protons.

The stereochemistry of *t*-Bu-substituted alcohol *anti*-**123** was determined using X-ray crystallography (Figure 2.2). Due to the proximity of the sulfoximine oxygen atom and the hydroxyl group, it is likely that a 6-membered ring hydrogen bonding interaction is present. The stereochemistry of *i*-Pr alcohol *anti*-**126** was also assigned using X-ray crystallography (Figure 2.2). Similarly, a hydrogen bond interaction is indicated by the positions of the sulfoximine oxygen and the OH substituent. Both X-ray structures show that the major products had *anti* configuration. Therefore, each of the major diastereomeric alcohols resulting from lithiation and trapping with benzophenone shown in Table 2.1 was assigned as *anti* by analogy. Furthermore, this assigned stereochemistry is consistent with that of alcohol *anti*-**88** generated from the lithiation-trapping of diethyl sulfoximine **86** with benzophenone.
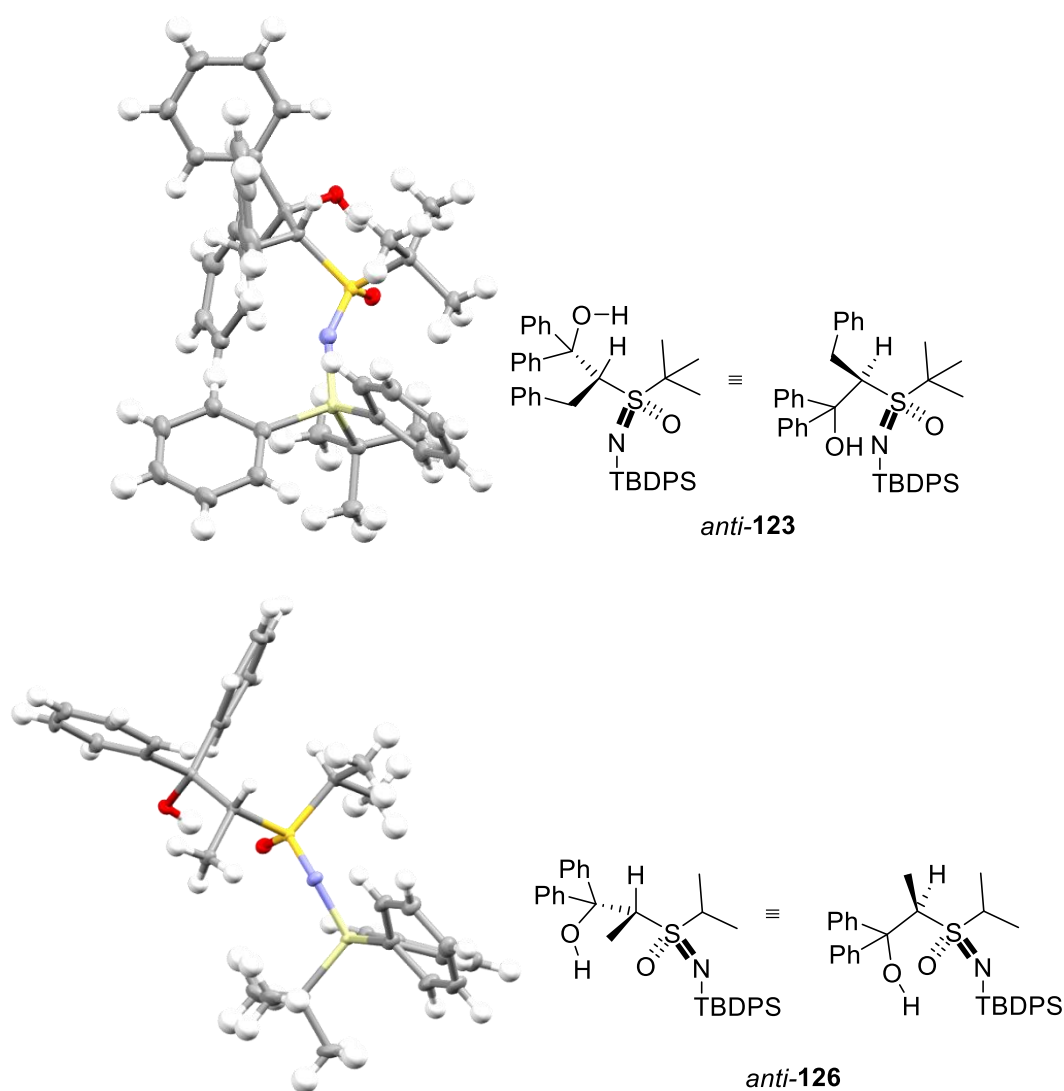
Figure 2.2 X-ray crystal structures of *N*-TBDPS sulfoximines *anti*-**123** and *anti*-**126**

33

To explore the effects of other *N*-functionalised sulfoximines, *N*-Boc sulfoximine **120** was also lithiated and trapped with benzophenone. This gave a 55:45 mixture of diastereomeric alcohols *anti*-**128** and *syn*-**128** (isolated in 44% and 24% yields respectively) (Scheme 2.11). The diastereoselectivity of this reaction was significantly lower than the analogous reaction of *N*-TBDPS sulfoximine **86** (see Scheme 2.10). Alcohols *anti*-**128** and *syn*-**128** showed α-CH signals at δ_H 4.66 (q, *J* = 7.5 Hz) and δ_H 4.34 (q, *J* = 7.5 Hz) respectively. In this case, crystals of the minor diastereomeric alcohol *syn*-**128** were grown and the structure was identified by X-ray crystallography (Figure 2.3).
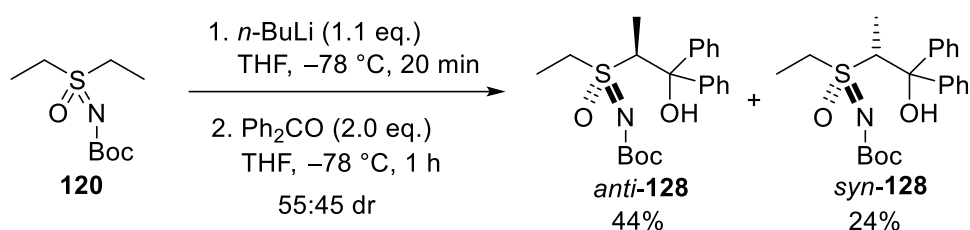
Scheme 2.11
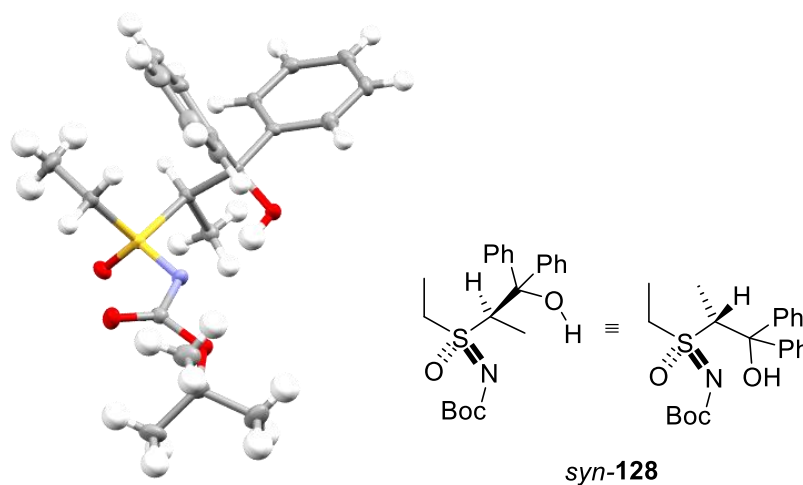
Figure 2.3 X-ray crystal structure of *N*-Boc sulfoximine *syn*-**128**

With *N*-Boc sulfoximine *anti*-**128** of known stereochemistry in hand, we converted it into the corresponding *N*-TBDPS sulfoximine using a method from previous work in the group.[43] This would allow us to assign the stereochemistry of *N*-TBDPS sulfoximine *anti*-**88**. Thus, the Boc group in *N*-Boc sulfoximine *anti*-**128** was removed using TFA in CH$_2$Cl$_2$ (rt, 24 h). This produced the NH sulfoximine *anti*-**129** in 30% yield (Scheme 2.12). Subsequent treatment with TBDPSCl and imidazole under the standard TBDPS protection conditions gave traces of the corresponding *N*-TBDPS sulfoximine *anti*-**88**.

Due to the small scale, and *anti*-**88** being isolated with an unknown by-product, the yield was not calculated. However, all key ¹H NMR spectroscopic signals required for comparison were present and identified, allowing the stereochemistry to be assigned.
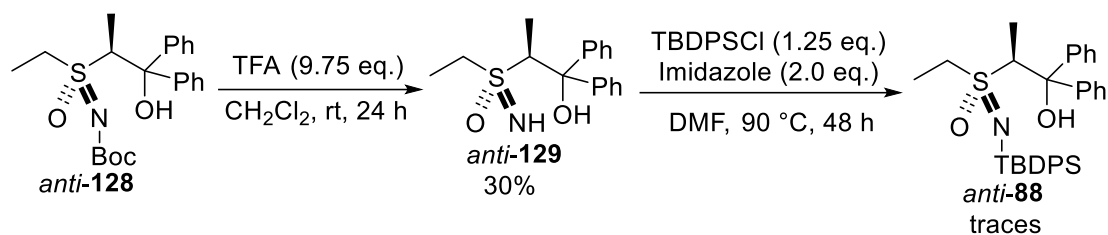
Scheme 2.12

As the TBDMS installation was shown to be easier than with TBDPS (see Scheme 2.9), the lithiation-trapping of an *N*-TBDMS sulfoximine was explored. *N*-TBDMS sulfoximine **121** was lithiated and trapped with benzophenone to give an 80:20 mixture of diastereomeric alcohols *anti*-**130** and *syn*-**130** (isolated in yields of 66% and 17% respectively) (Scheme 2.13). The ¹H NMR spectrum of the crude product showed two overlapping signals at δ_H 4.31 (q, J = 7.5 Hz) and δ_H 4.24 (q, J = 7.5 Hz) for the α-CH environment of each diastereomeric alcohol. The resulting diastereoselectivity was slightly lower than that of the analogous lithiation-trapping of *N*-TBDPS sulfoximine **87**, where an 85:15 dr of diastereomeric alcohols **89** was obtained.
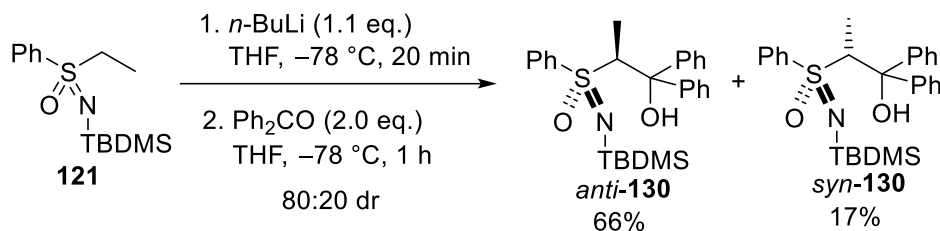
Scheme 2.13

It was hoped that removal of the TBDMS substituent would generate a solid from which crystals could be grown, and the stereochemistry could be assigned. Using a procedure previously performed within the group, *N*-TBDMS sulfoximine *anti*-**130** was treated with TBAF in THF (48 h, rt)[43] (Scheme 2.14). However, the desired NH sulfoximine *anti*-**131** was not formed and, instead, a 91% yield of NH sulfoximine **98** was isolated. It is believed that the NH sulfoximine originates from a mechanism which we have termed as a 'retro-aldol'-type. After deprotection of the TBDMS group, *anti*-**132** can rearrange to produce the NH sulfoximine **98** and benzophenone (Scheme 2.14). As this approach was

unsuccessful, the stereochemistry of both diastereomeric alcohols *anti*-**130** and *syn*-**130** was assigned by analogy with the *N*-TBDPS examples.
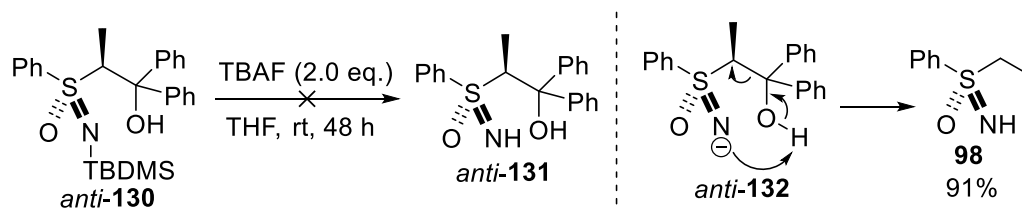
Scheme 2.14

Due to the high yields and diastereoselectivity observed for the lithiation-trappings with *N*-TBDPS sulfoximines, other electrophiles were explored. Acetone was selected as an alternative symmetrical ketone and lithiation-trapping was performed for several selected substrates (Scheme 2.15). *t*-Bu-substituted sulfoximines **118** and **119** gave single diastereomeric alcohols *anti*-**133** and *anti*-**134** respectively in 50% and 72% yields. This high diastereoselectivity was comparable with the related lithiation-trappings with benzophenone (>98:2 dr) (see Table 2.1). The analogous reaction using diethyl sulfoximine **86** provided an 80:20 mixture of diastereomeric alcohols *anti*-**135** and *syn*-**135** (isolated in 82% yield as an 85:15 mixture). This was a lower diastereoselectivity than with benzophenone (>98:2 dr). *i*-Pr-substituted sulfoximine **104** gave an 80:20 mixture of diastereomeric alcohols *anti*-**136** and *syn*-**136**. These were isolated as 95:5 mixture of alcohols **136** (as an 80:20 mixture of *anti* and *syn* in 49% yield) and starting sulfoximine **86**, This diastereoselectivity was slightly lower than the related reaction with benzophenone (85:15 dr).
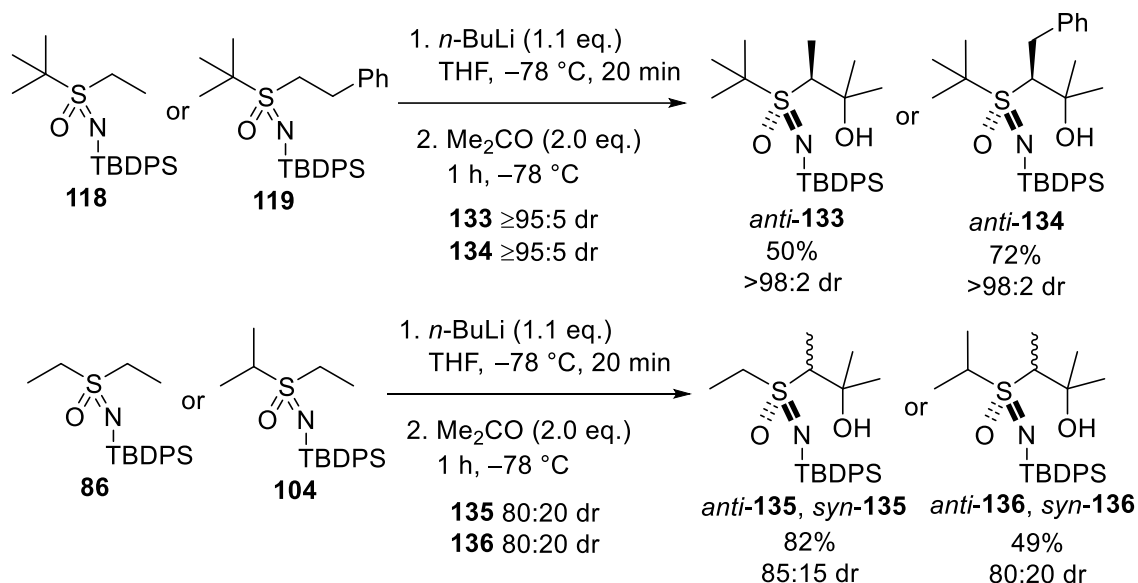
Scheme 2.15

Analysis of the ^{1}H NMR spectrum of each crude product was used to determine the diastereoselectivity. For *t*-Bu alcohols *anti*-**133** and *anti*-**134** and ethyl diastereomeric alcohols *anti*-**135** and *syn*-**135**, the signal corresponding to the α-CH position was the most useful. For *i*-Pr alcohols **136**, the signals corresponding to the α-CH of each diastereomer were not resolved. Therefore, the signals at δ_H 2.88 and δ_H 2.81 (septet, $J =$ 8.0 Hz) corresponding to the SC*H*Me$_2$ position were used to determine the diastereoselectivity.

The stereochemistry of alcohol *anti*-**133** was assigned *via* a conversion into *N*-4-bromobenozyl sulfoximine *anti*-**138**, using a procedure adapted from the literature,[62] and subsequent analysis by X-ray crystallography (Scheme 2.16). *N*-TBDPS sulfoximine *anti*-**133** was treated with TBAF in THF (rt, 48 h) to yield the corresponding NH sulfoximine *anti*-**137** in 80% yield. Of note, there were no issues in this case with a 'retro-aldol'-type reaction. Attempts to grow crystals of NH sulfoximine *anti*-**137** were unsuccessful. To try to obtain a crystalline compound, NH sulfoximine *anti*-**137** was treated with Et$_3$N and 4-bromobenzoyl chloride in CH$_2$Cl$_2$ (0 °C, 1 h then rt, 64 h) to yield a 70:30 mixture of 4-bromobenzoic acid and *N*-4-bromobenzoyl sulfoximine *anti*-**138** in 26% yield. The observed benzoic acid would be generated by hydrolysis of 4-bromobenzoyl chloride. Aromatic signals for 4-bromobenzoic acid in the ^{1}H NMR spectrum at δ_H 7.99 (d, $J = 8.5$ Hz) and δ_H 7.68 (d, $J = 8.5$ Hz) were consistent with those in the literature.[63] The corresponding aromatic signals in the ^{13}C NMR spectrum were also observed as well as a signal at δ_C 161.6 which was assigned to the COOH.
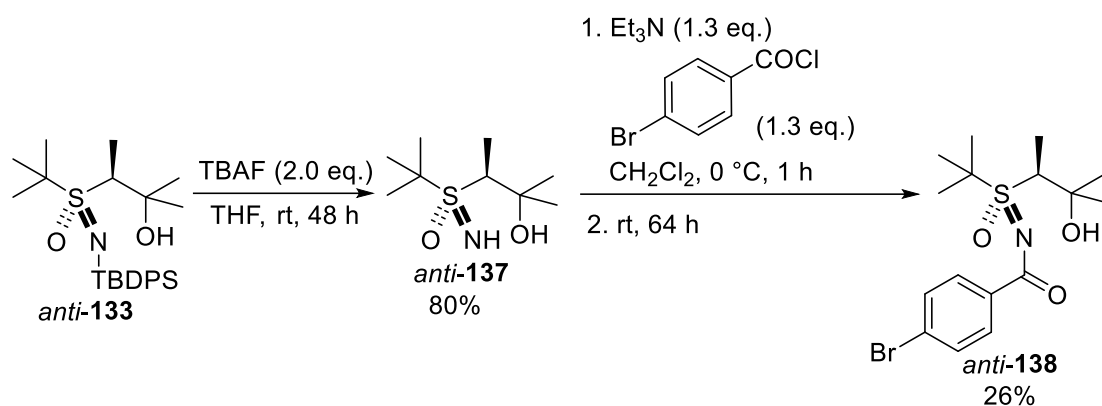
Scheme 2.16

Suitable crystals of *anti*-**138** were grown and the stereochemistry was assigned using X-ray crystallography (Figure 2.4). The X-ray structure showed a hydrogen bond interaction between the carbonyl oxygen and the hydroxyl group. This assigned relative stereochemistry is consistent with that shown previously in this chapter.
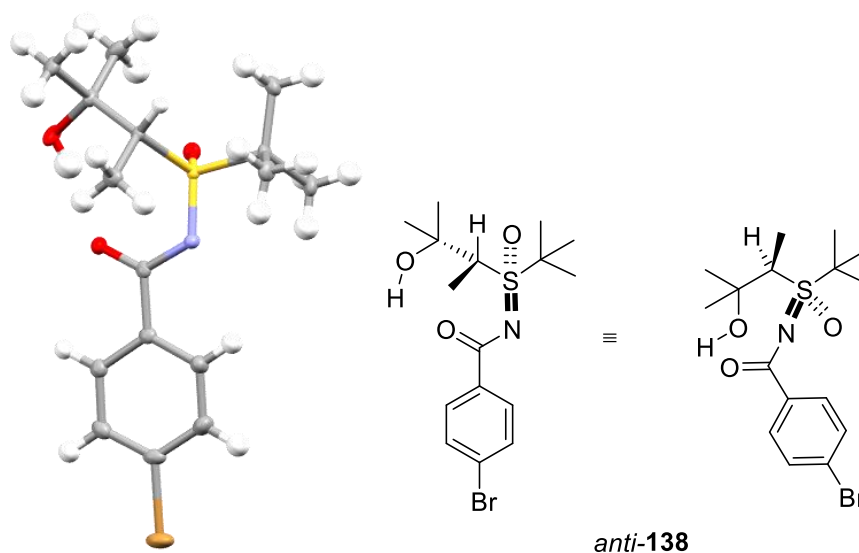
Figure 2.4 X-ray crystal structure of sulfoximine *anti*-**138**

In order to assign the stereochemistry of alcohol *anti*-**134**, TBDPS removal was attempted. TBAF was reacted with alcohol *anti*-**134** in THF at rt for 48 h (Scheme 2.17). However, the ^{1}H NMR spectrum of the crude product showed no formation of NH sulfoximine *anti*-**139** and no product was isolated during purification. The stereochemistry of *anti*-**134** was therefore assigned by analogy with related alcohol *anti*-**133**. Similarly, for alcohols **135** and **136**, the stereochemistry of the major diastereomeric alcohols was also assigned as *anti* by analogy.
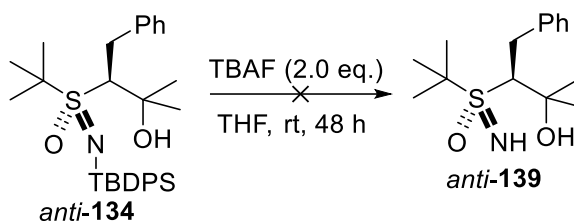
Scheme 2.17

Previous work in the group had used Weinreb amides to install a ketone into the sulfoximine product. Using a literature procedure,[64] Weinreb amide **141** was prepared in 64% yield from *N,O*-dimethylhydroxylamine, Et$_3$N and nicotinoyl hydrochloride **140** in CH$_2$Cl$_2$ (0 °C to rt, 2 h) (Scheme 2.18).
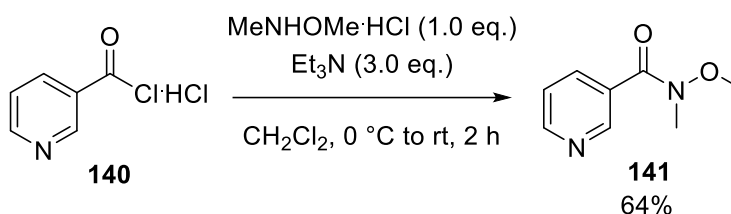
Scheme 2.18

Three examples of trapping with Weinreb amides are shown in Scheme 2.19. The ^{1}H NMR spectrum of the crude products of ketones **142**, **143** and **145**, particularly the signals for the α-CH position, were used to determine the diastereoselectivity in each case. Lithiation of *t*-Bu-substituted sulfoximine **118** and trapping with Weinreb amide **73** yielded a 97:3 mixture of ketones *anti*-**142** and *syn*-**142** (isolated in 87% yield as a 96:4 mixture). In contrast, the analogous reaction with diethyl sulfoximine **86** showed poor diastereoselectivity, and a 55:45 mixture of ketones *syn*-**143** and *anti*-**143** was obtained. After chromatography, 52% of *syn*-**143**, 9% of a 93:7 mixture and 32% of a 75:25 mixture of *anti*-**143** and *syn*-**143** were isolated. Thus, a total of 61% of *syn*-**143** and 32% of *anti*-**143** were produced. The amount of *syn*-**143** obtained was higher than that present in the ^{1}H NMR spectrum of the crude product. To account for this, we suggest that epimerisation had occurred during purification. This likely occurred *via* an enolisation process due to the acidity of the α-proton when adjacent to both the ketone and sulfoximine groups. Trapping lithiated **86** with Weinreb amide **144** gave ketones *syn*-**145** and *anti*-**145** as a 65:35 mixture. After chromatography, a 70:30 mixture of *syn*-**145** and *anti*-**145** was isolated in 66% yield. In order to try to separate the diastereomers, a second purification

by chromatography was attempted. This gave a 90:10 mixture of *syn*-**145** and *anti*-**145** obtained in 22% yield.
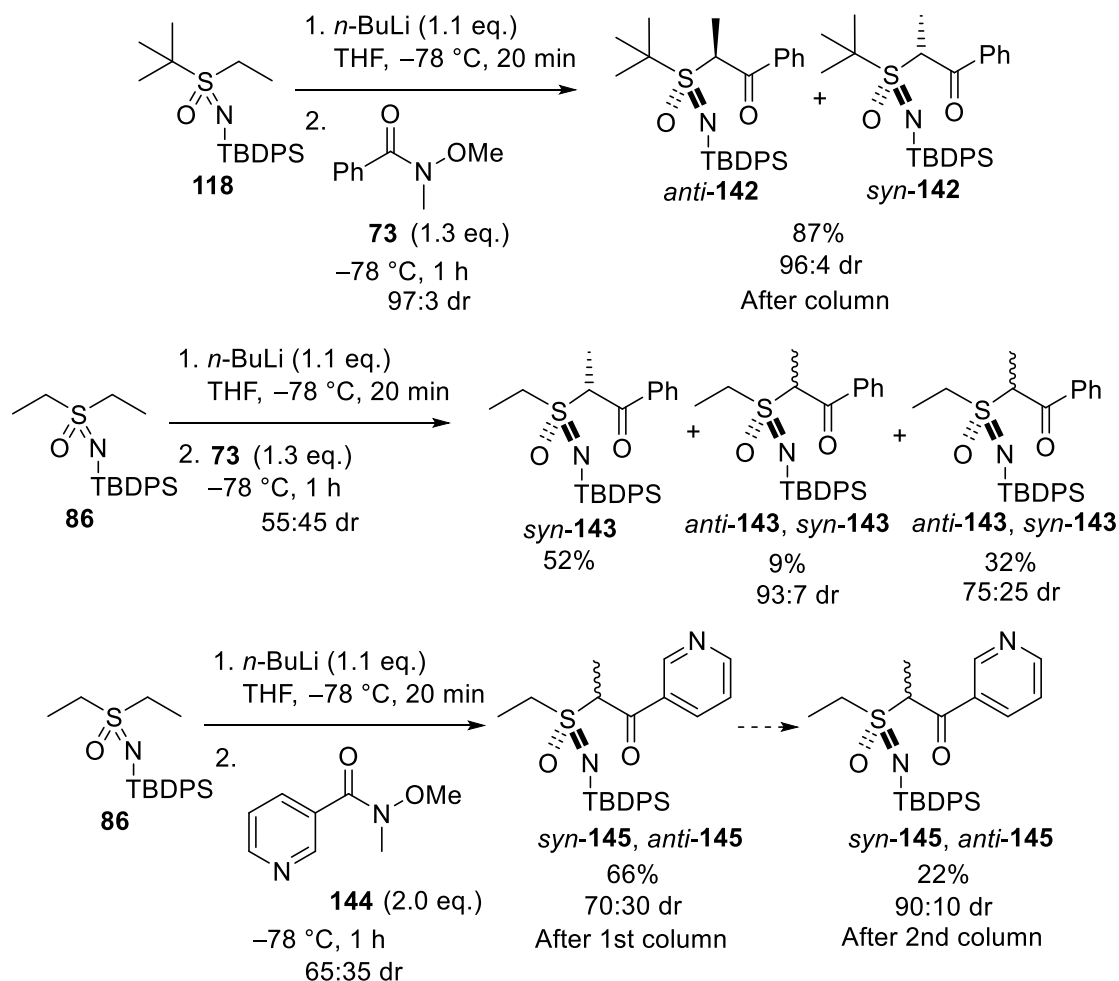
Scheme 2.19

The stereochemistry of ketone *syn*-**143** was assigned using X-ray crystallography (Figure 2.5). In the ^{1}H NMR spectrum of the crude product, signals appeared at δ_H 4.36 (q, J = 7.5 Hz) and δ_H 1.52 (d, J = 7.5 Hz) for the α-CH and CH*Me* environments of *syn*-**143**. For *anti*-**143**, these signals were present at δ_H 4.85 and δ_H 1.66 respectively. In addition, the R_F value for *syn*-**143** was higher than for *anti*-**143**. To assign the stereochemistry of ketones **142** and **145**, ^{1}H NMR spectroscopic data and R_F values were compared. The trends seen with ketones *anti*-**143** and *syn*-**143** allowed the *anti* and *syn* stereochemistry of ketones **142** and **145** to be tentatively assigned.

It is surprising that the three reactions with Weinreb amides (Scheme 2.19) gave very different outcomes. One was highly *anti*-selective and one was *syn*-selective. Both this work and previous work in the group (see Scheme 1.21) have suggested that epimerisation

may occur during the synthesis or purification of the ketone-containing products. As a result, the diastereoselectivity with Weinreb amide trappings is often different to that with other electrophiles. This is because it is difficult to quantify how much epimerisation will occur in each example. However, even when variable diastereoselectivity was observed as in these three reactions, it was still possible to isolate ketones in high dr and good yields.
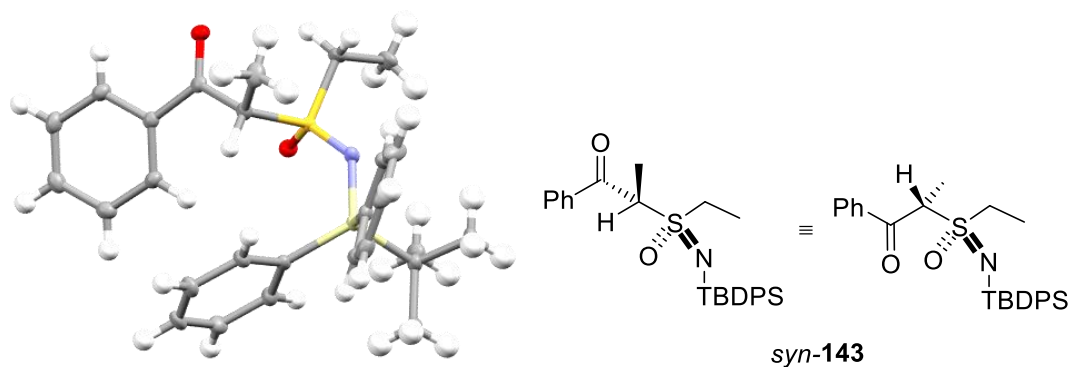
Figure 2.5 X-ray crystal structure of *N*-TBDPS sulfoximine *syn*-**143**

Lithiation of sulfoximine **86** and trapping with benzaldehyde gave a 50:35:15 mixture of three diastereomeric alcohols *anti*,*anti*-**146**, *syn*,*syn*-**146** and *anti*,*syn*-**146**. After chromatography, alcohols *anti*,*anti*-**146** and *syn*,*syn*-**146** were isolated in 80% yield as a 60:40 mixture and *anti*,*syn*-**146** was isolated in 7% yield (Scheme 2.20). The 60:40 ratio of alcohols *anti*,*anti*-**146** and *syn*,*syn*-**146** was determined using signals at δ_H 3.20 (quintet, J = 7.0 Hz) and δ_H 3.02 (q, J = 7.0 Hz) for the α-CH position. For alcohol *anti*,*syn*-**146**, a signal at δ_H 2.91 (qd, J = 7.5, 1.0 Hz) was assigned to the α-CH position. The relatively low diastereoselectivity (65:35 dr) at the α-position was surprising. However, when trapping with aldehydes, the preferred formation of a 1,3-*syn* relationship between the oxygen atoms of the sulfoximine and hydroxyl groups has been observed in related compounds (see Scheme 1.7). In our example, the 1,3-selectivity is 85:15 dr. We suggest that the impact of the preference for 1,3-*syn* selectivity lowers the overall α-diastereoselectivity compared to benzophenone (see Scheme 2.10).
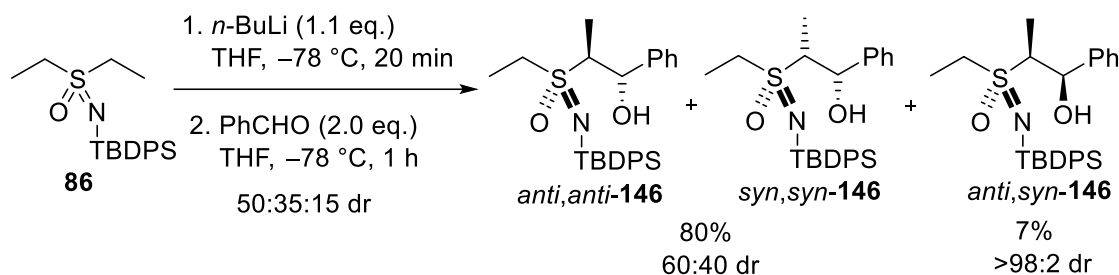
Scheme 2.20

To assign the stereochemistry of alcohols **146**, ketone *syn*-**143** of known stereochemistry was reduced using L-Selectride®.[65] L-Selectride® was selected as a sterically hindered reducing agent which we expected to proceed under Felkin-Ahn control and so could be used to predict the stereochemistry. Reaction of ketone *syn*-**143** with L-Selectride® in THF at −78 °C gave a single diastereomer of an alcohol in 85% yield, which was assigned as *syn,anti*-**146** (Scheme 2.21). The Felkin-Ahn model for the L-Selectride® reduction of ketone *syn*-**143** is shown in Figure 2.6; the bulky sulfoximine group is expected to sit perpendicular to the ketone functionality and the hindered hydride will attack the carbonyl group on the least sterically hindered face. This model would predict *syn,anti*-**146** as the major product.
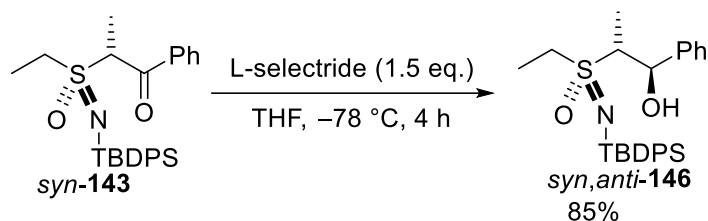
Scheme 2.21
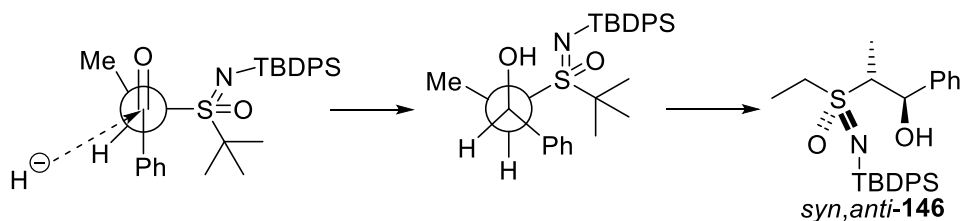
Figure 2.6 Felkin-Ahn model for the L-Selectride® reduction of *syn*-**143**

In an attempt to favour chelation control and therefore the formation of alcohol *syn,syn*-**146**, Red-Al® was employed as a reducing agent. Use of Red-Al® has been shown to give high levels of chelation control in the reduction of α-alkoxy ketones.[66] Reaction of ketone *syn*-**143** with Red-Al® in CH$_2$Cl$_2$ at 0 °C produced alcohols *syn,anti*-**146** and

syn,syn-**146** as an 80:20 mixture (isolated as an 85:15 mixture in 49% yield) (Scheme 2.22). Unfortunately, alcohol *syn,anti*-**146** was still the major product indicating that Felkin-Ahn reduction remained the main pathway.
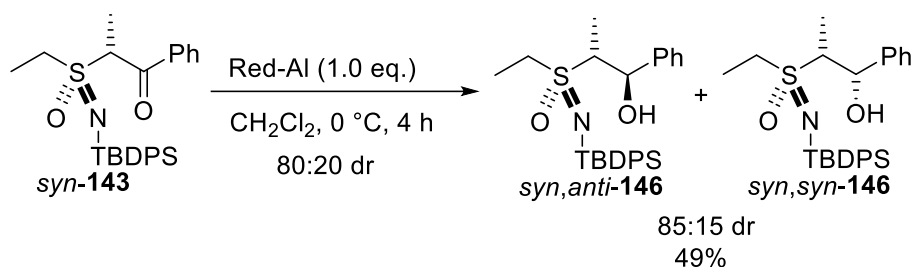
Scheme 2.22

By comparing the ^{1}H NMR spectra of the purified alcohol *syn,anti*-**146** and the lithiation-trapping products (see Scheme 2.20), it was shown that *syn,anti*-**146** was not formed in the initial lithiation-trapping reaction. When comparing the ^{1}H NMR spectra of the 85:15 mixture of *syn,anti*-**146** and *syn,syn*-**146**, it was determined that *syn,syn*-**146** was the minor diastereomeric alcohol in the 60:40 mixture. The two remaining alcohols therefore had *anti*-α-stereochemistry. Lithiation-trapping reactions with aldehydes have been previously shown to favour the 1,3-*syn* configuration between the sulfoximine oxygen and hydroxyl substituents (see Scheme 1.7).[28] Therefore, we assumed that the major alcohol would exhibit this 1,3-*syn* configuration and it was therefore assigned as *anti,anti*-**146**. The minor alcohol was assigned as *anti,syn*-**146**.

Trapping with imines had previously been investigated by Pyne.[36,37] Therefore, *t*-Bu-substituted sulfoximine **118** was lithiated and trapped with imine **45** to give a 40:30:20:10 mixture of amines **147a**, **147b**, **147c** and **147d** in a total yield of 79% (Scheme 2.23). In a similar way to the lithiation and trapping of diethyl sulfoximine **86** with benzaldehyde (see Scheme 2.20), a lower diastereoselectivity was achieved compared to the electrophiles discussed in this chapter. Pyne had also investigated precomplexing the imine with boron trifluoride-diethyl ether prior to trapping.[36,37] When the analogous reaction with the precomplexed imine was performed, a 30:35:10:25 mixture of amines **147a**, **147b**, **147c** and **147d** was produced in a 62% yield. The diastereoselectivity was determined in each case using the signals corresponding to the C*H*NH environment for each diastereomer in the ^{1}H NMR spectrum of the crude product. The C*H*NH signals were chosen, due to overlapping of the α-CH signals. The stereochemistry of amines **147** was

not determined. With or without boron trifluoride-etherate present, poor diastereoselectivity was observed.

$$\text{no BF}_3 \quad 40{:}30{:}20{:}10 \text{ dr}$$

147b,147d,147a + **147a,147d,147b,147c**
27% 92:6:2 dr 52% 75:15:5:5 dr

$$\text{BF}_3 \quad 30{:}35{:}10{:}25 \text{ dr}$$

147b,147a,147d,147c
62% 35:30:25:10 dr
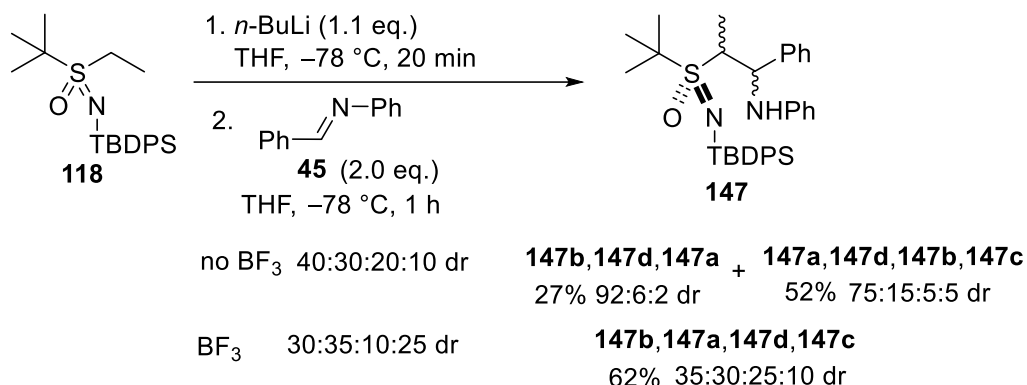
Scheme 2.23

Most of the acyclic *N*-TBDPS sulfoximines presented in this chapter have displayed high *anti*-α-diastereoselectivity in lithiation-trapping reactions with a range of electrophiles. To explain this, we propose the models shown in Figure 2.7. For the formation of the *anti*-diastereomer (pathway A), we suggest that the α-carbanion is sp^2 hybridised and that the R^1 and R^2 substituents are in an antiperiplanar orientation to minimise unfavourable steric interactions. Electrophilic trapping then occurs on the face opposite to the bulky TBDPS group to give the observed *anti*-configured products. The formation of the *syn* product is proposed to occur *via* pathway B, where the α-R^2 and α-H substituents are in opposite positions. Pathway B would be especially disfavoured when R^1 is a sterically demanding substituent. This is supported by the high diastereoselectivity observed for the bulky Ad-substituted and *t*-Bu-substituted sulfoximines.
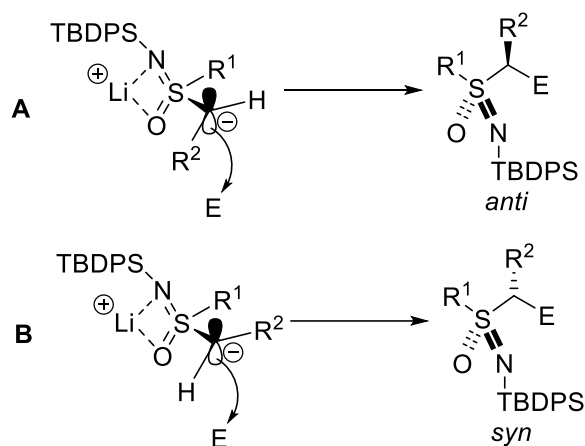
Figure 2.7 Proposed models for electrophilic trapping of acyclic sulfoximines

44

In conclusion, a range of α-substituted products have been synthesised from *t*-Bu and Ad-substituted sulfoximines **118**, **119** and **107** in high diastereoselectivity. The diastereoselectivity has generally been slightly lower for Et, *i*-Pr and Ph-substituted sulfoximines **86**, **104**, **87** and **117**. Alternative nitrogen protecting groups (TBDMS and Boc) have been explored briefly and have resulted in high and low diastereoselectivity respectively. Products with *anti*-α-stereochemistry are the major diastereomers across most examples. This differs to the *syn*-α-stereochemistry reported by Pyne in trapping methyl benzyl sulfoximine **43** with aldehydes and imines (see Chapter 1.3). This difference is explored further in Chapter 2.2.3.

2.2.2 Lithiation and Trapping of Sulfoximines with Alkyl Halides and Silyl Chlorides

To further explore the scope of the lithiation-trapping methodology, benzyl bromide, methyl iodide, ethyl iodide, deuterated methanol and trimethylsilyl chloride were investigated as electrophiles. The reactions of four sulfoximines with benzyl bromide were studied first and the results are shown in Scheme 2.24. Lithiation of adamantyl-substituted sulfoximine **107** and trapping with benzyl bromide provided *anti*-**148** in 69% yield. The analogous reaction of *t*-Bu-substituted sulfoximine **118** gave an inseparable 97:3 mixture of sulfoximines *anti*-**149** and *syn*-**149** in 96% yield. Lithiation-trapping of *i*-Pr-substituted sulfoximine **104** resulted in a 70:30 mixture of *anti*-**150** and *syn*-**150** in 94% yield. The reaction of Ph-substituted sulfoximine **87** gave a 60:40 mixture of *anti*-**151** and *syn*-**151** in 84% yield. The reactions of adamantyl and *t*-Bu-substituted sulfoximines provided high diastereoselectivity, whereas those of *i*-Pr and Ph-substituted sulfoximines were lower. These trends were consistent with the results discussed in the previous chapter.
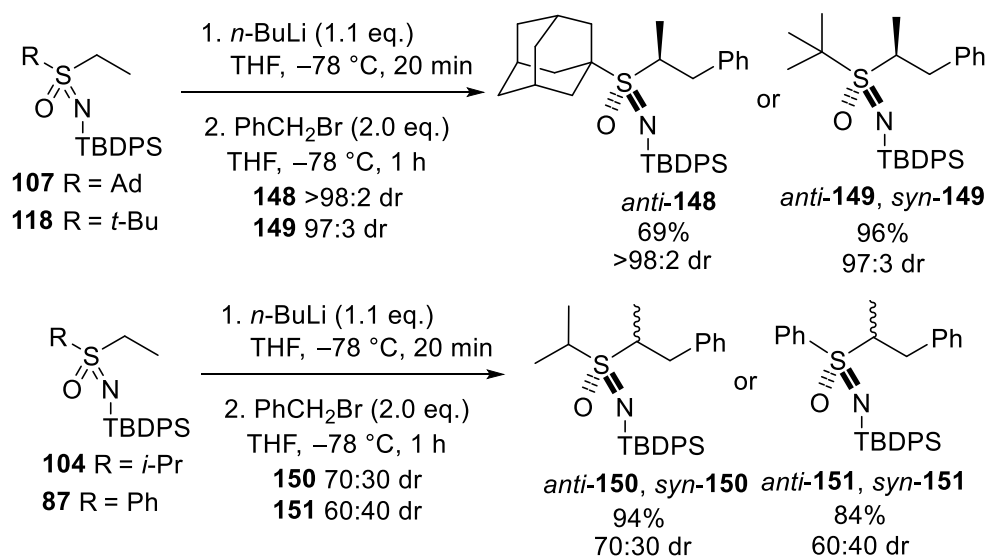
Scheme 2.24

The signals in the ^{1}H NMR spectra for the crude products were used to measure the diastereoselectivity for each reaction. In each spectrum, the signals corresponding to the α-CH environment for each diastereomer were not resolved and so the signals corresponding to the diastereotopic CH_2 position were used to determine the diastereoselectivity. For example, from the ^{1}H NMR spectrum of the crude product, *anti*-

150 presented a signal at δ$_H$ 2.31 (dd, J = 13.0, 11.0 Hz) for the C*H*Ph environment and *syn*-**150** showed a signal at δ$_H$ 2.44 (dd, J = 13.0, 11.0 Hz).

The stereochemistry of *anti*-**148** was assigned by its conversion into *N*-4-bromobenzoyl sulfoximine *anti*-**153** and subsequent X-ray analysis. *N*-TBDPS sulfoximine *anti*-**148** was treated with TBAF to give NH sulfoximine *anti*-**152** in 93% yield. Then, reaction of *anti*-**152** with 4-bromobenzoyl chloride and Et$_3$N produced *anti*-**153** in 84% yield (Scheme 2.25). X-ray crystallography was then used to establish its stereochemistry (Figure 2.8). The stereochemistry of the related major diastereomeric sulfoximines *anti*-**149**, *anti*-**150** and *anti*-**151** was assigned by analogy.

Scheme 2.25
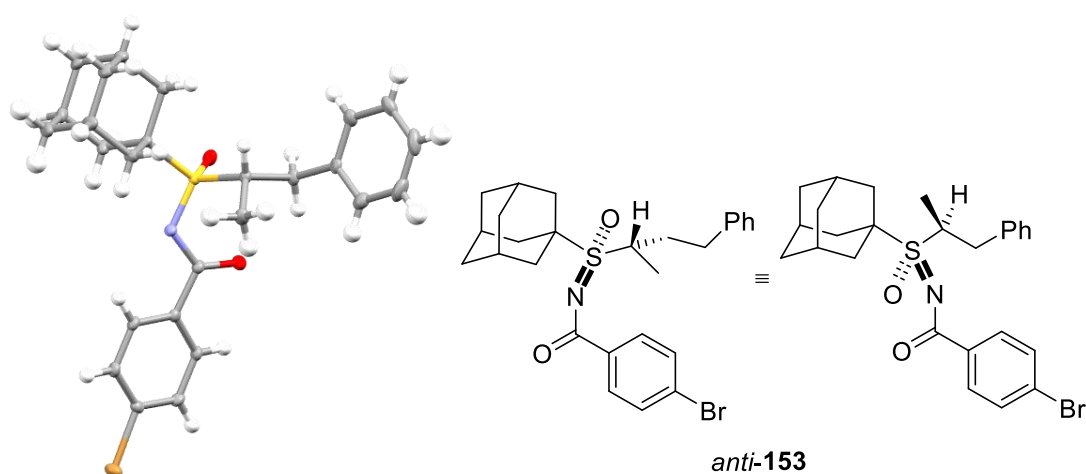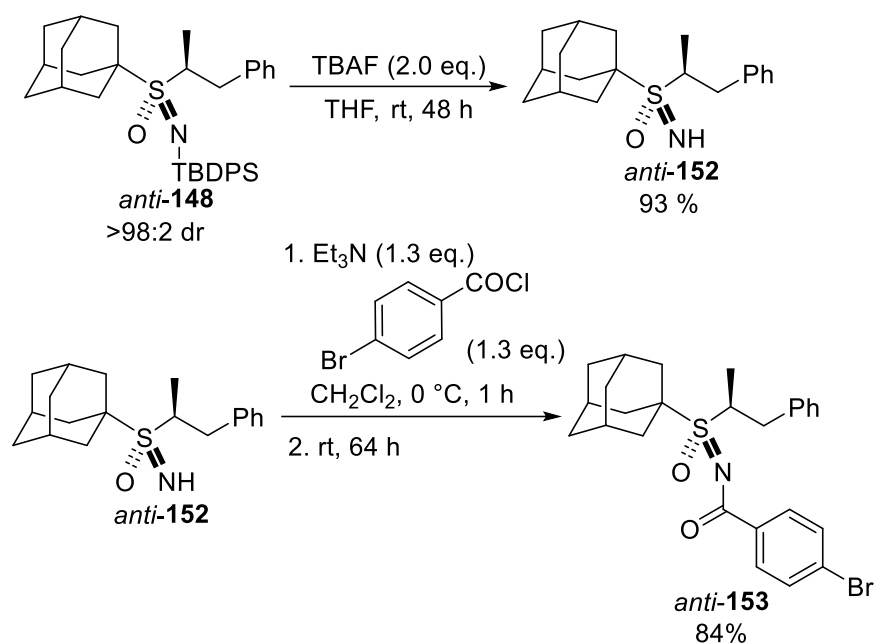
Figure 2.8 X-ray crystal structure of *N*-4-bromobenzoyl sulfoximine *anti*-**153**

Trapping with benzyl bromide was also explored with diethyl sulfoximine **86**. In this case, an unquantifiable mixture of monosubstituted diastereomeric sulfoximines *anti*-**154** and *syn*-**154** and disubstituted sulfoximine **155** (unknown mixture of diastereomers) was obtained. After chromatography, monosubstituted sulfoximines *anti*-**154** and *syn*-**154** were isolated as a 75:25 mixture in 45% yield and disubstituted sulfoximines **155** were obtained as an unknown mixture of diastereomers in 26% yield (Scheme 2.26).
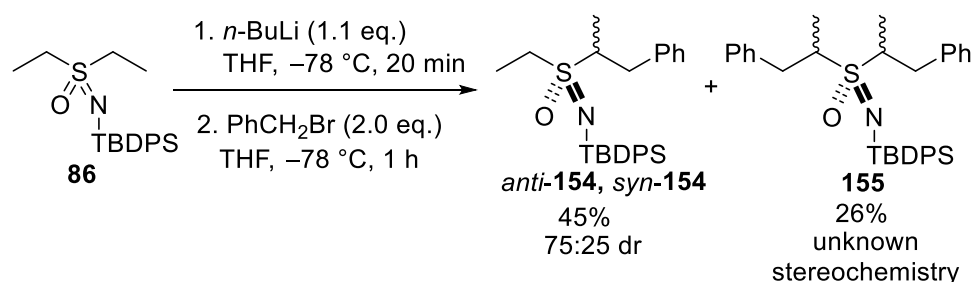
Scheme 2.26

The ^{1}H NMR spectrum for the purified mixture of *anti*-**154** and *syn*-**154** was used to determine the diastereoselectivity, specifically the signals corresponding to the benzylic CH$_2$ protons. The formation of a disubstituted product was identified by mass spectrometry. The structure of this disubstituted sulfoximine could not be deduced using the ^{1}H NMR spectrum as the key signals were overlapped. The ^{13}C NMR spectrum, however, showed no evidence of disubstitution occurring at the same α-carbon position. There were no signals corresponding to either the Et substituent or the quaternary α-CH. Figure 2.9 shows that four sets of signals for each of the Me, CH$_2$ and SCH environments were present in the ^{13}C NMR spectrum, which indicates that all three possible diastereomers of disubstituted sulfoximine **155** were formed (two of which are *meso* compounds).
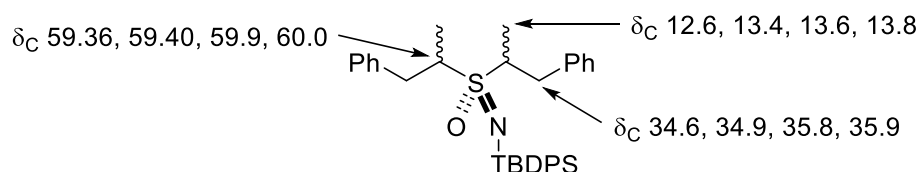
Figure 2.9 ^{13}C NMR spectroscopic data for disubstituted sulfoximine **155**

To explain the formation of disubstituted sulfoximine **155**, a mechanistic proposal is summarised in Scheme 2.27. We propose that, initially, deprotonation of sulfoximine **86** takes place followed by trapping with benzyl bromide to yield monosubstituted sulfoximine **154** of unknown stereochemistry. If this trapping process is relatively slow

then enough lithiated sulfoximine **156** may still be present to deprotonate at the other, less sterically hindered α-position of **154**. This would produce monosubstituted lithiated sulfoximine **157** and starting material **86**. Finally, **157** can undergo a second trapping reaction with benzyl bromide to produce disubstituted sulfoximine **155**. Another possible pathway for disubstitution is *via* dianion formation and has been proposed within the literature.[67] However, when sulfoximine **86** was lithiated and trapped with other electrophiles (see Chapter 2.2.1), no disubstitution was observed and so we disfavour this explanation. Furthermore, the ^{1}H NMR spectrum for the crude product shows evidence of some leftover starting sulfoximine **86** which supports the proposal of its regeneration during the formation of disubstituted sulfoximine **155**.
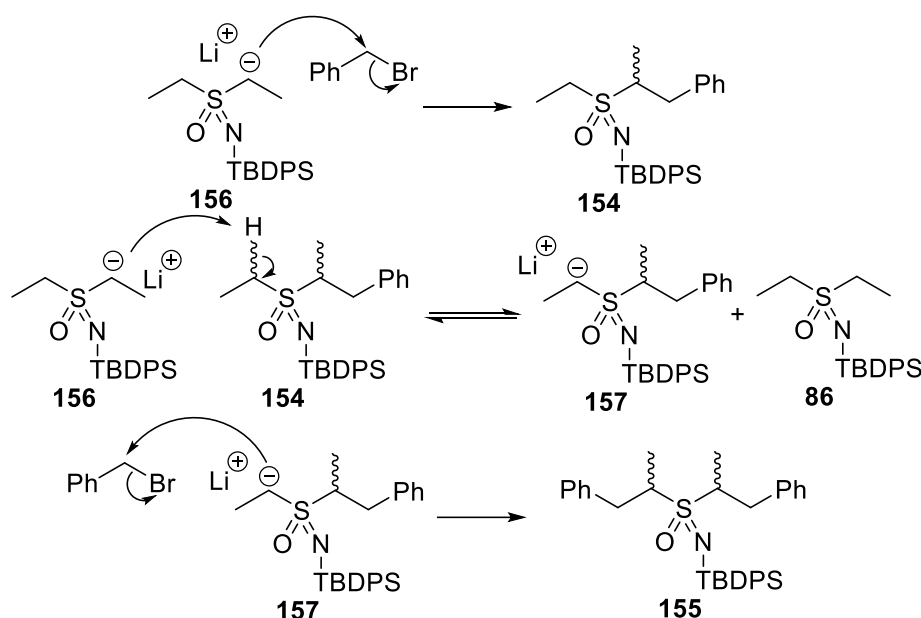
Scheme 2.27

The stereochemistry of the major and minor diastereomeric monosubstituted sulfoximines *anti*-**154** and *syn*-**154** has been assigned by analogy with the other benzyl bromide trappings (see Scheme 2.24). However, in this case, the assignment should be viewed as tentative since it is not possible to quantify the amount of each diastereomer that has contributed to the formation of disubstituted sulfoximine **155**.

In order to selectively access the *syn*-diastereomers, we planned to reverse the order in which the α-substituents would be installed onto the sulfoximine. For example, lithiation of *t*-Bu-substituted sulfoximine **119** and subsequent trapping with methyl iodide gave a 98:2 mixture of sulfoximines *syn*-**149** and *anti*-**149** (isolated as a 98:2 mixture in 96% yield) (Scheme 2.28). Lithiation-trapping of Ph-substituted sulfoximine **117** with methyl

iodide provided a 65:35 mixture of *syn*-**151** and *anti*-**151**, which were isolated as a 65:35 mixture in 71% yield. Both of these reactions gave similar diastereoselectivity to those in Scheme 2.24 but, as expected, the *syn* diastereomer was the major product.
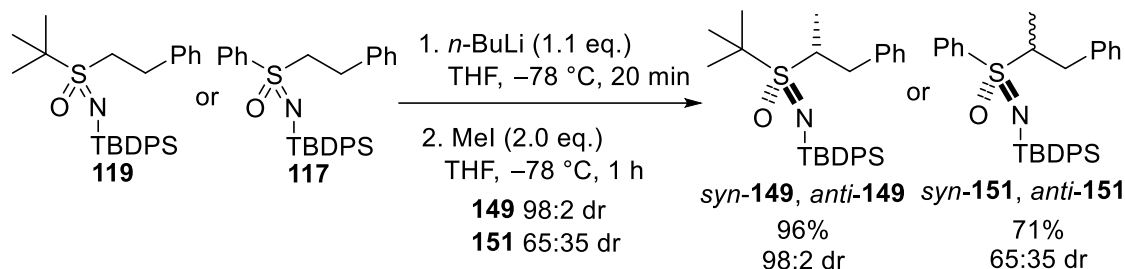
Scheme 2.28

Figure 2.10 compares the signal corresponding to the C*H*Ph proton for *syn*-**149** and *anti*-**149** in their associated ^{1}H NMR spectra. Each diastereomer was synthesised as the major product from the two decribed approaches.
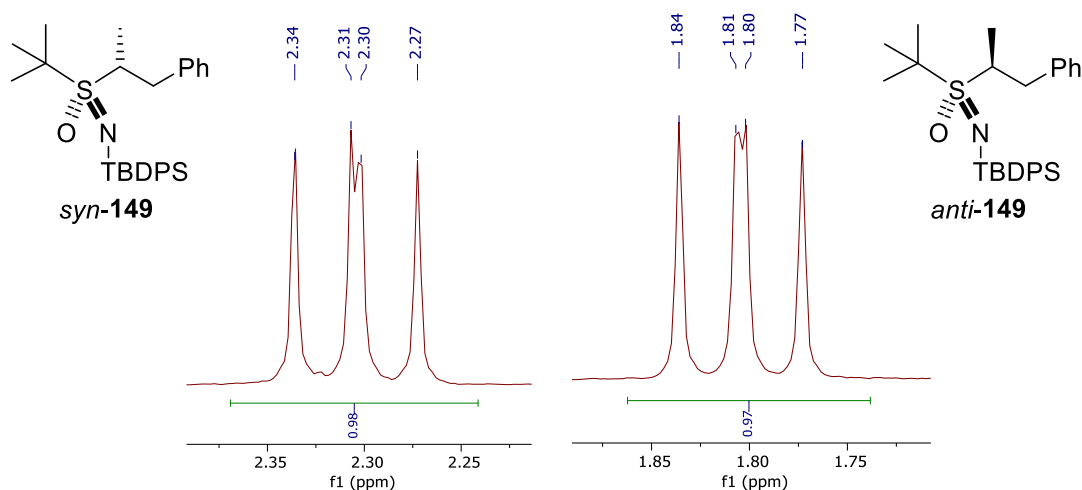
Figure 2.10 The C*H*Ph signal in the ^{1}H NMR spectra for *syn*-**149** and *anti*-**149**

Lithiation of *t*-Bu-substituted sulfoximine **119** and trapping with ethyl iodide gave a 97:3 mixture of diastereomeric sulfoximines *anti*-**158** and *syn*-**158** (isolated as a 97:3 mixture in 47% yield) (Scheme 2.29). From the ^{1}H NMR spectrum of the crude product, the signals corresponding to the CH$_2$ protons were used to determine the diastereoselectivity. The stereochemistry of *anti*-**158** was assigned by analogy with the other alkylations.
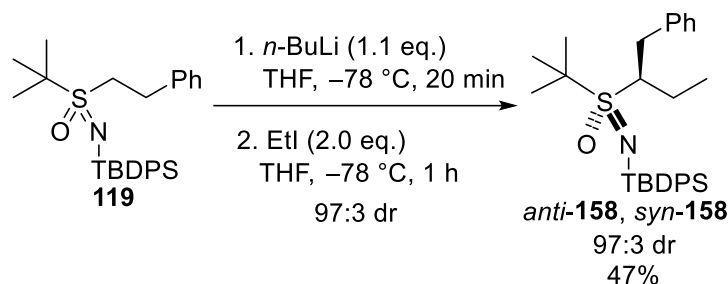
Scheme 2.29

Lithiation-trapping of *t*-Bu-substituted sulfoximine **118** with deuterated methanol provided a 60:40 mixture of deuterated sulfoximines **118-d** in 91% yield (Scheme 2.30). The diastereoselectivity was determined using the ^{1}H NMR spectrum of the crude product, specifically the signals corresponding to the α-CH position. The diastereoselectivity was significantly lower than the lithiation-trappings of *t*-Bu-substituted sulfoximines with other electrophiles. To explain this, one possibility is that the alkoxide generated during deuteration could epimerise the product to change the diastereomeric ratio. Alternatively, it could be that deuteration is simply much less diastereoselective than trappings with other electrophiles.
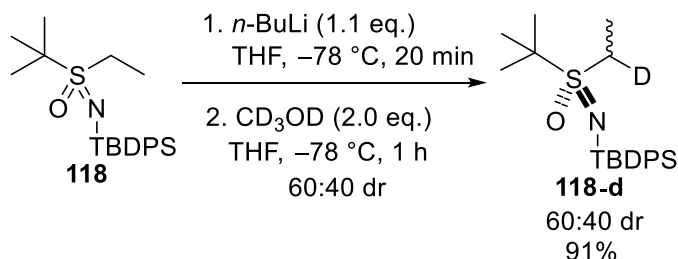
Scheme 2.30

For comparison, we also explored TMSCl trapping. Thus, lithiation of *t*-Bu-substituted sulfoximine **119** and subsequent trapping with TMSCl gave α-silylated sulfoximine *anti-***159** in 90% yield (Scheme 2.31). The analogous reaction of diethyl sulfoximine **86** provided a 67:33 mixture of monosubstituted sulfoximines *anti-***160** and *syn-***160** (as an 80:20 mixture of diastereomers) and disubstituted sulfoximine **161**. An 80:20 mixture of sulfoximines *anti-***160** and *syn-***160** was isolated in 59% yield and disubstituted sulfoximine **161** was recovered in 24% yield (Scheme 2.31). The stereochemistry for both *anti-***159** and *anti-***160** was assigned by analogy.
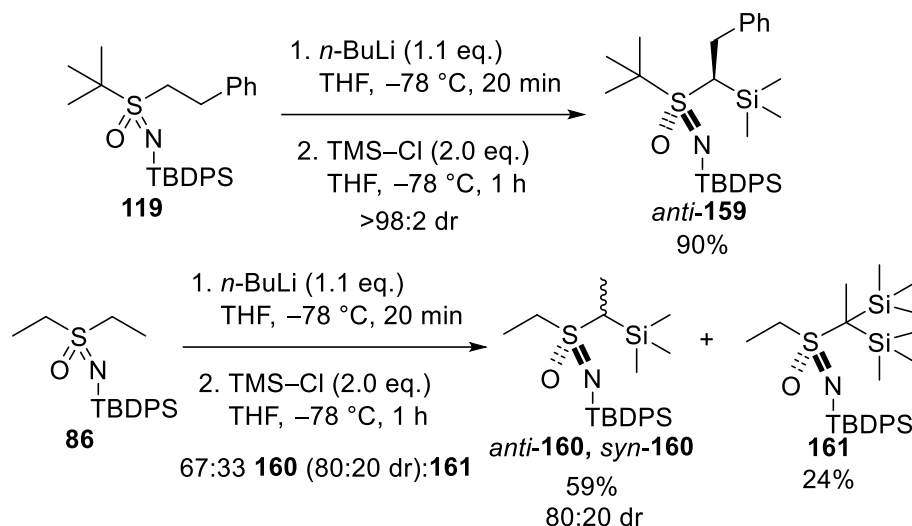
Scheme 2.31

Mass spectrometry indicated the formation of a disubstituted sulfoximine and evidence that both silyl groups were on the same carbon came from the ^{1}H and ^{13}C NMR spectra. A 3H singlet was observed in the ^{1}H NMR spectrum at δ_H 1.39 corresponding to the α-methyl substituent, which suggested that the adjacent α-carbon must be quaternary and therefore disubstituted. This quaternary α-carbon was present in the ^{13}C NMR spectrum at δ_C 51.3.

In order to explain the double silylation, a mechanism similar to that used to rationalise the formation of dibenzylated sulfoximine **155** can be proposed (see Scheme 2.27). However, to form dibenzylated sulfoximine **155**, the benzylations occurred on different carbons. With disilylated sulfoximine **161**, the double silylation on the same carbon can be explained by the α-anion stabilising effect of silicon. Presumably, lithiation of sulfoximine **86** and subsequent trapping with TMSCl would take place to give silylated sulfoximine **162** and subsequently monosubstituted sulfoximine **160** (Scheme 2.32). Another carbanion adjacent to silicon would then result from deprotonation of the α-proton by the remaining lithiated sulfoximine **156**. This is favourable due to the ability of silicon to stabilise the α-carbanion *via* silicon's empty σ* antibonding orbital. Trapping of lithiated sulfoximine **163** would then give disubstituted sulfoximine **161**. The stereochemistry of *anti*-**160** and *syn*-**160** is also assigned tentatively due to the formation of disubstituted sulfoximine **161**.
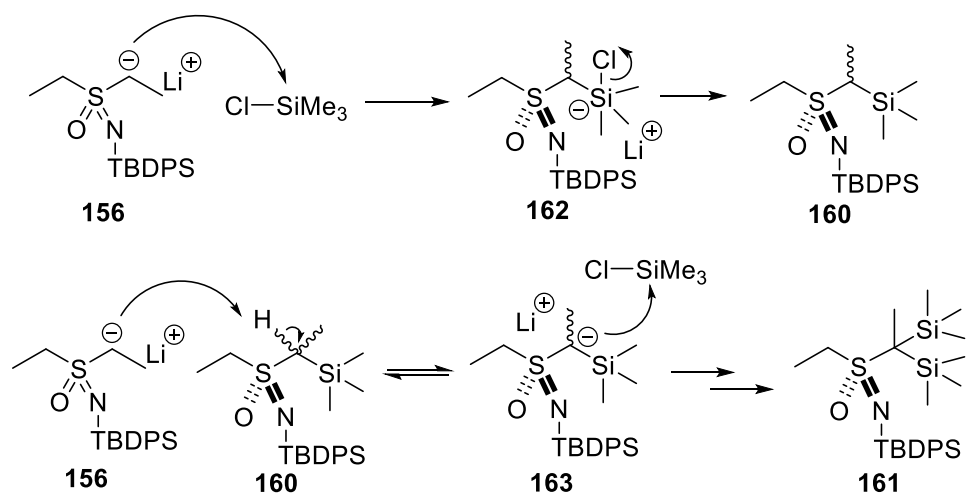
Scheme 2.32

To conclude, *t*-Bu-substituted and adamantyl-substituted sulfoximines **118**, **119** and **107** provided high diastereoselectivity when lithiated and trapped with alkyl halides and silyl chlorides. This diastereoselectivity was lower when Ph, *i*-Pr and Et-substituted sulfoximines **87**, **117**, **104** and **86** were employed. These trends are consistent with those identified for the same sulfoximines with carbonyl-containing electrophiles (see Chapter 2.2.1). These results suggest that the model presented in Figure 2.7 can explain the diastereoselectivity in the lithiation-trappings of sulfoximine with alkyl halides.

2.2.3 Lithiation and Trapping of Benzylic Sulfoximines

The results in the literature that are most similar to the examples described in the previous two chapters were reported by Pyne *et al.*[36,37] Pyne investigated the lithiation of *N*-TBDPS protected methyl benzyl sulfoximine **43** and trapping with aldehydes and imines. Two representative examples are shown in Scheme 2.33.[36,37] Trapping with benzaldehyde gave alcohols *syn,syn*-**44**, *anti,anti*-**44**, *anti,syn*-**44** and *syn,anti*-**44** as a 48:26:10:16 mixture, i.e. a 64:36 *syn:anti* ratio at the α-position. Use of imine **45** provided a 79:21 mixture of amine *syn,anti*-**46** and another unidentified diastereomer of **46**. Models were presented which rationalised the formation of the major diastereomer in each case, both of which had *syn* relative stereochemistry between the sulfoximine oxygen and α-phenyl substituent (see Figure 1.8). In contrast, the major products that we had obtained from the results presented in Chapters 2.2.1 and 2.2.2 were consistently *anti* at the α-position. The reason for the difference could be because sulfoximine **43** produces a benzylic lithiated sulfoximine or it could be due to the electrophile used. To probe this, we decided to carry out some lithiation-trappings with sulfoximine **43** and its *t*-Bu analogue **110** (Figure 2.11).
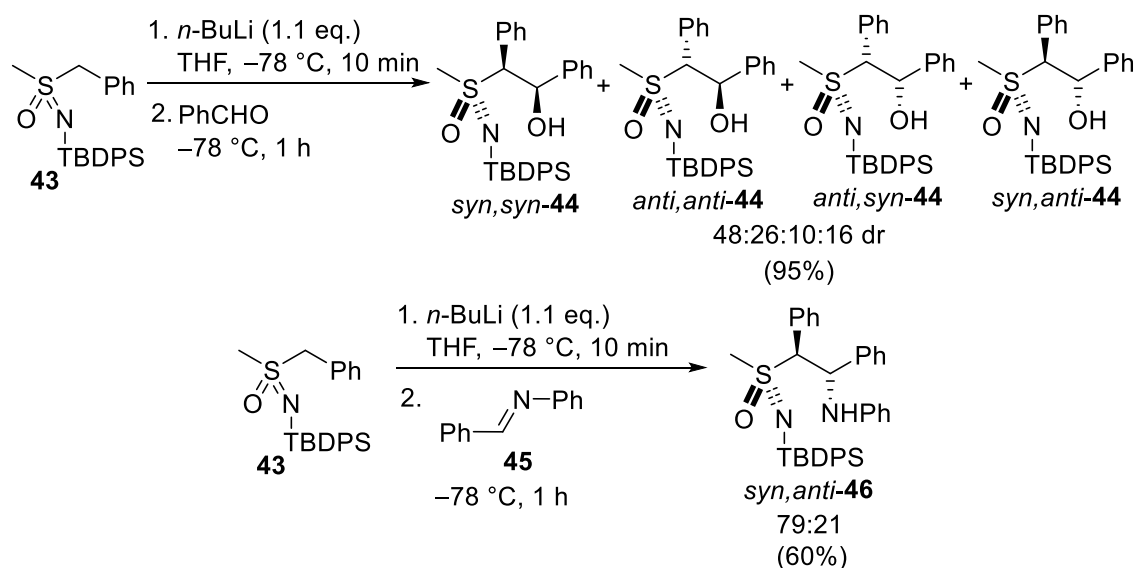
Scheme 2.33
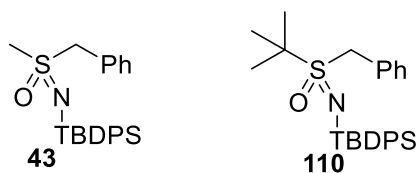
Figure 2.11 The structures of benzylic sulfoximines **43** and **110**

We began with sulfoximine **43** and repeated the reactions initially carried out by Pyne.[37] In our hands, lithiation of Me-substituted sulfoximine **43** and trapping with benzaldehyde gave a 70:25:5 mixture of alcohols **44a**, **44b** and **44c** (Scheme 2.34). A 95:5 mixture of sulfoximines **44a** and **44c** was isolated in 40% yield and sulfoximine **44b** was isolated in 13% yield. The signals at δ_H 6.07 (dd, $J = 2.0, 2.0$ Hz), δ_H 5.78 (d, $J = 9.5$ Hz) and δ_H 5.64 (dd, $J = 9.5, 1.0$ Hz) in the ^{1}H NMR spectrum of the crude product were assigned to the C*H*OH positions of **44b**, **44a** and **44c** respectively. These signals were used to determine the diastereoselectivity as they were better resolved than those for the α-CH environment. However, the stereochemistry was not assigned since Pyne's data is not available for comparison, and unfortunately, we were not able to reproduce Pyne's results.
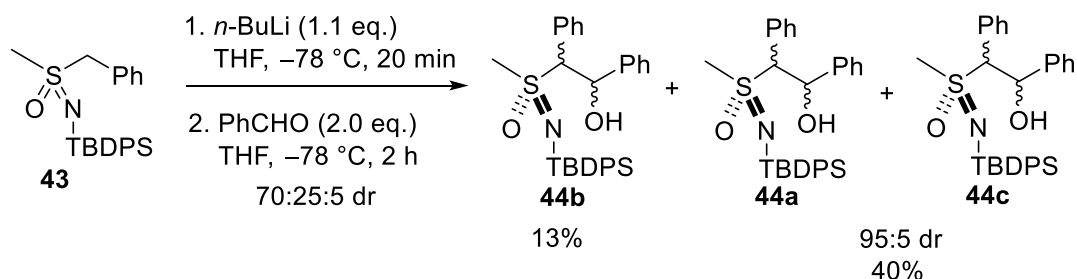
Scheme 2.34

Lithiation of sulfoximine **43** and trapping with imine **45** provided a 50:35:10:5 mixture of diastereomeric amines **46a**, **46b**, **46c** and **46d** (Scheme 2.35). Amine **46b** was isolated in 8% yield whereas **46a**, **46c** and **46d** were isolated as an 80:15:5 mixture in 38% yield. When imine **45** was precomplexed with boron trifluoride-diethyl ether prior to trapping, Pyne obtained a 95:5 mixture of amines **46** (see Scheme 1.12). When we attempted the boron trifluoride-diethyl ether reduction, a 15:20:50:15 mixture of amines **46a**, **46b**, **46c** and **46d** was obtained. The diastereoselectivity of these reactions was determined using the ^{1}H NMR spectra of the crude products. The signals corresponding to the SMe environment were the most useful, as these were the best resolved. The singlets at δ_H 2.20, δ_H 2.27, δ_H 2.32 and δ_H 2.38 were assigned to amines **46a**, **46b**, **46c** and **46d** respectively. Even though the stereochemistry has not been assigned, the ratio of diastereomeric products **46a**-**d** from imine **45** were not in line with those reported by Pyne.
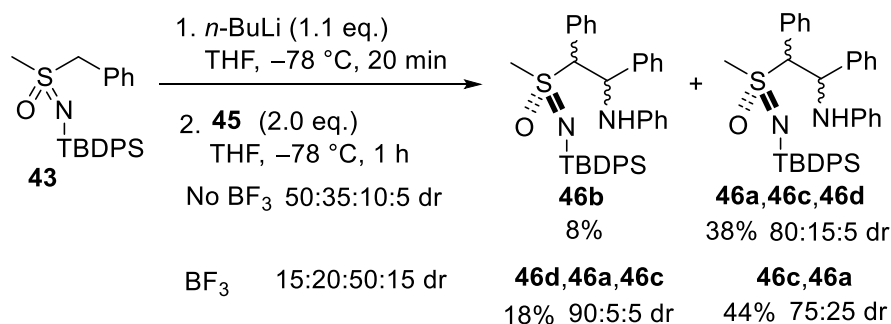
Scheme 2.35

Disappointingly, we were unable to reproduce Pyne's reactions of lithiated sulfoximine **43** with benzaldehyde and imine **45**. It is not clear to as why our ratios were so different to Pyne's. Nevertheless, two other electrophiles were investigated in order to explore the α-diastereoselectivity. Lithiation and trapping using benzophenone did not give any of the desired alcohol **164** (Scheme 2.36). After purification, the starting sulfoximine **43** was isolated in 36% yield together with alcohol **165**, which was obtained as a 70:30 mixture with TBDPSOH (calculated by ^{1}H NMR spectroscopy). Comparison of a literature ^{1}H NMR spectrum of TBDPSOH provided evidence of the impurity in this case.[68] The formation of sulfoximine **165** was shown by mass spectrometry and ^{1}H and ^{13}C NMR spectroscopy of the purified product. The ^{1}H NMR spectrum showed 1H, 1H and 2H signals at δ$_H$ 3.74 (d, *J* = 14.5 Hz, 1H, SC*H*Ph), δ$_H$ 3.66 (d, *J* = 14.5 Hz, 1H, SC*H*Ph) and δ$_H$ 3.42 (s, 2H, SC*H*$_2$COH), corresponding to the two CH$_2$ environments. The corresponding signals were also observed in the ^{13}C NMR spectrum. To explain the lack of formation of **164**, we speculate that the trapping reaction is reversible *via* a 'retro-aldol'-type process. In this case, the retro-process could occur because of the stability of the benzylic anion that is generated. Furthermore, since product **165** has been functionalised on the less acidic methyl position, it is possible that the reversibility of the trapping allows anion equilibration to occur.
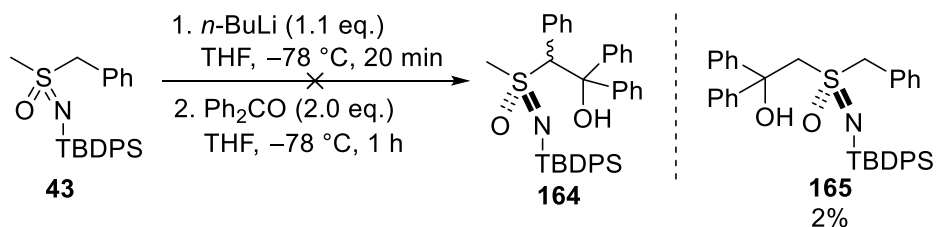
Scheme 2.36

Lithiation of Me-substituted sulfoximine **43** and trapping with methyl iodide provided an 85:15 mixture of monosubstituted sulfoximine **166** (as a 90:10 mixture of *syn*-**166** and

anti-**166**) and disubstituted sulfoximine **167** (as a 60:40 mixture of unknown diastereomers **167a** and **167b**) (Scheme 2.37). Sulfoximines *syn*-**166** and **167b** were isolated in 74% yield (as a 94:6 mixture). Disubstituted sulfoximine **167a** was obtained in 8% yield and monosubstituted *anti*-**166** was isolated in 10% yield.
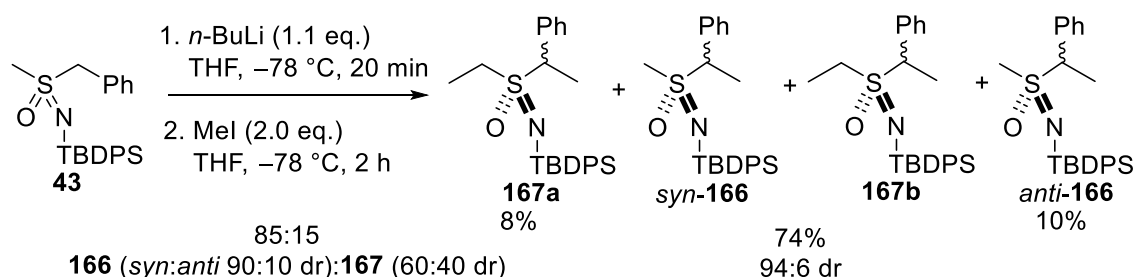
Scheme 2.37

The ^{1}H NMR spectrum of the crude product was used to determine the diastereoselectivity. For diastereomeric sulfoximines *syn*-**166** and *anti*-**166**, the signals corresponding to the S*Me* environment were the most useful. The presence of disubstituted sulfoximines **167** were indicated by the signals at δ_H 1.04 (t, $J = 7.0$ Hz) and δ_H 1.02 (t, $J = 7.0$ Hz) for the SCH$_2$*Me* position in the ^{1}H NMR spectra of the purified products. The diastereoselectivity was identified by the signals in the ^{1}H NMR spectra of the crude product at δ_H 1.72 (d, $J = 7.5$ Hz) and δ_H 1.68 (d, $J = 7.5$ Hz) which were assigned to the SCH*Me* environment. Mass spectrometry was also used to establish the formation of the disubstituted product. The stereochemistry of the minor monosubstituted product, *anti*-**166**, was assigned using X-ray crystallography (Figure 2.12). The relative stereochemistry of major monosubstituted sulfoximine, *syn*-**166**, has an α-stereochemistry that is the same as Pyne observed with imine **45** (see Scheme 2.33) but opposite to that from our results (see Chapters 2.2.1 and 2.2.2).
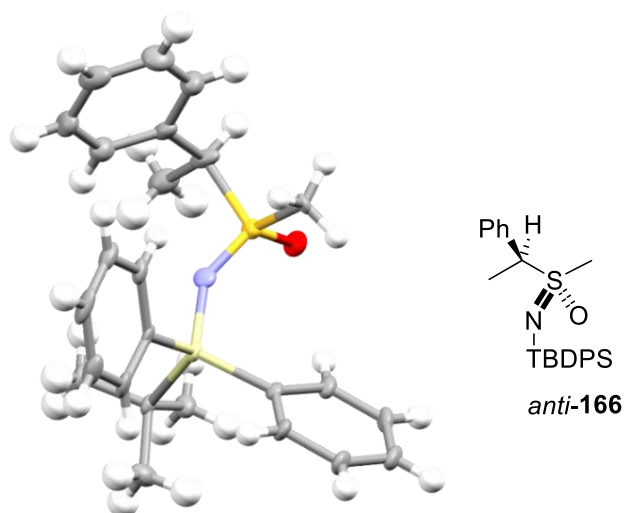
Figure 2.12 X-ray crystal structure of *N*-TBDPS sulfoximine *anti*-**166**

To explain the formation of disubstituted sulfoximine **167**, a similar mechanism is proposed to the related trapping of diethyl sulfoximine **86** with benzyl bromide (see Scheme 2.27). It is likely that lithiation would initially take place at the benzylic position to give **166** after methylation. As the trapping process with alkyl halides is believed to be slow, this could allow a second lithiation and trapping at the methyl position, leading to the disubstituted sulfoximine **167** (Scheme 2.38).
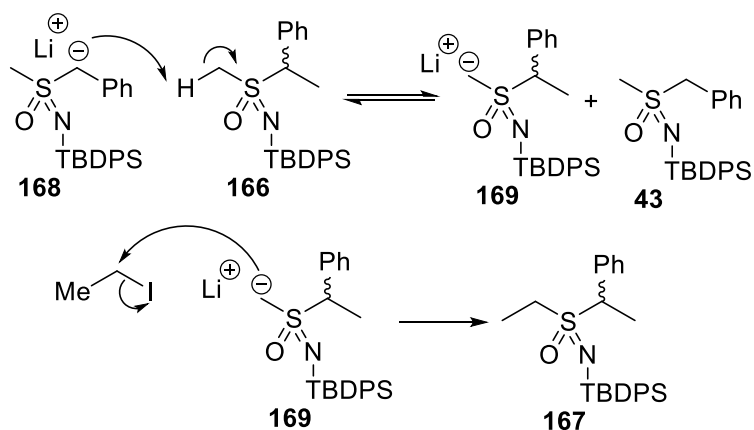
Scheme 2.38

With limited information obtained with methyl benzyl sulfoximine **43** so far, we decided to investigate *t*-Bu-substituted benzylic sulfoximine **110**. This was because of the high diastereoselectivity exhibited by structurally similar *t*-Bu-substituted alkyl sulfoximines **118** and **119**. As an initial test, *t*-Bu-substituted sulfoximine **110** was lithiated and trapped with deuterated methanol (Scheme 2.39). This gave deuterated sulfoximine **110-d** as a 65:35 mixture of diastereomers in 99% yield.
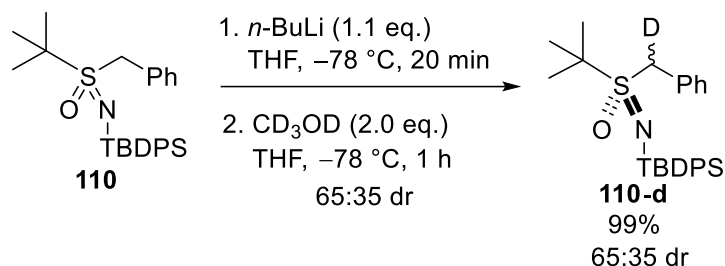
Scheme 2.39

Next, lithiation and trapping with benzaldehyde was explored. This gave an 85:15 mixture of diastereomeric alcohols *anti,anti*-**170** and *syn,syn*-**170** which were isolated in respective yields of 77% and 6% (Scheme 2.40). The α-SCH signals in the ^{1}H NMR spectra of the crude product were used to determine the diastereoselectivity. The stereochemistry of sulfoximines *anti,anti*-**170** and *syn,syn*-**170** were assigned using X-ray crystallography (Figure 2.13). For *anti,anti*-**170**, the proximity of the hydroxyl substituent and the sulfoximine oxygen indicated a hydrogen bonding interaction. The relative α-stereochemistry of major alcohol *anti,anti*-**170** is *anti* which is different to that observed by Pyne (see Scheme 2.33) but consistent with that observed in our examples shown in the previous chapters.
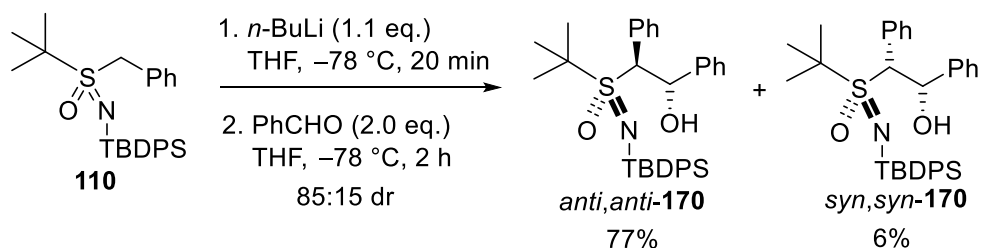
Scheme 2.40
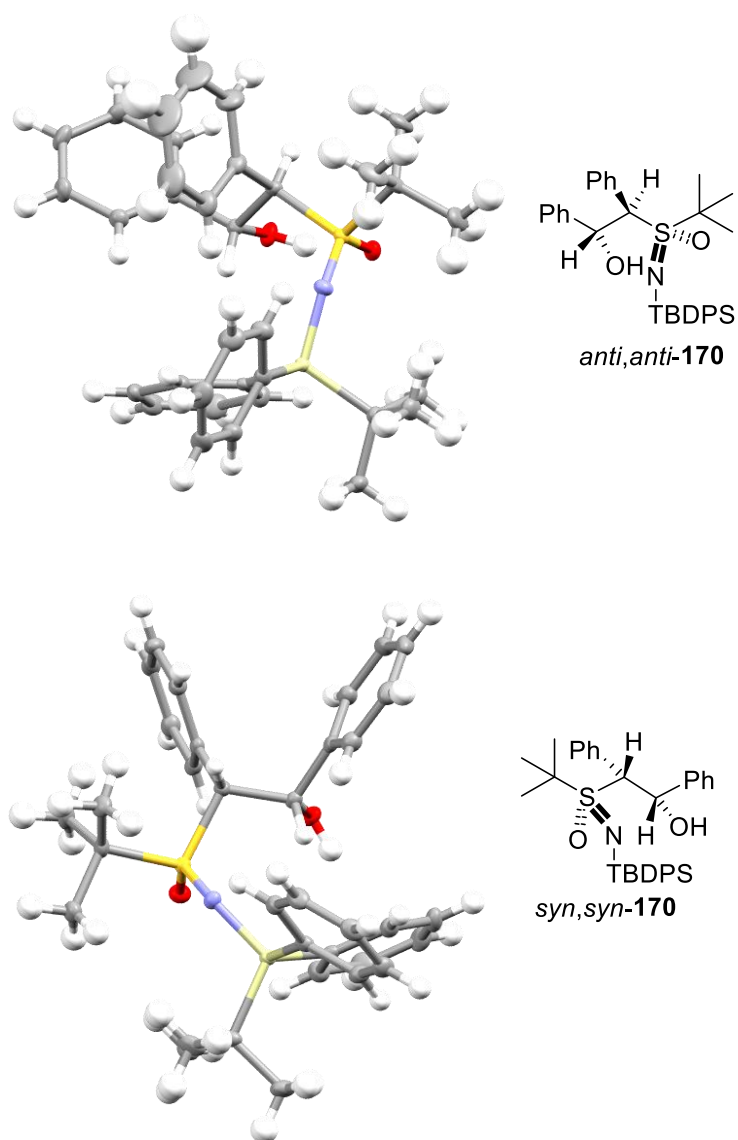
Figure 2.13 X-ray crystal structures of *N*-TBDPS sulfoximines *anti*,*anti*-**170** and *syn*,*syn*-**170**

Lithiation of *t*-Bu-substituted sulfoximine **110** and trapping with benzophenone did not give any of the desired alcohol **171**. This is a similar outcome to that obtained with methyl benzyl sulfoximine **43** (see Scheme 2.36). Trapping with imine **45** was also unsuccessful and gave none of the desired product **172** (Scheme 2.41).
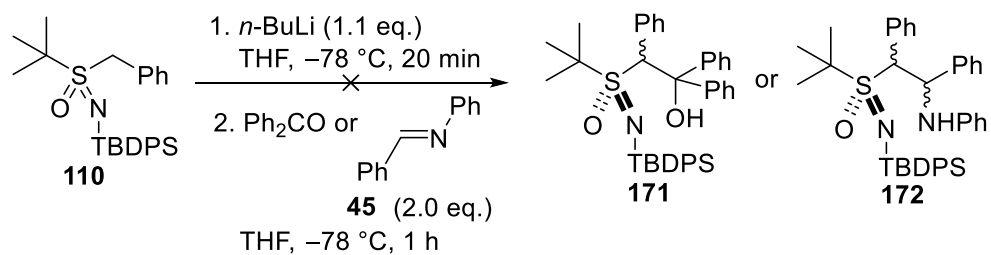
Scheme 2.41

In contrast, trapping with methyl iodide was more successful. The reaction gave a 50:50 mixture of diastereomeric sulfoximines **173** (Scheme 2.42). After purification, **173a** was isolated in 47% yield and a 96:4 mixture of **173b** and **173a** were isolated in 41% yield. The signals for the α-CH position within the ¹H NMR spectrum of the crude product were used to determine the diastereoselectivity. Compared to the benzaldehyde trapping, the low diastereoselectivity with methyl iodide was surprising. We suggest that slow trapping allows equilibration between lithiated **110** and the product which would impact on the ratio of diastereomeric products.
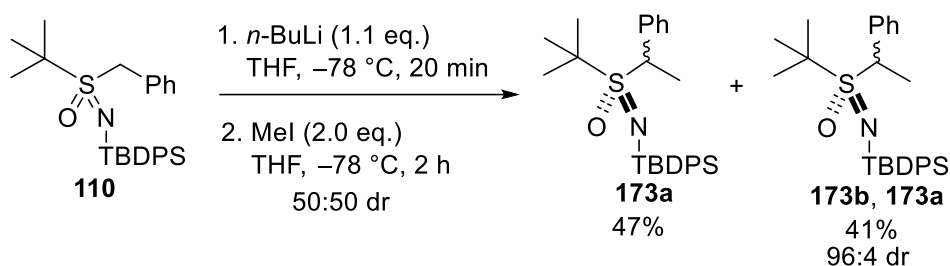
Scheme 2.42

To summarise, the reactions of benzylic sulfoximines **43** and **110** in this chapter have shown variable diastereoselectivity with a range of electrophiles. This is surprising as the related reactions of alkyl sulfoximines were consistently *anti*-diastereoselective (see Chapters 2.2.1 and 2.2.2). However, *anti*-diastereoselectivity was observed in one example: the lithiation-trapping of *t*-Bu-substituted sulfoximine **110** with benzaldehyde. In this reaction, an 85:15 mixture of *anti*,*anti*-**170** and *syn*,*syn*-**170** were obtained and the major product had the *anti*-α-stereochemistry.

2.3 Synthesis of Tetrasubstituted Sulfoximines

The lithiation-trappings of *t*-Bu-substituted *N*-TBDPS sulfoximines **118** and **119** provided a high yielding and diastereoselective approach for the α-functionalisation of sulfoximines using a range of electrophiles. Due to the success of this work, it was decided that some of these α-functionalised products could provide a means of diastereoselectively synthesising tetrasubstituted sulfoximines using a second lithiation-trapping reaction. *t*-Bu-substituted sulfoximine *syn*-**149** was selected as a candidate for this work as it had no protons that would be more acidic than those at the α-position. The plan was to employ conditions similar to those that were used previously, utilising *n*-BuLi for deprotonation followed by trapping with an electrophile to give sulfoximines **174** (Scheme 2.43).
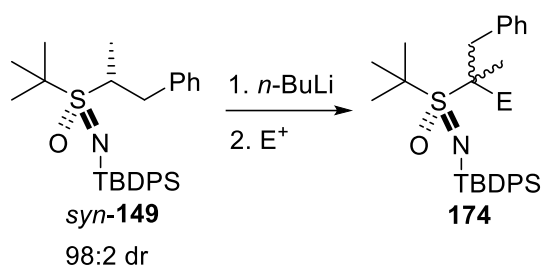
Scheme 2.43

There were two key factors to consider. First, due to the extra steric hindrance, both the lithiation and the electrophile trapping steps may be slower. Second, it was unclear whether the second lithiation-trapping would be diastereoselective. To investigate whether complete lithiation of the starting sulfoximine would occur, *syn*-**149** was lithiated and trapped with deuterated methanol. This gave an 85:15 mixture of deuterated diastereomeric sulfoximines *syn*-**149**-**d** and *anti*-**149**-**d** in 89% yield (Scheme 2.44). This high diastereoselectivity was very promising.
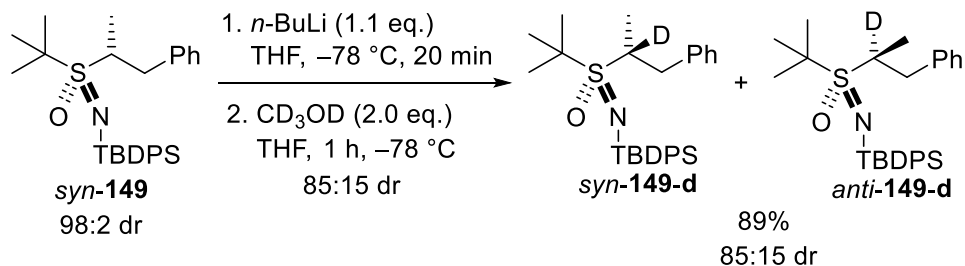
Scheme 2.44

Analysis of the ^{1}H NMR spectrum of the crude product showed that complete lithiation of starting sulfoximine *syn*-**149** had occurred after 20 min at −78 °C. The stereochemistry of the major deuterated product *syn*-**149-d** was assigned as *syn*. The ^{1}H NMR spectrum of **149-d** allowed the stereochemistry to be determined by analogy with protonated sulfoximine *syn*-**149**. Protonated *syn*-**149** presented ^{1}H NMR spectroscopic signals at δ_H 2.30 (dd, J = 13.5, 12.0 Hz) and δ_H 0.96 (d, J = 7.0 Hz) for one of the diastereotopic SCH$_2$ protons and the SCH*Me* environments respectively. In contrast, protonated sulfoximine *anti*-**149** exhibited these signals at δ_H 1.80 (dd, J = 13.5, 12.0 Hz) and δ_H 1.04 (d, J = 7.0 Hz). The chemical shifts of the analogous signals for deuterated sulfoximines *syn*-**149-d** (δ_H 2.30 and δ_H 0.96) and *anti*-**149-d** (δ_H 1.85 and δ_H 1.08), showed that *syn*-**149-d** was the major diastereomer.

Next, a protonation reaction was carried out to confirm this stereochemical assignment. Sulfoximine *syn*-**149** was lithiated and trapped with an excess of saturated ammonium chloride solution. This gave *syn*-**149** and *anti*-**149** as a 90:10 mixture in 47% yield (Scheme 2.45), thus supporting the assignment of stereochemistry for deuterated sulfoximine *syn*-**149-d**.
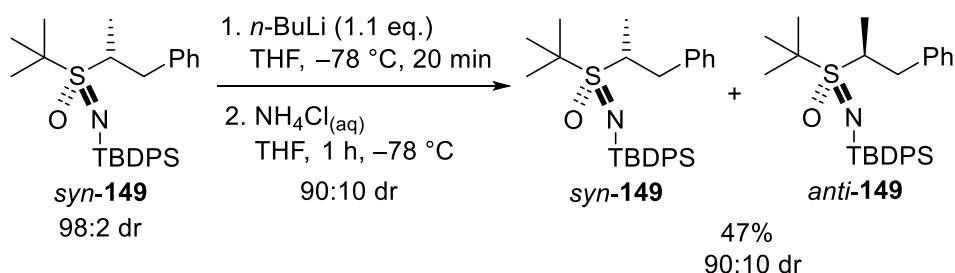
Scheme 2.45

We then decided to explore the lithiation-trapping reactions of disubstituted sulfoximine *syn*-**149** with various electrophiles. Initially, lithiation of *syn*-**149** and subsequent trapping with benzophenone was attempted using the standard conditions of *n*-BuLi in THF at −78 °C for 20 min followed by trapping for 1 h at −78 °C. This resulted in no formation of alcohol **175**. A 65:35 mixture of diastereomeric starting sulfoximines *syn*-**149** and *anti*-**149** was isolated (Scheme 2.46). As the lithiation step had previously been shown to be successful, we suspected that the trapping step was the problem. With this in mind, the reaction mixture for the electrophilic trapping was left overnight and allowed to warm to rt. However, this also gave no evidence of product formation and only a 65:35 mixture of *syn*-**149** and *anti*-**149** was isolated (Scheme 2.46).
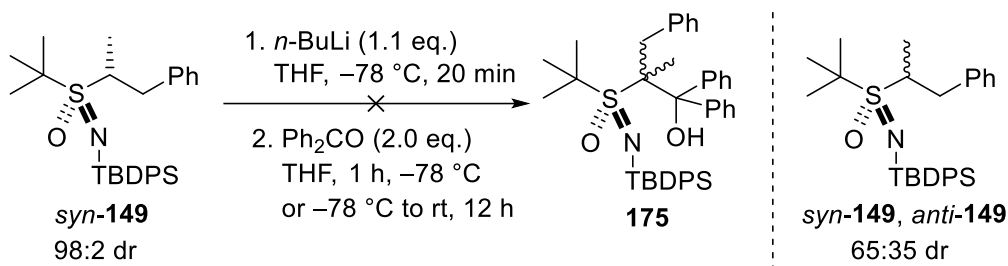
Scheme 2.46

Trapping with Weinreb amide **73** was also unsuccessful and provided none of the desired ketone **176** after a trapping duration of 2 h at −78 °C (Scheme 2.47). The fluorination[38] of *syn*-**149** was also attempted by trapping with NFSI but this reaction gave no desired fluorinated sulfoximine **177** (by ^{1}H and ^{19}F NMR spectroscopy). Allowing the reaction mixture to warm to rt over a period of 12 h during the trapping step showed no change in the ^{1}H NMR spectrum of the crude product. Analysis of the ^{1}H NMR spectrum of the crude product in each case indicated the formation of 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149**.
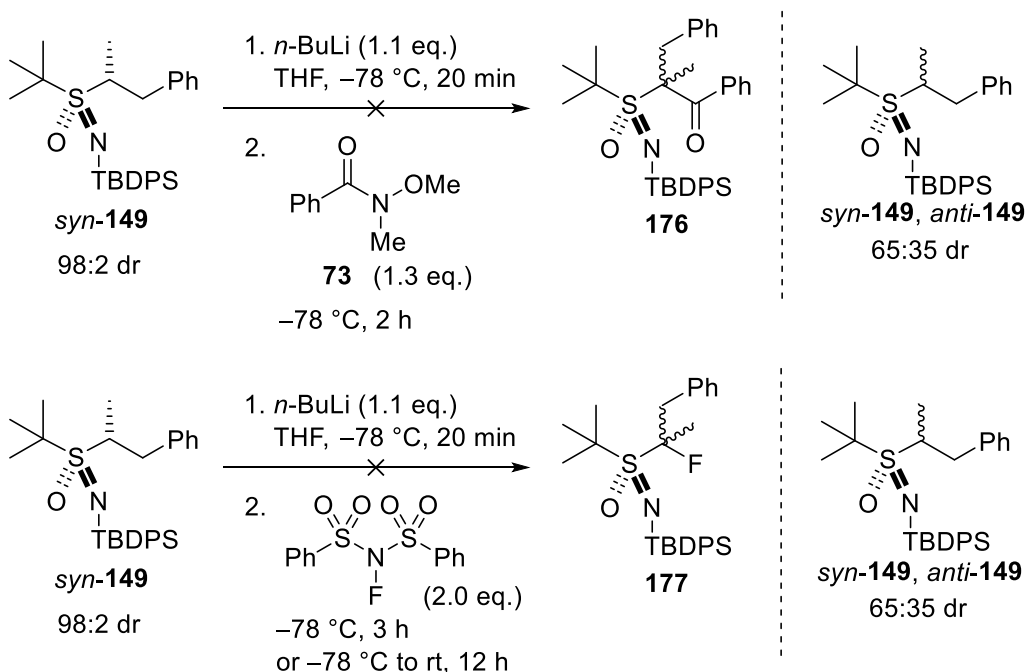
Scheme 2.47

To explore whether trapping with less sterically demanding electrophiles was possible, methyl iodide was selected. To our delight, trapping with methyl iodide afforded sulfoximine **178** and starting sulfoximines *syn*-**149** and *anti*-**149** as an 80:17:3 mixture (calculated yield of 80% for sulfoximine **178** by ^{1}H NMR spectroscopy) (Scheme 2.48).

Ethyl iodide was then employed as an alternative electrophile that would allow us to explore the diastereoselectivity. Trapping with ethyl iodide provided a 75:25 mixture of diastereomeric sulfoximines **179**. A 90:10 mixture of **179** and starting material *anti-***149** were then isolated after two attempts at separation (calculated yield of 28% by ^{1}H NMR spectroscopy).
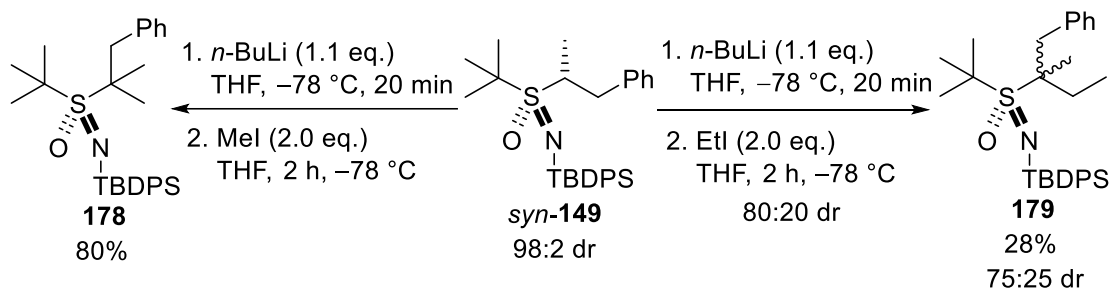
Scheme 2.48

^{1}H NMR spectroscopy was used to determine that the ethylation of sulfoximine *syn-***149** was successful. For sulfoximines **179**, signals at δ_H 0.73 (dd, $J = 9.5, 7.5$ Hz), δ_H 0.72 (dd, $J = 9.5, 7.5$ Hz), δ_H 1.59–1.52 (m), δ_H 1.85–1.76 (m) and δ_H 2.2–2.93 (m) were assigned to the CH$_2$*Me* and C*H*Me environments which showed the installation of the ethyl substituent. The signals at δ_H 3.10 and δ_H 3.16 corresponding to the C*H*Ph environment were used to determine the diastereoselectivity. The stereochemistry of sulfoximines **179** could not be assigned in this case.

Finally, benzaldehyde was investigated and this gave the best result. Lithiation and trapping of *syn-***149** with benzaldehyde gave alcohol **180** as a 95:5 mixture of diastereomers **180a** and **180b** from which single diastereomeric sulfoximine **180a** was isolated in 67% yield after chromatography (Scheme 2.49). Successful trapping with benzaldehyde was presumably due to its increased electrophilicity when compared to the other carbonyl-containing electrophiles employed (benzophenone and Weinreb amide **73**). In the ^{1}H NMR spectrum of the crude product, the signals at δ_H 5.61 and δ_H 6.54 were assigned to the C*H*OH and CHO*H* environments of alcohol **180a**, which showed the incorporation of the newly formed alcohol unit. Signals were observed at δ_H 5.30 (d, $J = 7.0$ Hz) and δ_H 6.16 (d, $J = 7.0$ Hz) for the minor diastereomer **180b**.
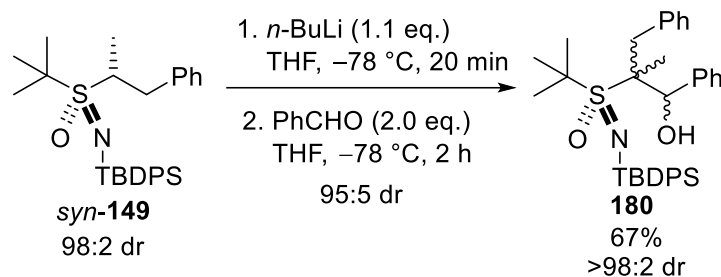
Scheme 2.49

Due to the poor crystallinity of sulfoximine **180a**, X-ray crystallography could not be used to assign the stereochemistry. In an attempt to produce a crystalline compound, TBDPS removal was explored. Thus, *N*-TBDPS sulfoximine **180a** was treated with TBAF in THF (rt, 64 h) which gave a complex mixture and none of the desired NH sulfoximine **181** was formed (Scheme 2.50). In a similar system, we observed deprotection taking place followed by a 'retro-aldol' type process (see Scheme 2.14). We therefore suspect that sulfoximine **180a** may have undergone a similar process under the basic conditions. To overcome this, a procedure for TBDPS removal under acidic conditions was employed. Reaction of *N*-TBDPS sulfoximine **180a** with HCl (generated *in situ* from AcCl and dry MeOH) gave none of the desired product.[69] The use of TBAF with AcOH has also been described for the silyl deprotection of base-sensitive compounds.[70] Therefore, in a final attempt, sulfoximine **180a** was treated with AcOH and TBAF in THF (rt, 96 h) but the formation of the NH sulfoximine **181** was not observed.

Conditions **A**: TBAF (2.0 eq.), THF, rt, 64 h
Conditions **B**: AcCl (0.15 eq.), MeOH, 0 °C to rt, 24 h
Conditions **C**: TBAF (1.5 eq.), AcOH (1.5 eq.), THF, rt, 96 h
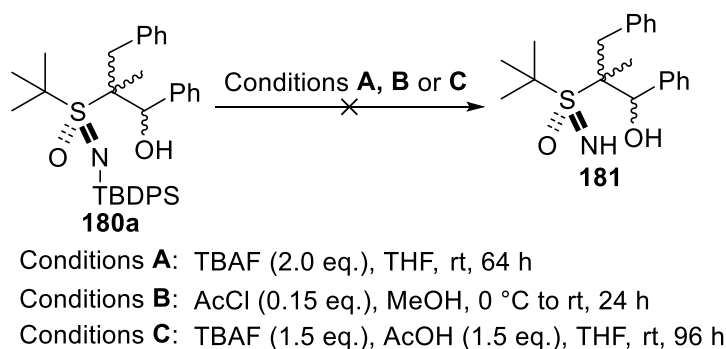
Scheme 2.50

As an alternative approach to obtaining a more crystalline compound, we tried to functionalise at the hydroxy group without removing the TBDPS group. Sulfoximine **180a** was treated with Et$_3$N and 4-bromobenzoyl chloride in CH$_2$Cl$_2$ (rt, 96 h). This gave none of the desired ester **182** and only starting sulfoximine **180a** (Scheme 2.51). A similar procedure, adapted from the literature,[71] which employed catalytic DMAP, was then also

attempted. Unfortunately, only the starting sulfoximine **180a** was observed in the ^{1}H NMR spectrum of the crude product.

Conditions **A**: Et$_3$N (1.3 eq.), 4-bromobenzoyl chloride (1.3 eq.)
CH$_2$Cl$_2$, 0 °C, 1 h, rt, 96 h

Conditions **B**: DMAP (0.25 eq.), Et$_3$N (1.5 eq.),
4-bromobenzoyl chloride (1.1 eq.), CH$_2$Cl$_2$, 0 °C to rt, 24 h
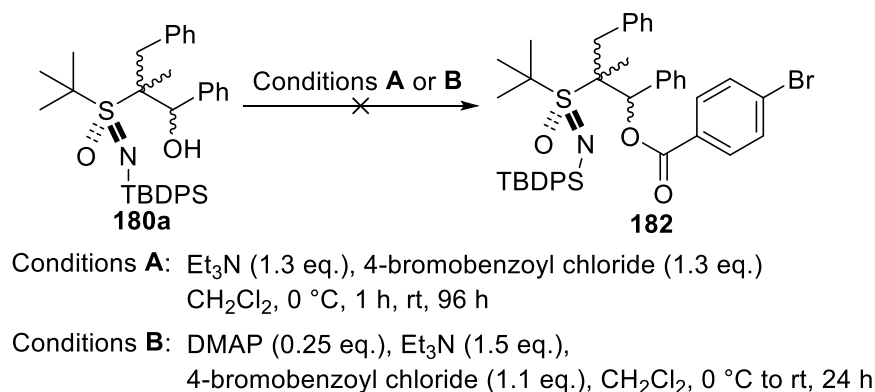
Scheme 2.51

The lithiation-trapping of *syn*-**149** with benzaldehyde was highly diastereoselective. We therefore wondered if employing the opposite diastereomeric starting sulfoximine would lead to the same or a different outcome. Lithiation of *anti*-**149** and subsequent trapping with benzaldehyde provided a 95:5 mixture of diastereomeric alcohols **180a** and **180b** (Scheme 2.52). After purification, a 90:10 mixture of **180a** and starting sulfoximine *anti*-**149** were isolated, with a calculated yield of 68% for **180a** (by ^{1}H NMR spectroscopy). This was essentially the same result as that achieved from the reaction of starting sulfoximine *syn*-**149** with benzaldehyde (see Scheme 2.49). These results imply that the reactions of *syn*-**149** and *anti*-**149** proceed *via* the same pathway and therefore share a common intermediate. We suspect that the lithiated intermediate species would contain a sp^2 hybridised α-carbon. This may be similar to the previously proposed model for the lithiation-trappings discussed in Chapters 2.2.1 and 2.2.2 (see Figure 2.7). However, as the stereochemistry could not be assigned for the reactions of *syn*-**149** and *anti*-**149** with benzaldehyde, a model for the transition state cannot currently be proposed.
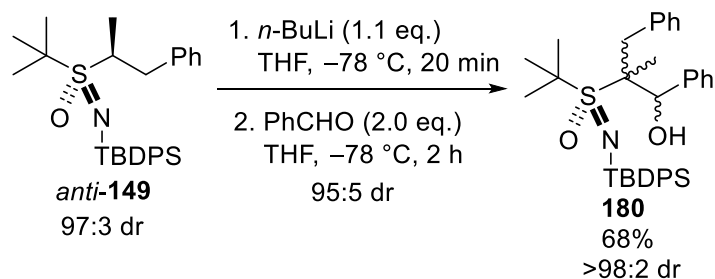
Scheme 2.52

To summarise, three tetrasubstituted sulfoximines have been successfully synthesised *via* lithiation of sulfoximine *syn*-**149** and subsequent trapping with methyl iodide, ethyl iodide and benzaldehyde. Trapping with benzaldehyde provided a highly diastereoselective reaction, and the same mixture of diastereomers could be obtained from either diastereomeric starting sulfoximine, *syn*-**149** or *anti*-**149**. Unfortunately, the stereochemistry could only be assigned for deuterated sulfoximines **149**-**d**, and further work is therefore required for the stereochemical assignment of the other examples.

3. Conclusions and Future Work

To conclude, we have synthesised a wide range of α-functionalised acyclic sulfoximines *via* lithiation-trapping methodology. *N*-TBDPS adamantyl and *t*-Bu-substituted sulfoximines have displayed high diastereoselectivity consistently across a range of carbonyl-containing and alkyl halide electrophiles. Some other functionalised *N*-TBDPS acyclic sulfoximines have also demonstrated good diastereoselectivity, including Ph, *i*-Pr, *o*-tol and Et-substituted sulfoximines. These reactions consistently give the *anti*-configured product as the major diastereomer and we have proposed a model which rationalises this. In contrast, when benzylic sulfoximines were employed, varied diastereoselectivity was observed. Examples of some of the most diastereoselective and high yielding results are presented in Figure 3.1. It was also discovered that, by changing the order of the installation of the α-substituents, the opposite diastereomer could be obtained. An example of this is shown by *t*-Bu-substituted sulfoximines *anti*-**149** and *syn*-**149** (Figure 3.1).
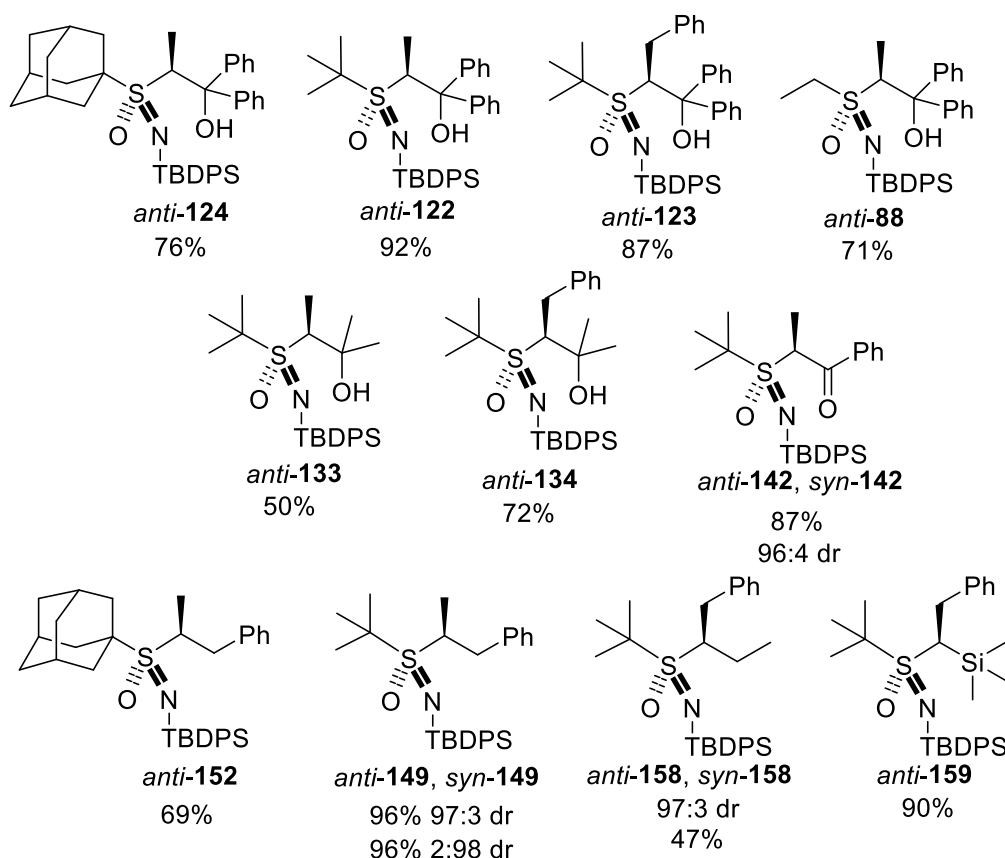
Figure 3.1 Products of highly diastereoselective lithiation-trapping reactions of *N*-TBDPS sulfoximines

Even in cases where a lower diastereoselectivity was observed, the *anti*-products could still be obtained in good yields after chromatography. Examples of this are shown in Figure 3.2. Some alternative functionalities on nitrogen were also explored including *N*-TBDMS and *N*-Boc which gave high and low diastereoselectivity respectively. Chromatography, however, enabled the isolation of both diastereomers and the major *anti*-configured products could therefore still be obtained in good yields (Figure 3.2).
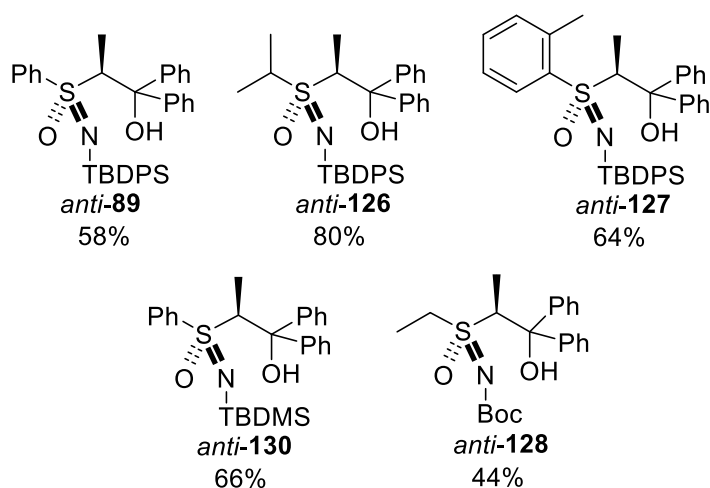
Figure 3.2 *N*-TBDPS, *N*-TBDMS and *N*-Boc lithiation-trapping products

Using the lithiation-trapping methodology, some tetrasubstituted acyclic sulfoximines were also successfully prepared. Lithiation and trapping of *t*-Bu-substituted sulfoximine **149** with deuterated methanol, alkyl halides and benzaldehyde afforded the corresponding products in moderate to high yields and diastereoselectivity (Figure 3.3). Furthermore, it was found that the same diastereomeric outcome was obtained when either diastereomeric starting sulfoximine, *syn*-**149** or *anti*-**149**, was employed.
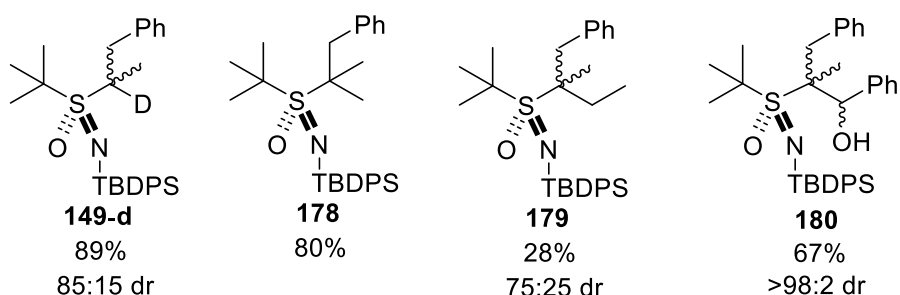
Figure 3.3 *N*-TBDPS tetrasubstituted lithiation-trapping products

Future work will involve completing the stereochemical assignments of some α-functionalised products. This will focus especially on the assignment of the stereochemistry of the tetrasubstituted sulfoximines which would allow a model for the

lithiation-trapping to be proposed. As we have been unable to grow crystals of alcohol **180a** suitable for X-ray crystallography, an alternative approach could be to employ other electrophiles in the synthesis, such as different aldehydes. These derivatives of sulfoximine **180a** may be more suitable for crystallisation.

Future work will also focus on the arylation of some acyclic sulfoximines using Negishi cross-coupling[72] (Scheme 3.1). This will employ *n*-BuLi as the base, followed by transmetallation with ZnCl$_2$. Then, the desired aryl bromide, Pd(OAc)$_2$ and X-Phos will be used to give the α-functionalised sulfoximine **184**. *N*-TBDPS acyclic sulfoximines **183** will be initially investigated and we expect that the bulky TBDPS substituent will offer high diastereoselectivity and preferentially give the *anti*-configured products. Other *N*-functionalised sulfoximines could also be explored in these reactions.
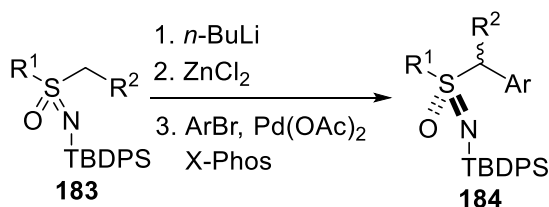
Scheme 3.1

Long term future plans may involve the enantioselective synthesis of α-functionalised sulfoximines using a chiral ligand such as sparteine[52] and related diamines. An example approach could involve the kinetic resolution of a racemic mixture of sulfoximine **119** in which a single enantiomer **185** could be isolated (Scheme 3.2).
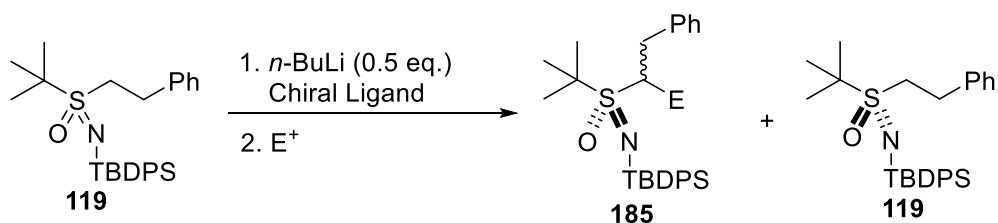
Scheme 3.2

4. Experimental

4.1 General Information

All-non aqueous reactions were carried out under oxygen−free Ar using flame-dried glassware. THF was freshly distilled from sodium and benzophenone. Alkyllithiums were titrated against *N*-benzylbenzamide before use.[73] Acetone, methyl iodide, ethyl iodide and benzaldehyde were distilled over CaH_2 before use. Benzophenone, benzyl bromide, TMSCl, Weinreb amide **73**, Weinreb amide **144**, CD_3OD, NFSI and *N*-benzylideneaniline were used without further purification. Brine refers to a saturated solution. Water is distilled water.

Flash column chromatography was carried out using Fluka Chemie GmbH silica (220-440 mesh). Thin layer chromatography was carried out using commercially available Merck F_{254} aluminium backed silica plates. Proton (400 MHz) and carbon (100.6 MHz) NMR spectra were recorded on a Jeol ECX-400 instrument using an internal deuterium lock. For samples recorded in $CDCl_3$, chemical shifts are quoted in parts per million relative to $CHCl_3$ (δ_H 7.26) and $CDCl_3$ (δ_C 77.0, central line of triplet). For samples recorded in d_6-DMSO, chemical shifts are quoted in parts per million relative to DMSO (δ_H 2.50, central line of quintet) and d_6-DMSO (δ_C 39.5, central line of septet). For samples recorded in d_6-acetone, chemical shifts are quoted in parts per million relative to acetone (δ_H 2.05, central line of quintet) and d_6-acetone (δ_C 29.8, central line of septet). Carbon NMR spectra were recorded with broad band proton decoupling and assigned using DEPT experiments. Coupling constants (*J*) are quoted in Hertz. Melting points were carried out on a Gallenkamp melting point apparatus. Infrared spectra were recorded on an ATI Mattson Genesis FT-IR spectrometer. Electrospray high and low resonance mass spectra were recorded at room temperature on a Bruker Daltronics microOTOF spectrometer.

4.2 General Procedures

General Procedure A: Synthesis of *N*-H sulfoximines

A solution of the sulfide (20.0 mmol, 1.0 eq.), (diacetoxyiodo)benzene (16.11 g, 50.0 mmol, 2.5 eq) and ammonium carbamate (3.12 g, 20.0 mmol, 2.0 eq.) in MeOH (40 mL) was stirred at rt for 3 h. The solvent was evaporated under reduced pressure to give the crude product.

General Procedure B: Synthesis of *N*-TBDPS sulfoximines from *N*-H sulfoximines

TBDPSCl (12.5 mmol, 1.25 eq. or 9.0 mmol, 0.9 eq.) was added dropwise to a stirred solution of the *N*-H sulfoximine (10.0 mmol, 1.0 eq.) and imidazole (20.0 mmol, 2.0 eq.) in DMF (3 mL) under Ar at 0 °C or rt. The resulting solution was stirred and heated at 90 °C for 48 h. The solution was allowed to cool to rt and then water (5 mL) was added to the solution. The two layers were separated and the aqueous layer was extracted with Et$_2$O (3 × 20 mL). The combined organic layers were washed with brine (5 × 60 mL), dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product.

General Procedure C: Lithiation-trapping of acyclic sulfoximines

n-BuLi (1.5–2.5 M solution in hexanes, 1.1 eq.) was added dropwise to a stirred solution of the sulfoximine (0.5 mmol, 1.0 eq.) in THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 20 min. Then, the electrophile (1.0 mmol, 2.0 eq. or 0.65 mmol, 1.3 eq.) (as a solution in THF for benzophenone, NFSI and *N*-benzylideneanailine) was added dropwise. The resulting solution was stirred at the desired temperature for the desired duration and then allowed to warm to rt. Then, water (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 20 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product.

4.3   Experimental Procedures and Characterisation Data

Diethyl(imino)-λ⁶-sulfanone 97

97
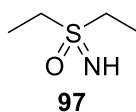
Using general procedure A, diethyl sulfide **96** (2.16 mL, 20.0 mmol, 1.0 eq.), (diacetoxyiodo)benzene (16.11 g, 50.0 mmol, 2.5 eq.) and ammonium carbamate (3.12 g, 40.0 mmol, 2.0 eq.) in MeOH (40 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave sulfoximine **97** (2.22 g, 92%) as a yellow oil, R_F (9:1 EtOAc-MeOH) 0.13; IR (ATR) 3401 (NH), 3260 (NH), 2981, 2943, 1666, 1457, 1414, 1186, 1103, 972, 781, 717, 495 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 3.03 (q, J = 7.5 Hz, 4H, SCH$_2$), 2.41 (s, 1H, NH), 1.38 (t, J = 7.5 Hz, 6H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 48.3 (SCH$_2$), 7.1 (SCH$_2$*Me*); MS (ESI) *m/z* 122 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_4$H$_{11}$NOS (M + H)$^+$ 122.0634, found 122.0630 (+3.8 ppm error). Spectroscopic data are consistent with those reported in the literature.[51]

Lab book reference: **AH-1-28**

[(*tert*-Butyldiphenylsilyl)imino]diethyl-λ⁶-sulfanone 86

86
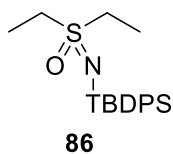
Using general procedure B, TBDPSCl (2.75 mL, 10.58 mmol, 1.25 eq.), sulfoximine **97** (1.02 g, 8.46 mmol, 1.0 eq.) and imidazole (1.15 g, 16.9 mmol, 2.0 eq.) in DMF (3 mL) added at 0 °C gave the crude product. Purification by flash column chromatography on silica with 9:1 hexane-EtOAc as eluent gave *N*-TBDPS sulfoximine **86** (2.42 g, 80%) as a clear oil, R_F (6:4 hexane-EtOAc) 0.42; IR (ATR) 3069, 2931, 2855, 1427, 1311, 1281, 1263, 1148, 1107, 821, 783, 738, 701, 625, 615, 589, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.77–7.74 (m, 4H, Ph), 7.40–7.32 (m, 6H, Ph), 2.89–2.74 (m, 4H, SCH$_2$), 1.24 (t, J = 7.5 Hz, 6H, SCH$_2$*Me*), 1.07 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.9 (*ipso*-Ph), 135.7 (Ph), 129.1 (Ph), 127.5 (Ph), 49.7 (SCH$_2$), 27.3 (C*Me₃*), 19.5 (*C*Me₃),

7.9 (SCH$_2$*Me*); MS (ESI) *m/z* 360 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{20}$H$_{29}$NOSSi (M + H)$^+$ 360.1812, found 360.1808 (+0.9 ppm error).

Lab book reference: **AH-1-21**

Ethyl(imino)phenyl-λ⁶-sulfanone 98

98
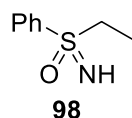
Using general procedure A, ethyl phenyl sulfide **186** (0.41 mL, 3.0 mmol, 1.0 eq.), (diacetoxyiodo)benzene (2.42 g, 7.5 mmol, 2.5 eq.) and ammonium carbamate (468 mg, 6.0 mmol, 2.0 eq.) in MeOH (6 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave sulfoximine **98** (295 mg, 58%) as a yellow oil, R_F (9:1 EtOAc-MeOH) 0.49; IR (ATR) 3268 (NH), 3063, 2938, 2878, 1446, 1209, 1096, 971, 761, 690, 568, 510 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.96 (d, *J* = 7.5 Hz, 2H, Ph), 7.61 (t, *J* = 7.5 Hz, 1H, Ph), 7.54 (dd, *J* = 7.5, 7.5 Hz, 2H, Ph), 3.17 (q, *J* = 7.5 Hz, 2H, SCH$_2$), 2.91 (br s, 1H, NH), 1.25 (t, *J* = 7.5 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 141.4 (*ipso*-Ph), 133.2 (Ph), 129.3 (Ph), 128.7 (Ph), 51.9 (SCH$_2$), 8.0 (SCH$_2$*Me*); MS (ESI) *m/z* 170 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_8$H$_{11}$NOS (M + H)$^+$ 170.0634, found 170.0633 (+0.9 ppm error). Spectroscopic data are consistent with those reported in the literature.[50]

Lab book reference: **AH-1-29**

Imino(methyl)phenyl-λ⁶-sulfanone 99

99
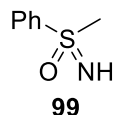
Using general procedure A, methyl phenyl sulfide **187** (0.35 mL, 3.0 mmol, 1.0 eq.), (diacetoxyiodo)benzene (2.42 g, 7.5 mmol, 2.5 eq.) and ammonium carbamate (468 mg, 6.0 mmol, 2.0 eq.) in MeOH (6 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave

sulfoximine **99** (145 mg, 31%) as a yellow oil, R_F (9:1 EtOAc-MeOH) 0.40; IR (ATR) 3266 (NH), 3063, 2928, 1446, 1218, 1098, 1010, 994, 742, 689, 524, 506 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.01 (d, J = 7.5 Hz, 2H, Ph), 7.61 (t, J = 7.5 Hz, 1H, Ph), 7.55 (dd, J = 7.5, 7.5 Hz, 2H, Ph), 3.11 (s, 3H, SMe), 2.96 (br s, 1H, NH); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 143.5 (*ipso*-Ph), 133.2 (Ph), 129.4 (Ph), 127.8 (Ph), 46.2 (SMe); MS (ESI) *m/z* 156 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_7$H$_9$NOS (M + H)$^+$ 156.0478, found 156.0473 (+2.9 ppm error). Spectroscopic data are consistent with those reported in the literature.[50]

Lab book reference: **AH-1-31**

Ethyl(imino)isopropyl-λ⁶-sulfanone 100

100
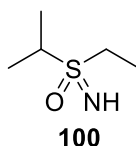
Using general procedure A, isopropyl ethyl sulfide **188** (0.64 mL, 5.0 mmol, 1.0 eq.), (diacetoxyiodo)benzene (4.03 g, 12.5 mmol, 2.5 eq.) and ammonium carbamate (781 mg, 10.0 mmol, 2.0 eq.) in MeOH (10 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave sulfoximine **100** (574 mg, 85%) as a yellow oil, R_F (9:1 EtOAc-MeOH) 0.19; IR (ATR) 3269 (NH), 2981, 2941, 1647, 1460, 1193, 995, 713 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 3.17 (septet, J = 7.5 Hz, 1H, SCH), 3.01 (q, J = 7.5 Hz, 2H, SCH$_2$), 2.57 (br s, 1H, NH), 1.41–1.33 (m, 9H, SCH$_2$*Me*, SCH*Me*$_2$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 53.7 (SCH), 45.5 (SCH$_2$), 16.1 (SCH*Me*), 15.4 (SCH*Me*), 6.5 (SCH$_2$*Me*); MS (ESI) *m/z* 136 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_5$H$_{13}$NOS (M + H)$^+$ 136.0791, found 136.0791 (−0.1 ppm error).

Lab book reference: **AH-1-32**

tert-Butyl(imino)methyl-λ⁶-sulfanone 101

101
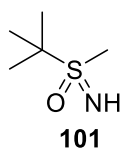
Using general procedure A, *tert*-butyl methyl sulfide **189** (2.21 mL, 17.5 mmol, 1.0 eq.), (diacetoxyiodo)benzene (14.09 g, 43.75 mmol, 2.5 eq.) and ammonium carbamate (2.73 g, 35.0 mmol, 2.0 eq.) in MeOH (40 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave sulfoximine **101** (1.99 g, 84%) as a yellow oil, R_F (9:1 EtOAc-MeOH) 0.26; IR (ATR) 3413 (NH), 3270 (NH), 2977, 2939, 1667, 1369, 1197, 1004, 941, 752, 588, 482 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 2.86 (s, 3H, SMe), 2.24 (br s, 1H, NH), 1.43 (s, 9H, C*Me*$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 60.3 (*C*Me$_3$), 36.1 (SMe), 24.0 (C*Me*$_3$); MS (ESI) *m/z* 136 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_5$H$_{13}$NOS (M + H)$^+$ 136.0791, found 136.0789 (+1.0 ppm error). Spectroscopic data are consistent with those reported in the literature.[50]

Lab book reference: **AH-1-30**

Ethyl(imino)(2-methylphenyl)-λ⁶-sulfanone 102

102
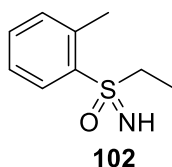
Using general procedure A, 2-(ethylsulfanyl)-1-methylbenzene **113** (2.81 g, 18.4 mmol, 1.0 eq.), (diacetoxyiodo)benzene (14.82 g, 46.0 mmol, 2.5 eq.) and ammonium carbamate (2.87 g, 36.8 mmol, 2.0 eq.) in MeOH (40 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave sulfoximine **102** (3.06 g, 91%) as a yellow oil, R_F (9:1 EtOAc-MeOH) 0.42; IR (ATR) 3271 (NH), 2978, 2938, 1456, 1210, 1072, 970, 804, 764, 718, 515, 474 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.05 (d, *J* = 7.5 Hz, 1H, Ar), 7.48 (dd, *J* = 7.5, 7.5 Hz, 1H, Ar), 7.38–7.29 (m, 2H, Ar), 4.69 (br s, NH), 3.24 (q, *J* = 7.5 Hz, 2H, SCH$_2$), 2.73 (s, 3H, ArMe), 1.25 (td, *J* = 7.5, 2.0 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 139.4 (*ipso*-Ar), 138.1 (*ipso*-Ar), 133.2 (Ar), 133.1 (Ar), 130.8 (Ar), 126.7 (Ar), 50.1 (SCH$_2$),

21.0 (Ar*Me*), 7.7 (SCH$_2$*Me*); MS (ESI) *m/z* 184 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_9$H$_{13}$NOS (M + H)$^+$ 184.0791, found 184.0792 (−1.0 ppm error).

Lab book reference: **AH-1-58**

Adamantan-1-yl(ethyl)imino-λ^6-sulfanone 103

103
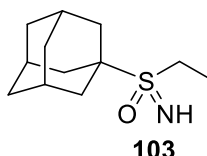
Using general procedure A, adamantyl ethyl sulfide **114** (2.42 g, 12.7 mmol, 1.0 eq.), (diacetoxyiodo)benzene (10.23 g, 31.75 mmol, 2.5 eq.) and ammonium carbamate (1.98 g, 25.4 mmol, 2.0 eq.) in MeOH (30 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave sulfoximine **103** (2.21 g, 77%) as a yellow oil, R_F (9:1 EtOAc-MeOH) 0.39; IR (ATR) 3275 (NH), 2908, 2851, 1453, 1198, 976, 957, 704, 575 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 3.00–2.85 (m, 2H, SCH$_2$), 2.24–2.14 (m, 3H, CH), 2.08–1.97 (m, 6H, CH$_2$), 1.92–1.79 (m, 1H, NH), 1.79–1.66 (m, 6H, CH$_2$), 1.41 (t, *J* = 7.5 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 61.5 (SC), 40.2 (SCH$_2$), 36.5 (CH$_2$), 36.0 (CH$_2$), 35.2 (CH$_2$), 28.7 (CH), 28.6 (CH), 5.4 (SCH$_2$*Me*); MS (ESI) *m/z* 228 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{12}$H$_{21}$NOS (M + H)$^+$ 228.1417, found 228.1416 (+0.4 ppm error).

Lab book reference: **AH-1-82**

(*tert*-Butyldiphenylsilyl)[ethyl(oxo)phenyl-λ^6-sulfanylidene]amine 87

87
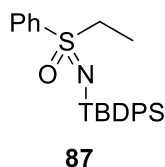
Using general procedure B, TBDPSCl (4.83 mL, 18.56 mmol, 1.25 eq.), sulfoximine **98** (2.51 g, 14.84 mmol, 1.0 eq.) and imidazole (2.02 g, 29.68 mmol, 2.0 eq.) in DMF (6 mL) added at 0 °C gave the crude product. Purification by flash column chromatography on silica with 95:5 hexane-EtOAc as eluent gave impure sulfoximine **87** (6.261 g). Further

purification by flash column chromatography on silica with 80:20 hexane-Et$_2$O gave *N*-TPDPS sulfoximine **87** (963 mg, 16%) as a colourless oil, R_F (6:4 hexane-EtOAc) 0.56; IR (ATR) 3069, 2931, 2855, 1427, 1323, 1295, 1152, 1107, 908, 732, 701, 689, 497 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.84 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.77–7.68 (m, 4H, Ph), 7.49 (tt, *J* = 7.5, 1.5 Hz, 1H, Ph), 7.44–7.26 (m, 8H, Ph), 3.01 (dq, *J* = 14.0, 7.5 Hz, 1H, SCH), 2.91 (dq, *J* = 14.0, 7.5 Hz, 1H, SCH), 1.12–1.05 (m, 12H, CMe$_3$, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 142.2 (*ipso*-Ph), 136.7 (*ipso*-Ph), 136.6 (*ipso*-Ph), 135.8 (Ph), 135.7 (Ph), 132.3 (Ph), 129.1 (Ph), 129.0 (Ph), 128.8 (Ph), 128.0 (Ph), 127.5 (Ph), 127.4 (Ph), 54.8 (SCH$_2$), 27.3 (C*Me*$_3$), 19.6 (*C*Me$_3$), 8.5 (SCH$_2$*Me*); MS (ESI) *m/z* 408 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{29}$H$_{29}$NOSSi (M + H)$^+$ 408.1812, found 408.1807 (+1.2 ppm error).

Lab book reference: **AH-1-7**

(*tert*-Butyldiphenylsilyl)[methyl(oxo)phenyl-λ^6-sulfanylidene]amine 19


19
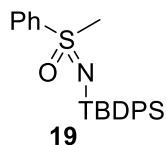
Using general procedure B, TBDPSCl (3.67 mL, 14.13 mmol, 1.25 eq.), sulfoximine **99** (1.75 g, 11.3 mmol, 1.0 eq.) and imidazole (1.54 g, 22.6 mmol, 2.0 eq.) in DMF (4 mL) added at 0 °C gave the crude product. Purification by flash column chromatography on silica with 9:1 hexane-Et$_2$O as eluent gave *N*-TBDPS sulfoximine **19** (987 mg, 22%) as a white solid, mp 58–60 °C; R_F (8:2 hexane-Et$_2$O) 0.25, IR (ATR) 3068, 2930, 2856, 1427, 1326, 1295, 1165, 1108, 956, 821, 742, 702, 650, 600, 498 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.94 (d, *J* = 8.0 Hz, 2H, Ph), 7.77 (d, *J* = 8.0 Hz, 2H, Ph), 7.71 (d, *J* = 7.5 Hz, 2H, Ph), 7.51 (t, *J* = 7.5 Hz, 1H, Ph), 7.45 (t, *J* = 8.0 Hz, 2H, Ph), 7.40–7.27 (m, 6H, Ph), 2.86 (s, 3H, SMe), 1.10 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 144.6 (*ipso*-Ph), 136.5 (*ipso*-Ph), 136.4 (*ipso*-Ph), 135.8 (Ph), 135.7 (Ph), 132.3 (Ph), 129.2 (Ph), 129.1 (Ph), 129.0 (Ph), 127.6 (Ph), 127.5 (Ph), 127.1 (Ph), 49.1 (SMe), 27.3 (C*Me*$_3$), 19.5 (*C*Me$_3$); MS (ESI) *m/z* 394 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{32}$H$_{27}$NOSSi (M + H)$^+$ 394.1656, found 394.1655 (−0.2 ppm error). Spectroscopic data are consistent with those reported in the literature.[54]

Lab book reference: **AH-1-12**

[(*tert*-Butyldiphenylsilyl)imino](ethyl)isopropyl-λ⁶-sulfanone 104

104
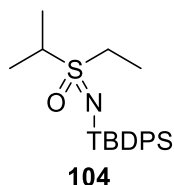
Using general procedure B, TBDPSCl (6.27 mL, 24.1 mmol, 1.25 eq.), sulfoximine **100** (2.60 g, 19.28 mmol, 1.0 eq.) and imidazole (2.63 g, 38.56 mmol, 2.0 eq.) in DMF (6 mL) added at 0 °C gave the crude product. Purification by flash column chromatography on silica with 9:1 hexane-Et₂O as eluent gave *N*-TBDPS sulfoximine **104** (3.33 g, 46%) as a colourless oil, R_F (8:2 hexane-Et₂O) 0.15; IR (ATR) 3069, 2931, 2855, 1427, 1309, 1143, 1107, 821, 734, 701, 612, 503 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.79–7.70 (m, 4H, Ph), 7.40–7.29 (m, 6H, Ph), 3.05 (septet, *J* = 7.0 Hz, 1H, SCH), 2.81–2.66 (m, 2H, SCH₂), 1.32 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.29 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.13 (t, *J* = 7.5 Hz, 3H, SCH₂*Me*), 1.06 (s, 9H, C*Me*₃); ¹³C NMR (100.6 MHz, CDCl₃) δ 137.1 (*ipso*-Ph), 136.9 (*ipso*-Ph), 135.82 (Ph), 135.75 (Ph), 129.0 (Ph), 127.5 (Ph), 54.3 (SCH₂), 47.3 (SCH), 27.4 (C*Me*₃), 19.6 (*C*Me₃), 16.7 (SCH*Me*), 15.4 (SCH*Me*), 7.6 (SCH₂*Me*) (two Ph resonances not resolved); MS (ESI) *m/z* 374 (M + H)⁺; HRMS (ESI) *m/z* calcd for C₂₁H₃₁NOSSi (M + H)⁺ 374.1968, found 374.1971 (−0.8 ppm error).

Lab book reference: **AH-1-9**

Using general procedure B, TBDPSCl (1.14 mL, 4.38 mmol, 1.25 eq.), sulfoximine **100** (473 mg, 3.5 mmol, 1.0 eq.) and imidazole (477 mg, 7.0 mmol, 2.0 eq.) in DMF (3 mL) added at rt gave the crude product. Purification by flash column chromatography on silica with 85:15 hexane-Et₂O as eluent gave *N*-TBDPS sulfoximine **104** (1.19 g, 91%) as a colourless oil.

Lab book reference: **AH-1-39**

***tert*-Butyl[(*tert*-butyldiphenylsilyl)imino]methyl-λ⁶-sulfanone 105**

105
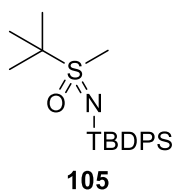
Using general procedure B, TBDPSCl (4.63 mL, 17.79 mmol, 1.25 eq.), sulfoximine **101** (1.92 g, 14.23 mmol, 1.0 eq.) and imidazole (1.94 g, 28.46 mmol, 2.0 eq.) in DMF (6 mL) added at 0 °C gave the crude product. Purification by flash column chromatography on silica with 9:1 hexane-Et$_2$O as eluent gave *N*-TBDPS sulfoximine **105** (3.90 g, 73%) as a white solid, mp 74–76 °C; R_F (8:2 hexane-Et$_2$O) 0.13, IR (ATR) 3069, 2958, 2930, 2855, 1427, 1315, 1294, 1137, 1108, 953, 821, 741, 722, 701, 671, 604, 507 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.77 (dd, J = 8.0, 2.0 Hz, 2H, Ph), 7.72 (dd, J = 8.0, 2.0 Hz, 2H, Ph), 7.41–7.30 (m, 6H, Ph), 2.45 (s, 3H, SMe), 1.43 (s, 9H, SCMe$_3$), 1.07 (s, 9H, SiCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.1 (*ipso*-Ph), 136.7 (*ipso*-Ph), 135.9 (Ph), 135.8 (Ph), 129.12 (Ph), 129.08 (Ph), 127.5 (Ph), 60.6 (S*C*Me$_3$), 37.6 (SMe), 27.3 (SiC*Me₃*), 23.9 (SC*Me₃*), 19.6 (Si*C*Me$_3$) (one Ph resonance not resolved); MS (ESI) *m/z* 374 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{21}$H$_{31}$NOSSi (M + H)$^+$ 374.1968, found 374.1966 (+0.6 ppm error).

Lab book reference: **AH-1-23**

Using general procedure B, TBDPSCl (3.74 mL, 14.38 mmol, 1.25 eq.), sulfoximine **101** (1.55 g, 11.5 mmol, 1.0 eq.) and imidazole (1.57 g, 23.0 mmol, 2.0 eq.) in DMF (5 mL) added at rt gave the crude product. Purification by flash column chromatography on silica with 9:1 hexane-Et$_2$O as eluent gave *N*-TBDPS sulfoximine **105** (3.28 g, 76%) as a white solid.

Lab book reference: **AH-2-12**

(*tert*-Butyldiphenylsilyl)[ethyl(2-methylphenyl)oxo-λ⁶-sulfanylidene]amine 106
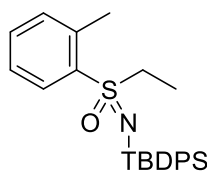
106

Using general procedure B, TBDPSCl (5.33 mL, 20.5 mmol, 1.25 eq.), sulfoximine **102** (3.00 g, 16.4 mmol, 1.0 eq.) and imidazole (2.23 g, 32.8 mmol, 2.0 eq.) in DMF (6 mL) added at rt gave the crude product. Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave impure sulfoximine **106**. Further purification by flash column chromatography on silica with 90:7:3 hexane-CH$_2$Cl$_2$-acetone as eluent gave impure sulfoximine **106**. Further purification by flash column chromatography on silica with 50:50 hexane-CH$_2$Cl$_2$ gave *N*-TPDPS sulfoximine **106** (903 mg, 13%) as a colourless oil, R_F (9:1 CH$_2$Cl$_2$-hexane) 0.37; IR (ATR) 3069, 2931, 2855, 1427, 1305, 1156, 1107, 821, 741, 701, 601, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.02 (dd, J = 7.5, 1.0 Hz, 1H, Ar), 7.74 (dd, J = 7.5, 1.0 Hz, 2H, Ar), 7.68 (dd, J = 7.5, 1.0 Hz, 2H, Ar), 7.39–7.20 (m, 8H, Ar), 7.18 (d, J = 7.5 Hz, 1H, Ar), 3.12 (dq, J = 14.0, 7.5 Hz, 1H, SCH), 3.00 (dq, J = 14.0, 7.5 Hz, 1H, SCH), 2.62 (s, 3H, ArMe), 1.12–1.04 (m, 12H, CMe$_3$, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 140.1 (*ipso*-Ar), 137.2 (*ipso*-Ar), 136.7 (*ipso*-Ar), 136.6 (*ipso*-Ar), 135.8 (Ar), 135.7 (Ar), 132.7 (Ar), 132.3 (Ar), 130.4 (Ar), 129.0 (Ar), 127.39 (Ar), 127.35 (Ar), 126.2 (Ar), 53.4 (SCH$_2$), 27.4 (C*Me*$_3$), 20.8 (ArMe), 19.6 (*C*Me$_3$), 8.2 (SCH$_2$*Me*) (one Ar resonance not resolved); MS (ESI) *m/z* 422 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{25}$H$_{31}$NOSSi (M + H)$^+$ 422.1968, found 422.1974 (−1.4 ppm error).

Lab book reference: **AH-1-59**

[Adamantan-1-yl(ethyl)oxo-λ⁶-sulfanylidene](*tert*-butyldiphenylsilyl)amine 107

107
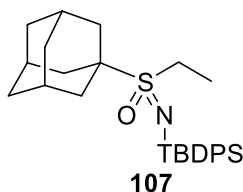
Using general procedure B, TBDPSCl (3.15 mL, 12.1 mmol, 1.25 eq.), sulfoximine **103** (2.20 g, 9.68 mmol, 1.0 eq.) and imidazole (1.32 g, 19.36 mmol, 2.0 eq.) in DMF (4 mL) added at 0 °C gave the crude product. Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave impure **107**. Further purification by flash column chromatography on silica with 8:2 and then 1:1 hexane-CH$_2$Cl$_2$ as eluent gave *N*-TBDPS sulfoximine **107** (445 mg, 10%) as a clear oil, R_F (1:1 hexane-CH$_2$Cl$_2$) 0.25; IR (ATR) 2910, 2853, 1427, 1325, 1301, 1252, 1155, 1107, 821, 734, 702, 634, 598, 504 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.82–7.78 (m, 2H, Ph), 7.78–7.74 (m, 2H, Ph), 7.40–7.31 (m, 6H, Ph), 2.80 (dq, *J* = 14.0, 7.0 Hz, 1H, SCH), 2.70 (dq, *J* = 14.0, 7.0 Hz, 1H, SCH), 2.16–2.09 (m, 3H, CH), 2.06–1.99 (m, 6H, CH), 1.74–1.66 (m, 3H, CH), 1.66–1.59 (m, 3H, CH), 1.06 (s, 9H, C*Me*$_3$), 0.97 (t, *J* = 7.0 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 137.3 (*ipso*-Ph), 137.1 (*ipso*-Ph), 135.9 (Ph), 135.8 (Ph), 128.9 (Ph), 127.4 (Ph), 127.3 (Ph), 62.6 (SC), 43.0 (SCH$_2$), 36.1 (CH$_2$), 35.5 (CH$_2$), 28.7 (CH), 27.4 (C*Me*$_3$), 19.8 (*C*Me$_3$), 6.6 (SCH$_2$*Me*) (one Ph resonance not resolved); MS (ESI) *m/z* 466 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{28}$H$_{39}$NOSSi (M + H)$^+$ 466.2594, found 466.2591 (+0.7 ppm error).

Lab book reference: **AH-1-83**

**Benzyl(*tert*-butyl)imino-λ⁶-sulfanone 108**

108
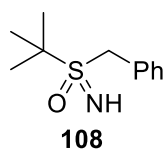
Using general procedure A, *tert*-butyl benzyl sulfide **118** (3.58 g, 19.85 mmol, 1.0 eq.), (diacetoxyiodo)benzene (15.99 g, 49.65 mmol, 2.5 eq.) and ammonium carbamate (3.10 g, 39.7 mmol, 2.0 eq.) in MeOH (40 mL) gave the crude product. Purification by flash column chromatography on silica with 50:50 hexane-EtOAc and then EtOAc as eluent

gave sulfoximine **108** (1.75 g, 42%) as a white solid, mp 118–120 °C; R_F (EtOAc) 0.32, IR (ATR) 3316 (NH), 2974, 1213, 1136, 1099, 963, 767, 702, 518, 472 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.42–7.37 (m, 5H, Ph), 4.30 (d, J = 12.0 Hz, 1H, SCH), 4.06 (d, J = 12.0 Hz, 1H, SCH$_2$), 2.37 (s, 1H, NH), 1.54 (s, 9H, SCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 131.7 (Ph), 128.94 (Ph), 128.90 (Ph), 127.5 (*ipso*-Ph), 59.9 (S*C*Me$_3$), 54.7 (SCH$_2$), 24.3 (SC*Me$_3$*); MS (ESI) *m/z* 234 (M + Na)$^+$; HRMS (ESI) *m/z* calcd for C$_{11}$H$_{17}$NOS (M + Na)$^+$ 234.0923, found 234.0920 (+1.2 ppm error).

Lab book reference: **AH-1-89**

Benzyl(imino)methyl-λ⁶-sulfanone 109

109
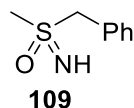
Using general procedure A, methyl benzyl sulfide **190** (2.72 mL, 20.0 mmol, 1.0 eq.), (diacetoxyiodo)benzene (16.11 g, 50.0 mmol, 2.5 eq.) and ammonium carbamate (3.12 g, 40.0 mmol, 2.0 eq.) in MeOH (40 mL) gave the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave sulfoximine **109** (1.15 g, 34%) as a pale orange solid, mp 74–76 °C (lit.,[53] mp 82–84 °C); R_F (9:1 EtOAc-MeOH) 0.31, IR (ATR) 3270 (NH), 2927, 1671, 1456, 1216, 1019, 782, 701, 499 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.45–7.36 (m, 5H, Ph), 4.40 (d, J = 13.0 Hz, 1H, SCH), 4.26 (d, J = 13.0 Hz, 1H, SCH), 2.93 (s, 3H, SMe), 2.06 (br s, 1H, NH); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 130.9 (Ph), 129.23 (Ph), 129.15 (Ph), 128.5 (*ipso*-Ph), 64.1 (SCH$_2$), 41.5 (SMe); MS (ESI) *m/z* 192 (M + Na)$^+$; HRMS (ESI) *m/z* calcd for C$_8$H$_{11}$NOS (M + Na)$^+$ 192.0454, found 192.0456 (−1.4 ppm error). Spectroscopic data are consistent with those reported in the literature.[53]

Lab book reference: **AH-2-4**

**Benzyl(*tert*-butyl)[(*tert*-butyldiphenylsilyl)imino]-λ⁶-sulfanone 110**

110
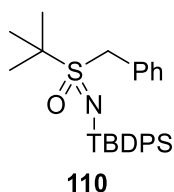
Using general procedure B, TBDPSCl (1.94 mL, 7.45 mmol, 0.9 eq.), sulfoximine **108** (1.75 g, 8.28 mmol, 1.0 eq.) and imidazole (1.13 g, 16.56 mmol, 2.0 eq.) in DMF (3 mL) added at rt gave the crude product. Purification by flash column chromatography on silica with 9:1 hexane-EtOAc as eluent gave *N*-TBDPS sulfoximine **110** (1.93 g, 52%) as a clear oil, R_F (9:1 hexane-EtOAc) 0.37; IR (ATR) 3069, 2930, 2855, 1427, 1300, 1150, 1123, 1108, 821, 799, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.68 (dd, J = 7.0, 3.0 Hz, 2H, Ph), 7.62 (dd, J = 7.0, 3.0 Hz, 2H, Ph), 7.37–7.27 (m, 6H, Ph), 7.24–7.13 (m, 5H, Ph), 4.17 (d, J = 14.0 Hz, 1H, SCH), 3.98 (d, J = 14.0 Hz, 1H, SCH), 1.31 (s, 9H, SCMe$_3$), 0.96 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 137.1 (*ipso*-Ph), 136.7 (*ipso*-Ph), 135.9 (Ph), 135.8 (Ph), 131.4 (Ph), 129.7 (*ipso*-Ph), 128.87 (Ph), 128.85 (Ph), 128.4 (Ph), 128.2 (Ph), 127.31 (Ph), 127.29 (Ph), 63.1 (S*C*Me$_3$), 57.6 (S*C*H$_2$), 27.3 (SiC*Me$_3$*), 24.6 (SC*Me$_3$*), 19.6 (Si*C*Me$_3$) (three Ph resonances not resolved); MS (ESI) *m/z* 450 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{27}$H$_{35}$NOSSi (M + H)$^+$ 450.2281, found 450.2270 (+2.6 ppm error).

Lab book reference: **AH-1-90**

**Benzyl[(*tert*-butyldiphenylsilyl)imino]methyl-λ⁶-sulfanone 43**

43
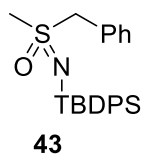
Using general procedure B, TBDPSCl (1.58 mL, 6.09 mmol, 0.9 eq.), sulfoximine **109** (1.15 g, 6.77 mmol, 1.0 eq.) and imidazole (0.92 g, 13.54 mmol, 2.0 eq.) in DMF (3 mL) added at rt gave the crude product. Purification by flash column chromatography on silica with 95:5 and then 9:1 hexane-EtOAc as eluent gave *N*-TBDPS sulfoximine **43** (1.84 g, 67%) as a white solid, mp 80–82 °C; R_F (6:4 hexane-EtOAc) 0.24; IR (ATR) 3068, 2929, 2855, 1427, 1319, 1297, 1123, 1140, 1108, 821, 700, 601, 500 cm^{-1}; ^{1}H NMR (400 MHz,

CDCl$_3$) δ 7.66 (dd, J = 8.0, 2.0 Hz, 2H, Ph), 7.62 (dd, J = 8.0, 2.0 Hz, 2H, Ph), 7.39–7.28 (m, 11H, Ph), 4.16 (d, J = 13.5 Hz, 1H, SCH), 4.10 (d, J = 13.5 Hz, 1H, SCH), 2.53 (s, 3H, SMe), 1.03 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.5 (*ipso*-Ph), 136.3 (*ipso*-Ph), 135.8 (Ph), 135.7 (Ph), 131.0 (Ph), 130.3 (*ipso*-Ph), 129.21 (Ph), 129.17 (Ph), 128.8 (Ph), 128.7 (Ph), 127.6 (Ph), 65.6 (SCH$_2$), 43.1 (SMe), 27.2 (C*Me$_3$*), 19.4 (*C*Me$_3$) (one Ph resonance not resolved); MS (ESI) *m/z* 408 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{24}$H$_{29}$NOSSi (M + H)$^+$ 408.1812, found 408.1806 (+1.5 ppm error).

Lab book reference: **AH-2-6**

1-(Ethylsulfanyl)-2-methylbenzene 113

113
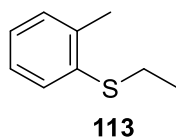
Bromoethane (1.64 mL, 22.0 mmol, 1.1 eq.) was added to a mixture of 2-thiocresol **111** (2.36 mL, 20.0 mmol, 1.0 eq.), KOH (1.23 g, 22.0 mmol, 1.1 eq.) and Aliquat 336$^{®}$ (0.2 g, 0.5 mmol, 0.02 eq.) in H$_2$O (10 mL) at rt. The resulting mixture was stirred at rt for 2.5 h. Then, saturated NH$_4$Cl$_{(aq)}$ (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 20 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with 98:2 and then 95:5 hexane-Et$_2$O as eluent gave sulfide **113** (2.82 g, 93%) as a colourless oil, R_F (9:1 hexane-Et$_2$O) 0.59; IR (ATR) 3060, 2972, 2927, 1589, 1468, 1378, 1067, 1049, 741 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.26 (dd, J = 7.5, 1.5 Hz, 1H, Ar), 7.19–7.13 (m, 2H, Ar), 7.08 (ddd, J = 7.5, 1.5, 1.5 Hz, 1H, Ar), 2.91 (q, J = 7.5 Hz, 2H, SCH$_2$), 2.37 (s, 3H, ArMe), 1.32 (t, J = 7.5 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 137.3 (*ipso*-Ar), 136.2 (*ipso*-Ar), 130.2 (Ar), 127.4 (Ar), 126.4 (Ar), 125.5 (Ar), 26.9 (SCH$_2$), 20.4 (ArMe), 14.3 (SCH$_2$*Me*); MS (APCI) *m/z* 153 (M + H)$^+$; HRMS (APCI) *m/z* calcd for C$_9$H$_{12}$S (M + H)$^+$ 153.0732, found 153.0736 (−2.5 ppm error). Spectroscopic data are consistent with those reported in the literature.[55]

Lab book reference: **AH-1-65**

1-(Ethylsulfanyl)adamantane 114

114
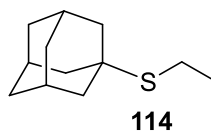
Bromoethane (1.3 mL, 17.38 mmol, 1.1 eq.) was added to a mixture of adamantane thiol **112** (2.66 g, 15.8 mmol, 1.0 eq.), KOH (980 mg, 17.38 mmol, 1.1 eq.) and Aliquat 336$^{®}$ (0.17 g, 0.4 mmol, 0.02 eq.) in H_2O (10 mL) at rt. The resulting mixture was stirred at rt for 1 h. Then, saturated $NH_4Cl_{(aq)}$ (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with 98:2 and then 95:5 hexane-Et_2O as eluent gave sulfide **114** (2.52 g, 81%) as a colourless oil, R_F (9:1 hexane-Et_2O) 0.63; IR (ATR) 2902, 2848, 1448, 1342, 1301, 1252, 1067, 1044, 975 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 2.56 (q, J = 7.5 Hz, 2H, SCH$_2$), 1.99–2.06 (m, 6H, CH), 1.89–1.82 (m, 3H, CH), 1.74–1.62 (m, 6H, CH), 1.22 (t, J = 7.5 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 44.2 (SC), 43.7 (CH$_2$), 36.5 (CH$_2$), 29.8 (CH), 19.7 (SCH$_2$), 15.3 (SCH$_2$*Me*); MS (APCI) *m/z* 197 (M + H)$^+$; HRMS (APCI) *m/z* calcd for C$_{12}$H$_{20}$S (M + H)$^+$ 197.1358, found 197.1355 (−1.6 ppm error). Spectroscopic data are consistent with those reported in the literature.[56]

Lab book reference: **AH-1-81**

[(*tert*-Butylsulfanyl)methyl]benzene 116

116
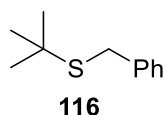
Benzyl bromide (2.38 mL, 20.0 mmol, 1.0 eq.) was added to a stirred solution of *tert*-butyl mercaptan **115** (2.25 mL, 20.0 mmol, 1.0 eq.) and KOH (1.23 g, 22.0 mmol, 1.1 eq.) in 1:1 H_2O-MeOH (10 mL). The resulting solution was stirred and heated at reflux for 16 h. The solution was then allowed to warm to rt. Then, saturated $NH_4Cl_{(aq)}$ (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were dried ($MgSO_4$) and evaporated

under reduced pressure to give the crude product. Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave sulfide **116** (3.58 g, 99%) as a colourless oil, R_F (9:1 hexane-Et$_2$O) 0.57; IR (ATR) 3029, 2960, 1495, 1454, 1364, 1167, 711, 695, 481 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.35 (d, J = 7.5 Hz, 2H, Ph), 7.30 (dd, J = 7.5, 7.5 Hz, 2H, Ph), 7.22 (t, J = 7.5 Hz, 1H, Ph), 3.77 (s, 2H, SCH$_2$), 1.36 (s, 9H, SCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 138.7 (*ipso*-Ph), 129.1 (Ph), 128.6 (Ph), 126.9 (Ph), 43.0 (S*C*Me$_3$), 33.6 (SCH$_2$), 31.0 (SC*Me$_3$*); MS (APCI) *m/z* 181 (M + H)$^+$; HRMS (APCI) *m/z* calcd for C$_{11}$H$_{16}$S (M + H)$^+$ 181.1045, found 181.1050 (−2.7 ppm error). Spectroscopic data are consistent with those reported in the literature.[57,58]

Lab book reference: **AH-1-88**

(*tert*-Butyldiphenylsilyl)[oxo(phenyl)(2-phenylethyl)-λ⁶-sulfanylidene]amine 117

117
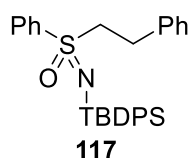
Using general procedure C, *N*-TBDPS sulfoximine **87** (680 mg, 1.72 mmol, 1.0 eq.), *n*-BuLi (0.82 mL of a 2.3 M solution in hexanes, 1.89 mmol, 1.1 eq.) and benzyl bromide (0.41 mL, 3.44 mmol, 2.0 eq.) in THF (17 mL) at −78 °C for 1 h gave the crude product. Purification by flash column chromatography on silica with 95:5 hexane-EtOAc as eluent gave *N*-TBDPS sulfoximine **117** (682 mg, 82%) as a colourless oil, R_F (8:2 hexane-EtOAc) 0.38; IR (ATR) 2930, 2858, 1427, 1320, 1296, 1154, 1108, 821, 741, 700, 523, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.90 (d, J = 7.5, 2H, Ph), 7.72–7.80 (m, 4H, Ph), 7.52 (t, J = 7.5 Hz, 1H, Ph), 7.47–7.40 (m, 2H, Ph), 7.40–7.27 (m, 6H, Ph), 7.21–7.11 (m, 3H, Ph), 6.88 (d, J = 7.5 Hz, 2H, Ph), 3.31–3.12 (m, 2H, SCH$_2$), 2.89–2.76 (m, 2H, C*H$_2$*Ph), 1.11 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 142.6 (*ipso*-Ph), 138.3 (*ipso*-Ph), 136.51 (*ipso*-Ph), 136.47, (*ipso*-Ph), 135.8 (Ph), 135.7 (Ph), 132.4 (Ph), 129.2 (Ph), 129.1 (Ph), 129.0 (Ph), 128.7 (Ph), 128.4 (Ph), 127.9 (Ph), 127.54 (Ph), 127.51 (Ph), 126.7 (Ph), 61.6 (SCH$_2$), 29.9 (SCH$_2$*C*H$_2$), 27.5 (C*Me$_3$*), 19.4 (*C*Me$_3$); MS (ESI) *m/z* 484 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{30}$H$_{33}$NOSSi (M + H)$^+$ 484.2125, found 484.2124 (+0.1 ppm error).

Lab book reference: **AH-1-14**

tert-Butyl[(tert-butyldiphenylsilyl)imino]ethyl-λ⁶-sulfanone 118

118
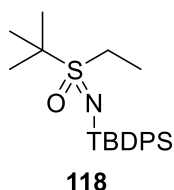
Using general procedure C, *N*-TBDPS sulfoximine **105** (2.70 g, 7.0 mmol, 1.0 eq.), *n*-BuLi (5.13 mL of a 1.5 M solution in hexanes, 7.7 mmol, 1.1 eq.) and methyl iodide (0.87 mL, 14.0 mmol, 2.0 eq.) in THF (70 mL) at −78 °C for 1 h gave the crude product. Purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave *N*-TBDPS sulfoximine **118** (2.52 g, 93%) as a white solid, mp 66–68 °C; R_F (6:4 hexane-Et₂O) 0.34; IR (ATR) 3070, 2931, 2855, 1473, 1313, 1138, 1107, 821, 736, 701, 610, 504 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.80 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.74 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.40–7.30 (m, 6H, Ph), 2.92-2.71 (m, 2H, SCH₂), 1.40 (s, 9H, SCMe₃), 1.05 (s, 9H, SiCMe₃), 0.98 (t, *J* = 7.5 Hz, 3H, SCH₂*Me*); ¹³C NMR (100.6 MHz, CDCl₃) δ 137.2 (*ipso*-Ph), 136.9 (*ipso*-Ph), 136.0 (Ph), 135.8 (Ph), 129.0 (Ph), 127.42 (Ph), 127.39 (Ph), 61.5 (S*C*Me₃), 44.3 (SCH₂), 27.4 (SiC*Me₃*), 24.3 (SC*Me₃*), 19.9 (Si*C*Me₃), 6.9 (SCH₂*Me*) (one Ph resonance not resolved); MS (ESI) *m/z* 388 [(M + H)⁺] HRMS (ESI) *m/z* calcd for C₂₂H₃₃NOSSi (M + H)⁺ 388.2125, found 388.2120 (+1.2 ppm error).

Lab book reference: **AH-2-45**

tert-Butyl[(tert-butyldiphenylsilyl)imino](2-phenylethyl)-λ⁶-sulfanone 119

119
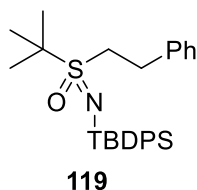
Using general procedure C, *N*-TBDPS sulfoximine **105** (3.59 g, 9.6 mmol, 1.0 eq.), *n*-BuLi (4.24 mL of a 2.5 M solution in hexanes, 10.6 mmol, 1.1 eq.) and benzyl bromide (2.28 mL, 19.2 mmol, 2.0 eq.) in THF (100 mL) at −78 °C for 1 h gave the crude product. Purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave *N*-TBDPS sulfoximine **119** (3.92 g, 88%) as a white solid, mp 88–90 °C; R_F (8:2

hexane-Et$_2$O) 0.43; IR (ATR) 3068, 2930, 2854, 1427, 1313, 1125, 1106, 820, 740, 698, 600, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.93 (dd, J = 7.5, 2.0 Hz, 2H, Ph), 7.86 (dd, J = 7.5, 2.0 Hz, 2H, Ph), 7.48–7.34 (m, 6H, Ph), 7.22–7.11 (m, 3H, Ph), 6.72 (dd, J = 7.5, 2.0 Hz, 2H, Ph), 3.15 (ddd, J = 12.5, 12.5, 4.5 Hz, 1H, SCH), 2.96 (ddd, J = 12.5, 12.5, 4.5 Hz, 1H, SCH), 2.81 (ddd, J = 12.5, 12.5, 4.5 Hz, 1H, C*H*Ph), 2.61 (ddd, J = 12.5, 12.5, 4.5 Hz, 1H, C*H*Ph), 1.49 (s, 9H, SCMe$_3$), 1.12 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 139.0 (*ipso*-Ph), 137.2 (*ipso*-Ph), 136.5 (*ipso*-Ph), 136.0 (Ph), 135.7 (Ph), 129.12 (Ph), 129.09 (Ph), 128.6 (Ph), 128.5 (Ph), 127.64 (Ph), 127.55 (Ph), 126.5 (Ph), 61.7 (S*C*Me$_3$), 51.4 (SCH$_2$), 28.1 (SCH$_2$CH$_2$), 27.3 (SiC*Me*$_3$), 24.2 (SC*Me*$_3$), 19.9 (Si*C*Me$_3$); MS (ESI) *m/z* 464 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{28}$H$_{37}$NOSSi (M + H)$^+$ 464.2438, found 464.2435 (−0.8 ppm error).

Lab book reference: **AH-1-60**

tert-Butyl *N*-[diethyl(oxo)-λ⁶-sulfanylidene]carbamate 120

120
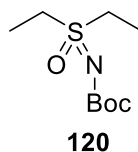
A solution of potassium *tert*-butoxide (1.26 g. 11.23 mmol, 1.3 eq.) in THF (23 mL) was added to a stirred solution of sulfoximine **97** (1.05 g, 8.64 mmol, 1.0 eq.) in THF (25 mL) at 0 °C under Ar. The resulting solution was stirred at 0 °C for 30 min. Then, a solution of Boc$_2$O (3.77 g, 17.28 mmol, 2.0 eq.) in THF (40 mL) was added and the resulting solution was stirred at 0 °C for 1 h. The solution was allowed to warm to rt and stirred at rt for 30 h. Saturated NH$_4$Cl$_{(aq)}$ (35 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 30 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with 1:1 hexane-EtOAc and then 1:4 hexane-EtOAc as eluent gave *N*-Boc sulfoximine **120** (274 mg, 14%) as a white solid, mp 54–56 °C; R_F (1:4 hexane-EtOAc) 0.33, IR (ATR) 2978, 2941, 1659 (C=O), 1366, 1273, 1252, 1207, 1161, 1069, 892, 866, 793 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 3.36 (q, J = 7.5 Hz, 4H, SCH$_2$), 1.48 (s, 9H, CMe$_3$), 1.42 (t, J = 7.5 Hz, 6H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 158.8 (C=O), 80.4 (*C*Me$_3$), 45.2 (SCH$_2$), 28.3 (C*Me*$_3$), 7.3

(SCH$_2$*Me*); MS (ESI) *m/z* 222 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_9$H$_{19}$NO$_3$S (M + H)$^+$ 222.1158, found 222.1156 (+1.0 ppm error).

Lab book reference: **AH-1-22**

(*tert*-Butyldimethylsilyl)[ethyl(oxo)phenyl-λ⁶-sulfanylidene]amine 121

121
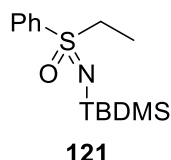
TBDMSCl (460 mg, 3.05 mmol, 1.2 eq.) was added to a stirred solution of sulfoximine **98** (430 mg, 2.54 mmol, 1.0 eq.) in pyridine (5.1 mL) at rt under Ar. The resulting solution was stirred at rt for 12 h and then water (5 mL) was added to the solution. The two layers were separated and the aqueous layer was extracted with EtOAc (3 × 50 mL). The combined organic layers were washed with brine (20 mL), dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave *N*-TBDMS sulfoximine **121** (624 mg, 87%) as a colourless oil, R_F (6:4 hexane-Et$_2$O) 0.40; IR (ATR) 2953, 2927, 2854, 1445, 1293, 1149, 1149, 829, 774, 720, 690, 534 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.92–7.87 (m, 2H, Ph), 7.58–7.46 (m, 3H, Ph), 3.07–2.92 (m, 2H, SCH$_2$), 1.18 (t, *J* = 7.5 Hz, 3H, SCH$_2$*Me*), 0.92 (s, 9H, C*Me*$_3$), 0.04 (s, 3H, SiMe), 0.03 (s, 3H, SiMe); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 143.2 (*ipso*-Ph), 132.3 (Ph), 128.9 (Ph), 128.0 (Ph), 54.8 (SCH$_2$), 26.2 (C*Me*$_3$), 18.2 (*C*Me$_3$), 8.2 (SCH$_2$*Me*), −2.3 (SiMe$_2$); MS (ESI) *m/z* 284 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{14}$H$_{25}$NOSSi (M + H)$^+$ 284.1499, found 284.1500 (−0.6 ppm error).

Lab book reference: **AH-1-18**

TBDMSCl (722 mg, 4.79 mmol, 1.5 eq.) was added, in two portions, to a stirred solution of sulfoximine **98** (539 mg, 3.19 mmol, 1.0 eq.) and imidazole (652 mg, 9.57 mmol, 3.0 eq.) in DMF (6.4 mL) at 0 °C under Ar. The resulting solution was stirred at rt for 12 h and then water (5 mL) was added to the solution. The two layers were separated and the aqueous layer was extracted with Et$_2$O (3 × 50 mL). The combined organic layers were

washed with brine (20 mL), dried (MgSO₄) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with 95:5 hexane-EtOAc as eluent gave *N*-TBDMS sulfoximine **121** (789 mg, 87%) as a colourless oil.

Lab book reference: **AH-1-19**

[(*tert*-Butyldiphenylsilyl)imino](ethyl)(1-hydroxy-1,1-diphenylpropan-2-yl)-λ⁶-sulfanone *anti*-88
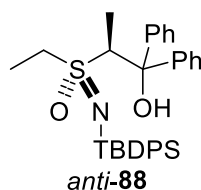
anti-**88**

Using general procedure C, *N*-TBDPS sulfoximine **86** (180 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained only alcohol *anti*-**88** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-EtOAc as eluent gave alcohol *anti*-**88** (191 mg, 71%) as a white solid, mp 52–54 °C; R_F (8:2 hexane-EtOAc) 0.47; IR (ATR) 3386 (OH), 2931, 2856, 1450, 1427, 1311, 1138, 1109, 743, 702, 504 cm^{-1}; ^{1}H NMR (400 MHz, CDCl₃) δ 7.73 (dd, *J* = 7.5, 1.0 Hz, 2H, Ph), 7.69–7.62 (m, 4H, Ph), 7.58 (d, *J* = 7.5 Hz, 2H, Ph), 7.42–7.28 (m, 10H, Ph), 7.21–7.18 (m, 2H, Ph), 6.31 (s, 1H, OH), 4.20 (q, *J* = 7.0 Hz, 1H, SC*H*(Me)COH), 2.19 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 1.69 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 1.47 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.06 (s, 9H, CMe₃), 0.93 (t, *J* = 7.0 Hz, 3H, SCH₂*Me*); ^{13}C NMR (100.6 MHz, CDCl₃) δ 146.0 (*ipso*-Ph), 145.7 (*ipso*-Ph), 136.2 (*ipso*-Ph), 135.9 (*ipso*-Ph), 135.8 (Ph), 135.7 (Ph), 129.34 (Ph), 129.31 (Ph), 128.5 (Ph), 128.3 (Ph), 127.64 (Ph), 127.55 (Ph), 127.3 (Ph), 126.9 (Ph), 126.1 (Ph), 125.2 (Ph), 79.0 (COH), 63.0 (SCH), 51.8 (SCH₂), 27.3 (C*Me₃*), 19.6 (*C*Me₃), 11.7 (SCH*Me*), 8.9 (SCH₂*Me*); MS (ESI) *m/z* 542 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C₃₃H₃₉NO₂SSi (M + H)$^+$ 542.2544, found 542.2544 (−0.1 ppm error). The stereochemistry of alcohol *anti*-**88** was assigned by synthesis from *N*-Boc sulfoximine *anti*-**128**.

Lab book reference: **AH-1-2**

Using general procedure B, TBDPSCl (0.03 mL, 0.09 mmol, 1.25 eq.), NH sulfoximine *anti*-**129** (21 mg, 0.07 mmol, 1.0 eq.) and imidazole (10 mg, 0.14 mmol, 2.0 eq.) in DMF (1.0 mL) at rt gave the crude product. Purification by flash column chromatography on silica with 9:1 hexane-EtOAc as eluent gave *impure N*-TBDPS sulfoximine *anti*-**88** (10 mg, traces) as a white solid.

Lab book reference: **AH-2-39**

tert-Butyl[(tert-butyldiphenylsilyl)imino](1-hydroxy-1,1-diphenylpropan-2-yl)-λ⁶-sulfanone *anti*-122 and *syn*-122

Using general procedure C, *N*-TBDPS sulfoximine **118** (194 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 95:5 mixture of alcohols *anti*-**122** and *syn*-**122** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave alcohol *anti*-**122** (262 mg, 92%) as a colourless oil, R_F (8:2 hexane-Et$_2$O) 0.31; IR (ATR) 3433 (OH), 3070, 2932, 2856, 1472, 1396, 1322, 1108, 820, 769, 730, 701, 648, 604, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.77 (dd, J = 7.5, 5.0 Hz, 4H, Ph), 7.57 (dd, J = 7.5, 3.0 Hz, 2H, Ph), 7.44 (d, J = 7.5 Hz, 2H, Ph), 7.42–7.29 (m, 8H, Ph), 7.28–7.23 (m, 1H, Ph), 7.22–7.18 (m, 3H, Ph), 5.41 (s, 1H, OH), 4.31 (q, J = 7.5 Hz, 1H, SCH), 1.41 (d, J = 7.5 Hz, 3H, SCH*Me*), 1.25 (s, 9H, SCMe$_3$), 1.11 (s, 9H, SiCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 147.0 (*ipso*-Ph), 143.8 (*ipso*-Ph), 136.7 (*ipso*-Ph), 136.4 (*ipso*-Ph), 136.2 (Ph), 136.1 (Ph), 129.11 (Ph), 129.08 (Ph), 128.03 (Ph), 127.96 (Ph). 127.9 (Ph), 127.4 (Ph), 127.2 (Ph), 127.1 (Ph), 126.7 (Ph), 81.3 (COH), 65.8 (S*C*Me$_3$), 63.6 (SCH), 27.6 (SiC*Me$_3$*), 24.4 (SC*Me$_3$*), 20.1 (Si*C*Me$_3$), 17.7 (SCH*Me*) (one Ph resonance not resolved); MS (ESI) *m/z* 592 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{35}$H$_{43}$NO$_2$SSi (M + Na)$^+$ 592.2676, found 592.2673 (+0.5 ppm error). Alcohol *syn*-**122** was not isolated. Diagnostic signal for alcohol *syn*-**122**: ^{1}H NMR (400 MHz, CDCl$_3$) δ

3.40 (q, *J* = 7.5 Hz, 1H, SCH). The stereochemistry of *anti*-**122** and *syn*-**122** was assigned by analogy with related examples.

Lab book reference: **AH-1-41**

tert-Butyl[(*tert*-butyldiphenylsilyl)imino](1-hydroxy-1,1,3-triphenylpropan-2-yl)-λ^6-sulfanone *anti*-123

anti-**123**

Using general procedure C, *N*-TBDPS sulfoximine **119** (232 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.25 mL of a 2.2 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained only alcohol *anti*-**123** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 97:3 hexane-Et$_2$O as eluent gave alcohol *anti*-**123** (281 mg, 87%) as a white solid, mp 140–142 °C; R_F (8:2 hexane-Et$_2$O) 0.31; IR (ATR) 3431 (OH), 3062, 2932, 2858, 1448, 1308, 1049, 1107, 906, 820, 728, 700, 649, 606, 498 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.93 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.90 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.68 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.55 (d, *J* = 7.5 Hz, 2H, Ph), 7.52–7.34 (m, 9H, Ph), 7.33–7.25 (m, 3H, Ph), 7.10–6.99 (m, 3H, Ph), 6.37 (d, *J* = 7.5 Hz, 2H, Ph), 5.84 (s, 1H, OH), 4.19 (dd, *J* = 7.0, 2.0 Hz, 1H, SCH), 4.10 (dd, *J* = 15.5, 7.0 Hz, 1H, C*H*Ph), 3.31 (dd, *J* = 15.5, 2.0 Hz, 1H, C*H*Ph), 1.29 (s, 9H, SCMe$_3$), 1.03 (s, 9H, SiCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 146.9 (*ipso*-Ph), 143.5 (*ipso*-Ph), 140.2 (*ipso*-Ph), 136.7 (*ipso*-Ph), 136.6 (*ipso*-Ph), 136.4 (Ph), 129.3 (Ph), 129.2 (Ph), 129.0 (Ph), 128.7 (Ph), 128.3 (Ph), 128.2 (Ph), 128.1 (Ph), 127.9 (Ph), 127.8 (Ph), 127.5 (Ph), 127.4 (Ph), 126.8 (Ph), 126.3 (Ph), 126.1 (Ph), 83.4 (COH), 73.6 (SCH), 65.9 (S*C*Me$_3$), 34.9 (*C*H$_2$Ph), 27.8 (SiC*Me*$_3$), 24.3 (SC*Me*$_3$), 20.2 (Si*C*Me$_3$); MS (ESI) *m/z* 668 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{41}$H$_{47}$NO$_2$SSi (M + Na)$^+$ 668.2989, found 668.2991 (−0.4 ppm error). The stereochemistry of *anti*-**123** was assigned by X-ray crystallography.

X-ray crystal structure determination of *anti*-**123**

$C_{41}H_{47}NO_2SSi$, $M = 645.94$, triclinic, $a = 10.8541(6)$, $b = 12.9867(7)$, $c = 13.7480(6)$ Å, $\beta = 101.226(4)°$, $U = 1789.89(17)$ Å^3, $T = 110.00(10)$ K, space group P-1, Z = 2, μ(CuKα) $= 1.390$ mm^{-1}, 11691 reflection measured, 6377 unique ($R_{int} = 0.0334$) which were used in calculation. The final R1 was 0.0441 (I≥2σ) and wR2 was 0.1253 (all data).

Lab book reference: **AH-1-54**

2-{Adamantan-1-yl[(*tert*-butyldiphenylsilyl)imino]oxo-λ⁶-sulfanyl}-1,1-diphenylpropan-1-ol *anti*-124

anti-**124**

Using general procedure C, *N*-TBDPS sulfoximine **107** (212 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained only alcohol *anti*-**124** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 1:1 hexane-CH$_2$Cl$_2$ as eluent gave alcohol *anti*-**124** (256 mg of a 95:5 mixture of *anti*-**124** and starting sulfoximine **107** i.e. 247 mg (76%) of *anti*-**124**) as a white solid, mp 110–112 °C; R_F (CH$_2$Cl$_2$) 0.51; IR (ATR) 3428 (OH), 2910, 2854, 1449, 1327, 1298, 1106, 820, 701, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) for *anti*-**124** δ 7.77 (dd, $J = 7.0$, 1.5 Hz, 2H, Ph), 7.72 (dd, $J = 7.0$, 1.5 Hz, 2H, Ph), 7.59 (dd, $J = 7.0$, 1.5 Hz, 2H, Ph), 7.42–7.29 (m, 11H, Ph), 7.24–7.19 (m, 3H, Ph), 5.45 (s, 1H, OH), 4.24 (q, $J = 7.5$ Hz, 1H, SCH), 1.99–1.93 (m, 3H, CH), 1.92–1.84 (m, 3H, CH), 1.79–1.71 (m, 3H, CH), 1.58–1.49 (m, 3H, CH), 1.39–1.32 (m, 6H, SCH*Me*, CH), 1.09 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) for *anti*-**124** δ 137.3 (*ipso*-Ph), 136.7 (*ipso*-Ph), 136.3 (Ph), 136.2 (Ph), 134.9 (*ipso*-Ph), 129.8 (*ipso*-Ph), 129.1 (Ph), 128.2 (Ph), 128.0 (Ph), 127.9 (Ph), 127.8 (Ph), 127.4 (Ph), 127.37 (Ph), 127.3 (Ph), 127.1 (Ph), 126.9 (Ph), 81.3 (COH), 67.4 (SCH), 61.5 (SC), 35.7 (CH$_2$), 35.3 (CH$_2$), 28.7 (CH), 27.7 (C*Me*$_3$), 26.7 (CH), 20.1 (*C*Me$_3$), 17.7 (SCH*Me*); MS (ESI) *m/z* 648 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for $C_{41}H_{49}NO_2SSi$ (M + H)$^+$ 648.3326, found 648.3317 (+1.3 ppm error). The stereochemistry of *anti*-**124** was assigned by analogy with related examples.

Lab book reference: **AH-1-84**

2-{[(*tert*-Butyldiphenylsilyl)imino](oxo)phenyl-λ⁶-sulfanyl}-1,1-diphenylpropan-1-ol *anti*-89 and *syn*-89
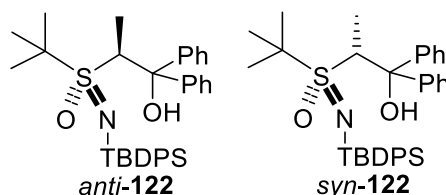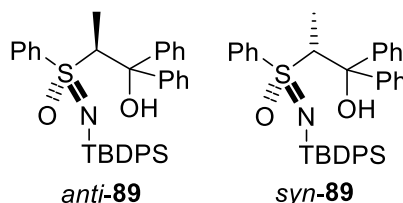

Using general procedure C, *N*-TBDPS sulfoximine **87** (204 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an 85:15 mixture of alcohols *anti*-**89** and *syn*-**89** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O gave alcohol *anti*-**89** (170 mg, 58%) as a white solid, mp 154–156 °C; R_F (9:1 hexane-Et$_2$O) 0.15; IR (ATR) 3422 (OH), 3068, 2930, 2856, 1448, 1298, 1141, 1109, 744, 703, 605, 567, 470 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.64 (d, J = 7.5 Hz, 2H, Ph), 7.55 (d, J = 8.0 Hz, 2H, Ph), 7.47 (d, J = 8.0 Hz, 2H, Ph), 7.44–7.39 (m, 3H, Ph), 7.33–7.23 (m, 6H, Ph), 7.22–7.06 (m, 5H, Ph), 7.06–6.95 (m, 5H, Ph), 6.38 (s, 1H, OH), 4.47 (q, J = 7.0 Hz, 1H, SCH), 1.46 (d, J = 7.0 Hz, 3H, SCH*Me*), 1.04 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 146.2 (*ipso*-Ph), 144.8 (*ipso*-Ph), 143.0 (*ipso*-Ph), 135.70 (Ph), 135.68 (Ph), 135.6 (*ipso*-Ph), 135.1 (*ipso*-Ph), 131.4 (Ph), 129.0 (Ph), 128.9 (Ph), 128.8 (Ph), 128.4 (Ph), 128.1 (Ph), 127.73 (Ph), 127.68 (Ph), 127.4 (Ph), 127.1 (Ph), 126.7 (Ph), 126.2 (Ph), 124.9 (Ph), 79.2 (COH), 67.8 (SCH), 27.2 (C*Me*$_3$), 19.4 (*C*Me$_3$), 12.5 (SCH*Me*); MS (ESI) *m/z* 590 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{37}$H$_{39}$NO$_2$SSi (M + H)$^+$ 590.2544, found 590.2532 (+2.0 ppm error). Alcohol *syn*-**89** was not isolated. Diagnostic signals for alcohol *syn*-**89**: ^{1}H NMR (400 MHz, CDCl$_3$) δ 4.43 (q, J = 7.0 Hz, 1H, SCH), 1.46 (d, J = 7.0 Hz, 3H, SCH*Me*). The stereochemistry of *anti*-**89** and *syn*-**89** was assigned by analogy with related examples.

Lab book reference: **AH-1-92**

2-{[(*tert*-Butyldiphenylsilyl)imino](oxo)phenyl-λ⁶-sulfanyl}-1,1,3-triphenylpropan-1-ol *anti*-125 and *syn*-125
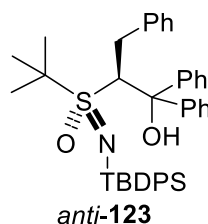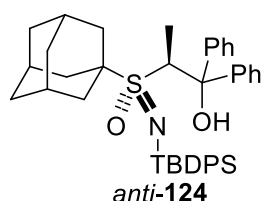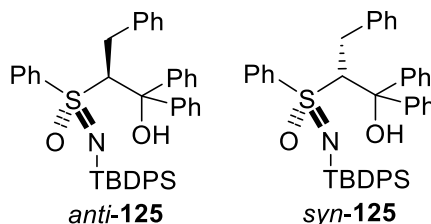

Using general procedure C, *N*-TBDPS sulfoximine **117** (175 mg, 0.36 mmol, 1.0 eq.), *n*-BuLi (0.18 mL of a 2.2 M solution in hexanes, 0.4 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 2.9 M solution in THF, 0.72 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an 85:15 mixture of diastereomeric alcohols *anti*-**125** and *syn*-**125** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave an 85:15 mixture of diastereomeric alcohols *anti*-**125** and *syn*-**125** (217 mg, 91%) as a colourless oil, R_F (8:2 hexane-Et$_2$O) 0.54; IR (ATR) 3411 (OH), 3067, 2930, 2856, 1806, 1493, 1448, 1259, 1139, 1110, 1078, 821, 739, 701, 606, 497 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.74 (s, 0.15H, COH), 7.66 (dd, J = 7.5, 2.0 Hz, 0.3 H, Ph), 7.55 (dd, J = 7.5, 2.0 Hz, 1.7H, Ph), 7.52 (dd, J = 7.5, 2.0 Hz, 1.7H, Ph), 7.47 (dd, J = 7.5, 2.0 Hz, 0.3 H, Ph), 7.44–7.37 (m, 3.5H, Ph), 7.35–7.29 (m, 1.5H, Ph), 7.29–7.19 (m, 4H, Ph), 7.19–7.03 (m, 10H, Ph), 6.99–6.90 (m, 5H, Ph), 6.77 (dd, J = 7.5, 2.0 Hz, 1.7H, Ph), 6.68 (dd, J = 7.5, 2.0 Hz, 0.3H, Ph), 6.50 (s, 0.85H, OH), 4.81 (dd, J = 5.0, 1.0 Hz, 0.85H, SCH), 4.50 (dd, J = 5.0, 1.0 Hz, 0.15H, SCH), 3.97 (dd, J = 16.0, 5.0 Hz, 0.85H, C*H*Ph), 3.85 (dd, J = 16.0, 5.0 Hz, 0.15H, C*H*Ph), 3.25 (dd, J = 16.0, 1.0 Hz, 0.85H, C*H*Ph), 3.19 (dd, J = 16.0, 1.0 Hz, 0.15H, C*H*Ph), 1.17 (s, 1.3H, CMe$_3$), 1.05 (s, 7.7H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 146.9 (*ipso*-Ph, *syn*-**125**), 145.2 (*ipso*-Ph, *anti*-**125**), 144.7 (*ipso*-Ph, *syn*-**125**), 144.6 (*ipso*-Ph, *anti*-**125**), 143.89 (*ipso*-Ph, *anti*-**125**), 143.86 (*ipso*-Ph, *syn*-**125**), 140.7 (*ipso*-Ph, *anti*-**125**), 140.6 (*ipso*-Ph, *syn*-**125**), 136.02 (Ph, *syn*-**125**), 135.95 (Ph, *syn*-**125**), 135.7 (Ph, *anti*-**125**), 135.5 (*ipso*-Ph, *anti*-**125**), 135.09 (*ipso*-Ph, *anti*-**125**), 135.05 (*ipso*-Ph, *syn*-**125**), 135.0 (*ipso*-Ph, *syn*-**125**), 131.4 (Ph, *syn*-**125**), 131.2 (Ph, *anti*-**125**), 129.2 (Ph, *syn*-**125**), 129.1 (Ph, *syn*-**125**), 129.0 (Ph, *anti*-**125**), 128.8 (Ph, *anti*-**125**), 128.7 (Ph, *syn*-**125**), 128.24 (Ph, *anti*-**125**), 128.21 (Ph, *anti*-**125**), 128.20 (Ph, *anti*-**125**), 128.1 (Ph, *anti*-**125**), 128.0 (Ph, *syn*-**125**), 127.8 (Ph, *syn*-**125**), 127.7 (Ph, *syn*-**125**), 127.6 (Ph, *anti*-**125**), 127.5 (Ph, *anti*-**125**), 127.4 (Ph, *syn*-**125**), 127.3 (Ph, *anti*-**125**), 127.2 (Ph, *syn*-**125**),

127.14 (Ph, *syn*-**125**), 127.06 (Ph, *anti*-**125**), 126.9 (Ph, *anti*-**125**), 126.63 (Ph, *anti*-**125**), 126.58 (Ph, *syn*-**125**), 126.5 (Ph, *syn*-**125**), 126.2 (Ph, *anti*-**125**), 126.1 (Ph, *syn*-**125**), 125.9 (Ph, *syn*-**125**), 125.8 (Ph, *anti*-**125**), 125.5 (Ph, *anti*-**125**), 80.4 (COH, *anti*-**125**), 80.3 (COH, *syn*-**125**), 76.1 (SCH, *syn*-**125**), 75.0 (SCH, *anti*-**125**), 32.0 (*C*H$_2$Ph, *syn*-**125**), 31.6 (*C*H$_2$Ph, *anti*-**125**), 27.5 (C*Me*$_3$, *syn*-**125**), 27.3 (C*Me*$_3$, *anti*-**125**), 19.5 (*C*Me$_3$, *syn*-**125**), 19.4 (*C*Me$_3$, *anti*-**125**) (two *syn*-**125** Ph and one *anti*-**125** Ph resonance not resolved); MS (ESI) *m/z* 666 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{43}$H$_{43}$NO$_2$SSi (M + H)$^+$ 666.2857, found 666.2423 (+0.4 ppm error). The stereochemistry of *anti*-**125** and *syn*-**125** was assigned by analogy with related examples.

Lab book reference: **AH-1-42**

[(*tert*-Butyldiphenylsilyl)imino](1-hydroxy-1,1-diphenylpropan-2-yl)isopropyl-λ^6-sulfanone *anti*-126 and *syn*-126

anti-**126**   *syn*-**126**

Using general procedure C, *N*-TBDPS sulfoximine **104** (187 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an 85:15 mixture of alcohols *anti*-**126** and *syn*-**126** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 97:3 hexane-EtOAc as eluent gave alcohol *anti*-**126** (222 mg, 80%) as a white solid, mp 164–166 °C; R_F (8:2 hexane-EtOAc) 0.47; IR (ATR) 3381 (OH), 3070, 2932, 2856, 1449, 1318, 1257, 1181, 1107, 907, 730, 699, 611, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.84–7.71 (m, 4H, Ph), 7.59 (d, *J* = 7.0 Hz, 2H, Ph), 7.50 (dd, *J* = 7.0, 7.0 Hz, 2H, Ph), 7.45–7.23 (m, 10H, Ph), 7.22–7.12 (m, 2H, Ph), 6.00 (s, 1H, OH), 4.23 (q, *J* = 7.0 Hz, 1H, SC*H*(Me)COH), 1.84 (septet, *J* = 7.0 Hz, 1H, SC*H*Me$_2$), 1.19 (d, *J* = 7.0 Hz, 3H, SCH(*Me*)COH), 1.11 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.04 (s, 9H, C*Me*$_3$), 0.88 (d, *J* = 7.0 Hz, 3H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 146.3 (*ipso*-Ph), 146.1 (*ipso*-Ph), 136.22 (*ipso*-Ph), 136.20 (*ipso*-Ph), 135.9 (Ph), 135.7 (Ph), 129.23 (Ph), 129.17 (Ph),

128.38 (Ph), 128.36 (Ph), 127.51 (Ph), 127.5 (Ph), 127.2 (Ph), 126.8 (Ph), 126.0 (Ph), 125.4 (Ph), 79.0 (C OH), 63.3 (SC H(Me)COH), 57.1 (SC HMe$_2$), 27.3 (C Me$_3$), 19.9 (C Me$_3$), 17.9 (SCH Me), 14.4 (SCH Me), 12.0 (SCH(Me)COH); MS (ESI) *m/z* 556 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{34}$H$_{41}$NO$_2$SSi (M + H)$^+$ 556.2700, found 556.2694 (+1.1 ppm error) and impure alcohol *syn*-**126** (25 mg) as a white solid. Further purification by flash column chromatography on silica with 6:4 and then 4:6 hexane-CH$_2$Cl$_2$ as eluent gave alcohol *syn*-**126** (8 mg, 3%), as a white solid; mp 148–150 °C; R_F (8:2 CH$_2$Cl$_2$-hexane) 0.38; IR (ATR) 3246 (OH), 3071, 2932, 2857, 1450, 1427, 1277, 1236, 1140, 1107, 701, 493 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.72 (dd, *J* = 8.5, 2.5 Hz, 2H, Ph), 7.69 (dd, *J* = 8.5, 2.5 Hz, 2H, Ph), 7.62 (dd, *J* = 8.5, 1.0 Hz, 2H, Ph), 7.58 (dd, *J* = 8.5, 1.0 Hz, 2H, Ph), 7.47–7.38 (m, 4H, Ph), 7.36–7.27 (m, 6H, Ph), 7.24–7.17 (m, 2H, Ph), 7.15 (s, 1H, OH), 4.25 (q, *J* = 7.0 Hz, 1H, SC H(Me)COH), 1.69–1.58 (m, 4H, SC HMe, SCH Me), 1.11 (s, 9H, SiCMe$_3$), 1.03 (d, *J* = 7.0 Hz, 3H, SCH Me), 0.55 (d, *J* = 7.0 Hz, 3H, SCH(Me)COH); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 146.2 (*ipso*-Ph), 145.7 (*ipso*-Ph), 136.14 (Ph), 136.10 (Ph), 135.9 (*ipso*-Ph), 129.3 (Ph), 129.2 (Ph), 128.4 (Ph), 128.3 (Ph), 127.53 (Ph), 127.50 (Ph), 127.2 (Ph), 127.0 (Ph), 126.4 (Ph), 125.5 (Ph), 78.3 (C OH), 61.4 (SC H(Me)COH), 57.4 (SC HMe$_2$), 27.4 (C Me$_3$), 19.9 (C Me$_3$), 18.3 (SCH Me), 15.0 (SCH Me), 10.4 (SCH(Me)COH) (one *ipso*-Ph resonance not resolved); MS (ESI) *m/z* 556 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{34}$H$_{41}$NO$_2$SSi (M + H)$^+$ 556.2700, found 556.2704 (−0.7 ppm error). The stereochemistry of *anti*-**126** was assigned by X-ray crystallography.

X-ray crystal structure determination of *anti*-**126**

C$_{34}$H$_{41}$NO$_2$SSi, *M* = 555.83, orthorhombic, *a* = 25.9296(3), *b* = 7.98537(10), *c* = 29.7696(4) Å, *β* = 90°, *U* = 6164.02(13) Å^3, *T* = 110.00(10) K, space group Pbcn, Z = 8, *μ*(CuKα) = 1.532 mm^{-1}, 14050 reflection measured, 5506 unique (R$_{int}$ = 0.0215) which were used in calculation. The final R1 was 0.0318 (I≥2σ) and wR2 was 0.0804 (all data).

Lab book reference: **AH-1-11**

2-{[(*tert*-Butyldiphenylsilyl)imino](2-methylphenyl)oxo-λ⁶-sulfanyl}-1,1-diphenylpropan-1-ol *anti*-127 and *syn*-127
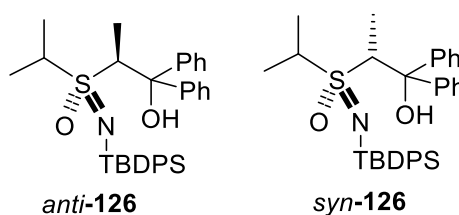

anti-**127**   *syn*-**127**
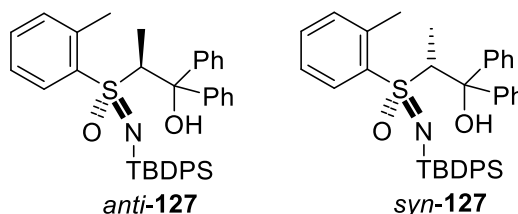
Using general procedure C, *N*-TBDPS sulfoximine **102** (211 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 65:35 mixture of diastereomeric alcohols *anti*-**127** and *syn*-**127** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave alcohol *anti*-**127** (193 mg, 64%) as a white solid, mp 138–140 °C; R_F (6:4 hexane-Et$_2$O) 0.43; IR (ATR) 3249 (OH), 3058, 2931, 2857, 1450, 1427, 1237, 1145, 1127, 1108, 907, 820, 729, 697, 645, 605, 582, 494 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.65 (br s, 4H, Ar), 7.57-7.11 (m, 14H, Ar, OH), 7.10-6.70 (m, 6H, Ar), 6.55 (br s, 1H, Ar), 4.35 (br q, J = 7.0 Hz, 1H, SCH), 2.70 (s, 3H, ArMe), 1.53 (br s, 3H, CH*Me*), 1.13 (s, 9H, CMe$_3$); ^{1}H NMR (400 MHz, d$_6$-DMSO) δ 7.67 (d, J = 7.0 Hz, 2H, Ar), 7.61 (dd, J = 7.0, 1.5 Hz, 2H, Ar), 7.50 (d, J = 7.0 Hz, 2H, Ar), 7.39–7.18 (m, 11H, Ar, OH), 7.16–7.06 (m, 3H, Ar), 6.84–6.67 (m, 4H, Ar), 6.42 (t, J = 7.0 Hz, 1H, Ar), 4.70 (q, J = 7.0 Hz, 1H, SCH), 2.69 (s, 3H, ArMe), 1.44 (d, J = 7.0 Hz, 3H, CH*Me*), 1.06 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 144.9 (*ipso*-Ar), 141.5 (*ipso*-Ar), 136.1 (Ar), 136.0 (Ar), 135.8 (*ipso*-Ar), 135.7 (*ipso*-Ar), 135.1 (*ipso*-Ar), 135.0 (*ipso*-Ar), 132.0 (Ar), 131.7 (Ar), 130.4 (Ar), 129.2 (Ar), 129.1 (Ar), 128.3 (Ar), 128.2 (Ar), 127.7 (Ar), 127.4 (Ar), 127.1 (Ar), 127.0 (Ar), 126.9 (Ar), 126.1 (Ar), 125.9 (Ar), 79.2 (br, COH), 66.3 (br, SCH), 27.5 (C*Me*$_3$), 21.2 (ArMe), 19.5 (*C*Me$_3$), 10.7 (br, SCH*Me*); MS (ESI) *m/z* 604 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{38}$H$_{41}$NO$_2$SSi (M + H)$^+$ 604.2700, found 604.2683 (+2.8 ppm error) and impure alcohol *syn*-**127**. Further purification by flash column chromatography on silica with 1:1 hexane-CH$_2$Cl$_2$ gave alcohol *syn*-**127** (151 mg of an 80:20 mixture of benzophenone and *syn*-**127** i.e. 60 mg (20%) of *syn*-**127**) as a white solid, R_F (1:1 hexane-CH$_2$Cl$_2$) 0.31; IR (ATR) 3407 (OH), 2930, 2856, 1659, 1449, 1277, 1109, 700, 639, 605, 499 cm^{-1}; ^{1}H NMR (400 MHz, d$_6$-DMSO, 80 °C) for *syn*-**127** δ 7.69–7.60 (m, 2H, Ph), 7.58–7.51 (m,

2H, Ph), 7.44 (d, J = 7.5 Hz, 2H, Ar), 7.39–7.33 (m, 2H, Ar), 7.31 (d, J = 7.5 Hz, 1H, Ar), 7.29–7.20 (m, 5H, Ar), 7.20–7.07 (m, 5H, Ar), 6.99 (d, J = 7.5 Hz, 1H, Ar), 6.87–6.81 (m, 3H, Ar), 6.79 (t, J = 7.5 Hz, 1H, Ar), 5.94 (s, 1H, OH), 4.90 (q, J = 7.0 Hz, 1H, SCH), 2.52 (s, 3H, ArMe), 1.43 (d, J = 7.0 Hz, 3H, CH*Me*), 0.94 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, d$_6$-DMSO) for *syn*-**127** δ 150.7 (*ipso*-Ar), 147.4 (*ipso*-Ar), 145.3 (*ipso*-Ar), 135.8 (Ar), 135.64 (Ar), 135.57 (Ar), 132.5 (Ar), 132.1 (Ar), 129.5 (Ar), 129.4 (Ar), 128.6 (Ar), 127.8 (Ar), 127.7 (Ar), 127.6 (Ar), 126.9 (Ar), 126.7 (Ar), 126.0 (Ar), 125.7 (Ar), 125.2 (Ar), 79.1 (COH), 27.4 (*CMe*$_3$), 21.1 (ArMe), 19.6 (*C*Me$_3$) (three *ipso*-Ar, one SCH and one SCH*Me* resonances not resolved); MS (ESI) *m/z* 604 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{38}$H$_{41}$NO$_2$SSi (M + H)$^+$ 604.2700, found 604.2700 (+0.0 ppm error). The stereochemistry of *anti*-**127** and *syn*-**127** was assigned by analogy with related examples.

Lab book reference: **AH-1-73**

tert-Butyl *N*-[ethyl(1-hydroxy-1,1-diphenylpropan-2-yl)oxo-λ⁶-sulfanylidene]carbamate *anti*-128 and *syn*-128

anti-**128**   *syn*-**128**

Using general procedure C, *N*-Boc sulfoximine **120** (111 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 55:45 mixture of alcohols *anti*-**128** and *syn*-**128** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-EtOAc as eluent gave alcohol *syn*-**128** (48 mg, 24%) as a white solid, mp 164–166 °C; R_F (8:2 hexane-EtOAc) 0.23; IR (ATR) 3234 (OH), 2979, 1676 (C=O), 1450, 1366, 1282, 1246, 1151, 1056, 860, 752, 705, 534 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.59 (d, J = 7.5 Hz, 2H, Ph), 7.52 (d, J = 7.5 Hz, 2H, Ph), 7.39–7.28 (m, 4H, Ph), 7.27–7.19 (m, 2H, Ph), 7.04 (s, 1H, OH), 4.34 (q, J = 7.5 Hz, 1H, SC*H*(Me)COH), 3.58 (dq, J = 14.0, 7.5 Hz, 1H, SC*H*Me), 1.60 (d, J = 7.5 Hz, 3H, SCH*Me*), 1.53–1.42 (m, 10H, SC*H*Me, CMe$_3$), 1.20 (t, J = 7.5 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 158.0 (C=O), 144.9 (*ipso*-Ph), 128.7 (Ph), 128.6 (Ph), 127.8 (Ph), 127.4 (Ph), 126.2 (Ph),

125.2 (Ph), 80.6 (*C*OH), 77.9 (*C*Me₃), 61.4 (S*C*H), 46.4 (S*C*H₂), 28.3 (C*Me₃*), 9.6 (SCH*Me*), 8.2 (SCH₂*Me*) (one *ipso*-Ph resonance not resolved); MS (ESI) *m/z* 404 [(M + H)⁺] HRMS (ESI) *m/z* calcd for C₂₂H₂₉NO₄S (M + H)⁺ 404.1890, found 404.1884 (+1.6 ppm error) and alcohol *anti*-**128** (88 mg, 44%) as a white solid, mp 124–126 °C; R_F (8:2 hexane-EtOAc) 0.13; IR (ATR) 3282 (OH), 2980, 1651, 1450, 1367, 1292, 1248, 1151, 1032, 907, 857, 771, 728, 703, 646, 535 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.63 (d, *J* = 7.5 Hz, 2H, Ph), 7.53 (d, *J* = 7.5 Hz, 2H, Ph), 7.35–7.27 (m, 4H, Ph), 7.25–7.18 (m, 2H, Ph), 5.57 (s, 1H, OH), 4.66 (q, *J* = 7.5 Hz, 1H, SC*H*(Me)COH), 3.21 (dq, *J* = 14.0, 7.5 Hz, 1H, SC*H*Me), 2.40 (dq, *J* = 14.0, 7.5 Hz, 1H, SC*H*Me), 1.55 (d, *J* = 7.5 Hz, 3H, SCH*Me*), 1.45 (s, 9H, CMe₃), 1.20 (t, *J* = 7.5 Hz, 3H, SCH₂*Me*); ¹³C NMR (100.6 MHz, CDCl₃) δ 157.7 (C=O), 145.0 (*ipso*-Ph), 144.7 (*ipso*-Ph), 128.7 (Ph), 128.6 (Ph), 127.7 (Ph), 127.3 (Ph), 125.9 (Ph), 125.0 (Ph), 80.5 (*C*OH), 79.0 (*C*Me₃), 65.0 (S*C*H), 47.5 (S*C*H₂), 28.2 (C*Me₃*), 11.3 (SCH*Me*), 6.6 (SCH₂*Me*); MS (ESI) *m/z* 404 [(M + H)⁺] HRMS (ESI) *m/z* calcd for C₂₂H₂₉NO₄S (M + H)⁺ 404.1890, found 404.1885 (+1.3 ppm error). The stereochemistry of *syn*-**128** was assigned by X-ray crystallography.

X-ray crystal structure determination of *syn*-**128**

C₂₂H₂₉NO₄S, *M* = 403.52, monoclinic, *a* = 9.1428(3), *b* = 11.0946(3), *c* = 10.8364(3) Å, *β* = 100.753(3)°, *U* = 1079.90(5) Å³, *T* = 110.00(10) K, space group P2₁, Z = 2, *μ*(CuKα) = 1.548 mm⁻¹, 14031 reflection measured, 2714 unique (R$_{int}$ = 0.0143) which were used in calculation. The final R1 was 0.0260 (I≥2σ) and wR2 was 0.0664 (all data).

Lab book reference: **AH-1-26**

Ethyl(1-hydroxy-1,1-diphenylpropan-2-yl)imino-λ⁶-sulfanone *anti*-129
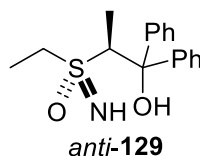
anti-**129**

TFA (0.18 mL, 2.2 mmol, 9.75 eq.) was added dropwise to a stirred solution of *N*-Boc sulfoximine *anti*-**128** (90 mg, 0.23 mmol, 1.0 eq.) in CH₂Cl₂ (1.3 mL) at rt under Ar. The resulting solution was stirred at rt for 24 h. The solvent was evaporated under reduced pressure and the residue was dissolved in water (1.3 mL). Saturated Na₂CO₃(aq) (2.6 mL) was added and the aqueous mixture was extracted with CH₂Cl₂ (3 × 20 mL). The

combined organic extracts were dried (Na$_2$SO$_4$) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with EtOAc and then 9:1 EtOAc-MeOH as eluent gave NH sulfoximine *anti*-**129** (21 mg, 30%) as a brown viscous oil, R_F (9:1 EtOAc-MeOH) 0.53; IR (ATR) 2926, 1728, 1576, 1492, 1458, 1205, 1134, 964, 750, 704, 471 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.62–7.50 (m, 4H, Ph), 7.41–7.29 (m, 5H, Ph), 7.24–7.21 (m, 1H, Ph), 6.27 (br s, 1H, OH), 4.16 (q, *J* = 7.0 Hz, 1H, SC*H*(Me)COH), 2.45 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 2.24 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 1.53 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.21 (t, *J* = 7.0 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 145.3 (*ipso*-Ph), 144.7 (*ipso*-Ph), 128.6 (Ph), 128.5 (Ph), 127.6 (Ph), 127.3 (Ph), 126.2 (Ph), 125.6 (Ph), 79.0 (COH), 64.7 (SCH), 49.2 (SCH$_2$), 11.3 (SCH*Me*), 7.1 (SCH$_2$*Me*); MS (ESI) *m/z* 304 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{17}$H$_{21}$NO$_2$S (M + H)$^+$ 304.1366, found 304.1363 (+0.9 ppm error).

Lab book reference: **AH-1-46**

2-{[(*tert*-Butyldimethylsilyl)imino](oxo)phenyl-λ^6-sulfanyl}-1,1-diphenylpropan-1-ol *anti*-130 and *syn*-130

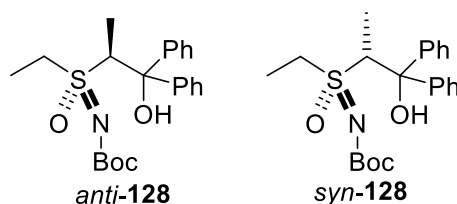*anti*-**130**   *syn*-**130**
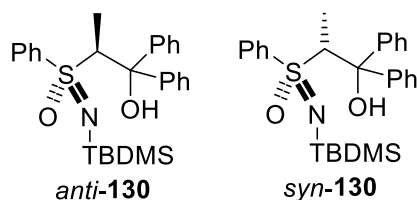
Using general procedure C, *N*-TBDMS sulfoximine **121** (142 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an 80:20 mixture of alcohols *anti*-**130** and *syn*-**130** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 97:3 and then 9:1 hexane-Et$_2$O as eluent gave alcohol *anti*-**130** (154 mg, 66%) as a white solid, mp 86–88 °C; R_F (6:4 hexane-Et$_2$O) 0.50; IR (ATR) 3401 (OH), 3061, 2953, 2928, 2855, 1449, 1249, 1137, 1072, 774, 703, 693, 553 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.59 (d, *J* = 7.5 Hz, 2H, Ph), 7.55 (d, *J* = 7.5 Hz, 2H, Ph), 7.49 (d, *J* = 7.5 Hz, 2H, Ph), 7.44 (t, *J* = 7.5 Hz, 1H, Ph), 7.34 (dd, *J* = 7.5, 7.5 Hz, 2H, Ph), 7.24 (dd, *J* = 7.5, 7.5 Hz, 2H, Ph), 7.18–7.06 (m, 4H, Ph), 6.76 (s, 1H, OH), 4.31 (q, *J* = 7.5 Hz, 1H, SCH), 1.21 (d, *J* = 7.5 Hz, 3H, SCH*Me*), 0.88 (s, 9H, CMe$_3$), −0.18 (s, 3H, SiMe), −0.21 (s, 3H,

SiMe); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 145.6 (*ipso*-Ph), 145.2 (*ipso*-Ph), 143.7 (*ipso*-Ph), 132.2 (Ph), 128.6 (Ph), 128.44 (Ph), 128.36 (Ph), 127.8 (Ph), 126.9 (Ph), 126.8 (Ph), 126.5 (Ph), 125.3 (Ph), 79.5 (COH), 67.9 (SCH), 26.0 (C*Me*$_3$), 18.1 (*C*Me$_3$), 13.5 (SCH*Me*), −2.7 (SiMe), −2.9 (SiMe); MS (ESI) *m/z* 466 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{27}$H$_{35}$NO$_2$SSi (M + H)$^+$ 466.2231, found 466.2225 (+1.3 ppm error) and alcohol *syn*-**130** (39 mg, 17%) as a colourless oil, R_F (9:1 hexane-Et$_2$O) 0.15; IR (ATR) 3234 (OH), 2952, 2855, 1447, 1246, 1135, 1074, 825, 776, 688, 578, 532 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.48 (d, *J* = 7.5 Hz, 2H, Ph), 7.38–7.27 (m, 3H, Ph), 7.23 (dd, *J* = 7.5, 7.5 Hz, 2H, Ph), 7.17–7.08 (m, 5H, Ph), 7.89–6.78 (m, 3H, Ph), 4.24 (q, *J* = 7.5 Hz, 1H, SCH), 1.53 (d, *J* = 7.5 Hz, 3H, SCH*Me*), 0.95 (s, 9H, CMe$_3$), −0.03 (s, 6H, SiMe$_2$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 145.9 (*ipso*-Ph), 144.9 (*ipso*-Ph), 131.6 (*ipso*-Ph), 128.6 (Ph), 128.3 (Ph), 127.8 (Ph), 127.6 (Ph), 126.8 (Ph), 126.7 (Ph), 126.6 (Ph), 125.9 (Ph), 125.2 (Ph), 78.3 (COH), 66.6 (SCH), 26.1 (C*Me*$_3$), 18.2 (*C*Me$_3$), 10.3 (SCH*Me*), −2.5 (SiMe), −2.6 (SiMe); MS (ESI) *m/z* 466 (M + H)$^+$; HRMS (ESI) *m/z* calcd for C$_{27}$H$_{35}$NO$_2$SSi (M + H)$^+$ 466.2231, found 466.2228 (+0.5 ppm error). The stereochemistry of *anti*-**130** and *syn*-**130** was assigned by analogy with related examples.

Lab book reference: **AH-1-20**

Attempted synthesis of (1-Hydroxy-1,1-diphenylpropan-2-yl)(imino)phenyl-λ^6-sulfanone *anti*-131
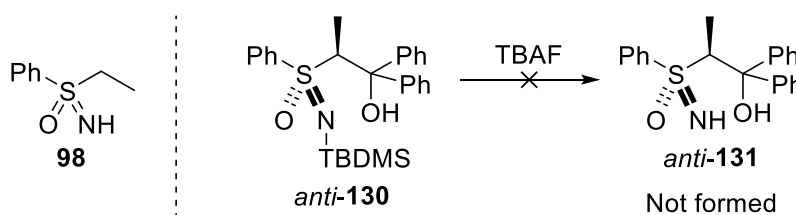
TBAF (0.56 mL of a 1 M solution in THF, 0.56 mmol, 2.0 eq.) was added dropwise to a stirred solution of *N*-TBDMS sulfoximine *anti*-**130** (130 mg, 0.28 mmol, 1.0 eq.) in THF (2 mL) at rt under Ar. The resulting solution was stirred at rt for 48 h. The solvent was evaporated under reduced pressure to give the crude product which contained none of the desired product *anti*-**131**. Purification by flash column chromatography on silica with EtOAc as eluent gave unsubstituted NH sulfoximine **98** (43 mg, 91%) as a yellow oil and none of the desired product *anti*-**131**.

Lab book reference: **AH-1-45**

tert-Butyl[(_tert_-Butyldiphenylsilyl)imino](3-hydroxy-3-methylbutan-2-yl)-λ^6-sulfanone _anti_-133
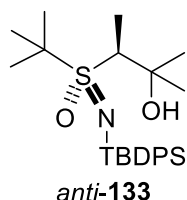
anti-**133**

Using general procedure C, *N*-TBDPS sulfoximine **118** (128 mg, 0.33 mmol, 1.0 eq.), *n*-BuLi (0.16 mL of a 2.2 M solution in hexanes, 0.36 mmol, 1.1 eq.) and acetone (0.05 mL, 0.66 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained only alcohol *anti*-**133** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave alcohol *anti*-**133** (73 mg, 50%) as a white solid, mp 110–112 °C; R_F (6:4 hexane-Et$_2$O) 0.22; IR (ATR) 3467 (OH), 3071, 2933, 2856, 1472, 1427, 1374, 1314, 1260, 1182, 1106, 949, 820, 729, 701, 627, 595 498 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.78–7.73 (m, 4H, Ph), 7.31–7.41 (m, 6H, Ph), 5.04 (s, 1H, OH), 3.48 (q, *J* = 7.5 Hz, 1H, SCH), 1.28 (s, 9H, SCMe$_3$), 1.26 (d, *J* = 7.5 Hz, 3H, SCH*Me*), 1.18 (s, 3H, C(OH)*Me*), 1.13 (s, 3H, C(OH)*Me*), 1.09 (s, 9H, SiCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.6 (*ipso*-Ph), 136.5 (*ipso*-Ph), 136.14 (Ph), 136.12 (Ph), 129.18 (Ph), 129.15 (Ph), 127.42 (Ph), 127.35 (Ph), 73.2 (COH), 65.1 (S*C*Me$_3$), 63.3 (SCH), 30.2 (C(OH)*Me*), 27.6 (SiC*Me*$_3$), 24.3 (C(OH)*Me*), 24.1 (SC*Me*$_3$), 20.0 (Si*C*Me$_3$), 16.4 (SCH*Me*); MS (ESI) *m/z* 468 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{25}$H$_{39}$NO$_2$SSi (M + Na)$^+$ 468.2363, found 468.2356 (+1.4 ppm error). The stereochemistry of *anti*-**133** was assigned by conversion into *anti*-**138**.

Lab book reference: **AH-1-56**

**tert-Butyl[(tert-butyldiphenylsilyl)imino](3-hydroxy-3-methyl-1-phenylbutan-2-yl)-
λ⁶-sulfanone anti-134**
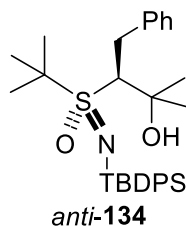
anti-**134**

Using general procedure C, *N*-TBDPS sulfoximine **119** (232 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.25 mL of a 2.2 M solution in hexanes, 0.55 mmol, 1.1 eq.) and acetone (0.07 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at –78 °C for 1 h gave the crude product which contained only alcohol *anti*-**134** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave alcohol *anti*-**134** (187 mg, 72%) as a white solid, mp 120–122 °C; R_F (8:2 hexane-Et$_2$O) 0.11; IR (ATR) 3458 (OH), 2932, 2857, 1472, 1395, 1313, 1195, 1107, 908, 820, 731, 698, 632, 599, 545, 497, 472 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.82–7.75 (m, 4H, Ph), 7.43–7.32 (m, 6H, Ph), 7.22 (dd, *J* = 7.0, 7.0 Hz, 2H, Ph), 7.19–7.14 (m, 1H, Ph), 7.07 (d, *J* = 7.0 Hz, 2H, Ph), 5.25 (s, 1H, OH), 3.77 (dd, *J* = 6.5, 5.0 Hz, 1H, SCH), 3.51 (dd, *J* = 16.5, 6.5 Hz, 1H, C*H*Ph), 2.59 (dd, *J* = 16.5, 5.0 Hz, 1H, C*H*Ph), 1.25 (s, 3H, C(OH)*Me*), 1.17 (s, 9H, SCMe$_3$), 1.14 (s, 9H, SiCMe$_3$), 1.09 (s, 3H, C(OH)*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 139.6 (*ipso*-Ph), 136.4 (*ipso*-Ph), 136.31 (Ph), 136.29 (Ph), 129.30 (Ph), 129.28 (Ph), 128.7 (Ph), 128.5 (Ph), 127.5 (Ph), 127.4 (Ph), 126.6 (Ph), 73.8 (COH), 69.6 (SCH), 65.4 (S*C*Me$_3$), 35.6 (*C*H$_2$Ph), 31.2 (C(OH)*Me*), 27.8 (SiC*Me$_3$*), 25.1 (C(OH)*Me*), 24.2 (SC*Me$_3$*), 20.1 (Si*C*Me$_3$) (one *ipso*-Ph resonance not resolved); MS (ESI) *m/z* 544 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{31}$H$_{43}$NO$_2$SSi (M + Na)$^+$ 544.2676, found 544.2676 (−0.1 ppm error). The stereochemistry of *anti*-**134** was assigned by analogy with related examples.

Lab book reference: **AH-1-51**

[(*tert*-Butyldiphenylsilyl)imino](ethyl)(3-hydroxy-3-methylbutan-2-yl)-λ⁶-sulfanone
*anti*-**135** and *syn*-**135**
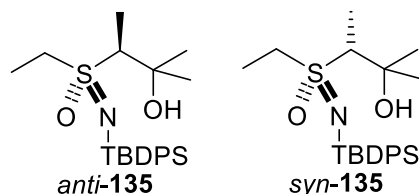
Using general procedure C, *N*-TBDPS sulfoximine **86** (180 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.25 mL of a 2.2 M solution in hexanes, 0.55 mmol, 1.1 eq.) and acetone (0.07 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an 80:20 mixture of alcohols *anti*-**135** and *syn*-**135** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave an 85:15 mixture of alcohols *anti*-**135** and *syn*-**135** (171 mg, 82%) as a colourless oil, R_F (8:2 hexane-Et$_2$O) 0.33; IR (ATR) 3467 (OH), 3071, 2932, 2856, 1427, 1307, 1258, 1181, 1107, 820, 733, 700, 631, 595 496 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.82–7.70 (s, 4H, Ph), 7.44–7.32 (m, 6H, Ph), 6.56 (s, 0.15H, OH), 5.16 (s, 0.85H, OH), 3.22 (q, *J* = 7.0 Hz, 0.15H, SC*H*(Me)COH), 3.16 (q, *J* = 7.0 Hz, 0.85H, SC*H*(Me)COH), 2.84 (dq, *J* = 14.0, 7.0 Hz, 0.15H, SC*H*Me), 2.73 (dq, *J* = 14.0, 7.0 Hz, 0.85H, SC*H*Me), 2.47 (dq, *J* = 14.0, 7.0 Hz, 0.85H, SC*H*Me), 2.05 (dq, *J* = 14.0, 7.0 Hz, 0.15H, SC*H*Me), 1.63 (s, 0.45H, C(OH)*Me*), 1.51 (s, 2.55H, C(OH)*Me*), 1.40 (d, *J* = 7.0 Hz, 2.55H, SCH*Me*), 1.37 (s, 2.55H, C(OH)*Me*), 1.32 (d, *J* = 7.0 Hz, 0.45H, SCH*Me*), 1.30 (s, 0.45H, C(OH)*Me*), 1.12–1.04 (s, 11.55H, SCH$_2$*Me*, SiCMe$_3$), 1.01 (t, *J* = 7.0 Hz, 0.45H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.5 (*ipso*-Ph, *anti*-**135**), 136.1 (Ph, *syn*-**135**), 136.0 (*ipso*-Ph, *anti*-**135**), 135.84 (Ph, *anti*-**135**), 135.79 (Ph, *syn*-**135**), 135.64 (Ph, *anti*-**135**), 135.55 (*ipso*-Ph, *syn*-**135**), 135.3 (*ipso*-Ph, *syn*-**135**), 129.6 (Ph, *syn*-**135**), 129.5 (Ph, *syn*-**135**), 129.32 (Ph, *anti*-**135**), 129.27 (Ph, *anti*-**135**), 127.7 (Ph, *syn*-**135**), 127.64 (Ph, *syn*-**135**), 127.56 (Ph, *anti*-**135**), 73.3 (COH, *syn*-**135**), 73.0 (COH, *anti*-**135**), 65.3 (SCH, *anti*-**135**), 63.9 (SCH, *syn*-**135**), 51.8 (SCH$_2$, *anti*-**135**), 49.1 (SCH$_2$, *syn*-**135**), 30.5 (C(OH)*Me*, *syn*-**135**), 30.2 (C(OH)*Me*, *anti*-**135**), 27.3 (C*Me$_3$*, *syn*-**135**), 27.2 (C*Me$_3$*, *anti*-**135**), 25.8 (C(OH)*Me*, *anti*-**135**), 24.9 (C(OH)*Me*, *syn*-**135**), 19.53 (*C*Me$_3$, *anti*-**135**), 19.47 (*C*Me$_3$, *syn*-**135**), 13.9 (SCH*Me*, *anti*-**135**), 12.3 (SCH*Me*, *syn*-**135**), 8.9 (SCH$_2$*Me*, *syn*-**135**), 8.5 (SCH$_2$*Me*, *anti*-**135**) (one Ph resonance not resolved); MS (ESI) *m/z* 418 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{23}$H$_{35}$NO$_2$SSi (M + H)$^+$ 418.2231, found 418.2228

(+0.7 ppm error). The stereochemistry of *anti*-**135** and *syn*-**135** was assigned by analogy with related examples.

Lab book reference: **AH-1-47**

[(*tert*-Butyldiphenylsilyl)imino](3-hydroxy-3-methylbutan-2-yl)isopropyl-λ⁶-sulfanone *anti*-136 and *syn*-136
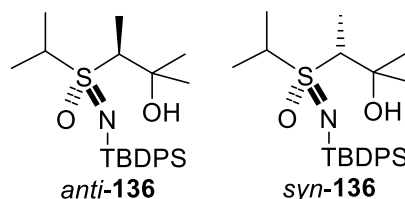
anti-**136**   *syn*-**136**

Using general procedure C, *N*-TBDPS sulfoximine **104** (187 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.25 mL of a 2.2 M solution in hexanes, 0.55 mmol, 1.1 eq.) and acetone (0.07 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an 80:20 mixture of alcohols *anti*-**136** and *syn*-**136** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 9:1 hexane-EtOAc as eluent gave an 80:20 mixture of alcohols *anti*-**136** and *syn*-**136** (110 mg of a 95:5 mixture of alcohol **136** and starting sulfoximine **104** i.e. 105 mg (49%) of **136**) as a colourless oil, R_F (6:4 hexane-Et$_2$O) 0.36; IR (ATR) 3465 (OH), 3071, 2932, 2856, 1463, 1427, 1310, 1257, 1181, 1106, 949, 820, 731, 700, 686, 597, 495 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) for *anti*-**136** and *syn*-**136** δ 7.83–7.71 (m, 4H, Ph), 7.43–7.30 (m, 6H, Ph), 6.43 (s, 0.2H, OH), 4.95 (s, 0.8H, OH), 3.31–3.20 (m, 1H, SC*H*(Me)COH), 2.88 (septet, *J* = 8.0 Hz, 0.8H, SC*H*Me$_2$), 2.81 (septet, *J* = 8.0 Hz, 0.2H, SC*H*Me$_2$),1.59 (s, 0.6H, C(OH)*Me*), 1.36 (s, 2.4H, C(OH)*Me*), 1.34 (s, 0.6H, C(OH)*Me*), 1.33–1.28 (m, 3H, SCH(*Me*)COH), 1.26 (s, 2.4H, C(OH)*Me*), 1.17 (d, *J* = 8.0 Hz, 4.8H, SCH*Me*$_2$), 1.14 (d, *J* = 8.0 Hz, 0.6H, SCH*Me*), 1.10 (s, 1.8H, C*Me*$_3$), 1.08 (s, 7.2H, C*Me*$_3$), 0.95 (d, *J* = 8.0 Hz, 0.6H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) for *anti*-**136** and *syn*-**136** δ 136.6 (*ipso*-Ph, *anti*-**136**), 136.29 (*ipso*-Ph, *anti*-**136**), 136.26 (Ph, *syn*-**136**), 136.0 (Ph, *syn*-**136**), 135.9 (Ph, *anti*-**136**), 135.8 (Ph, *anti*-**136**), 129.4 (Ph, *syn*-**136**), 129.22 (Ph, *syn*-**136**), 129.19 (Ph, *anti*-**136**), 127.7 (Ph, *anti*-**136**), 127.51 (Ph, *syn*-**136**), 127.47 (Ph, *anti*-**136**), 127.4 (Ph, *syn*-**136**), 73.2 (COH, *anti*-**136**), 64.5 (S*C*HMe, *anti*-**136**), 64.1 (S*C*HMe, *syn*-**136**), 59.8 (S*C*HMe$_2$, *anti*-**136**), 58.4 (S*C*HMe$_2$, *syn*-**136**), 30.6 (C(OH)*Me*, *syn*-**136**), 30.2 (C(OH)*Me*, *anti*-**136**), 27.4 (C*Me*$_3$, *syn*-**136**), 27.3 (C*Me*$_3$, *anti*-**136**), 25.0 (C(OH)*Me*,

syn-**136**), 24.9 (C(OH)*Me*, *anti*-**136**), 19.8 (*C*Me₃, *anti*-**136**), 19.7 (*C*Me₃, *syn*-**136**), 18.0 (SCH*Me*, *syn*-**136**), 16.8 (SCH*Me*, *anti*-**136**), 16.6 (SCH*Me*, *anti*-**136**), 16.0 (SCH*Me*, *syn*-**136**), 15.0 (SCH(*Me*)COH, *anti*-**136**), 13.2 (SCH(*Me*)COH, *syn*-**136**) (one COH, one Ph and two *ipso*-Ph resonances not resolved); MS (ESI) *m/z* 432 [(M + H)⁺] HRMS (ESI) *m/z* calcd for $C_{24}H_{37}NO_2SSi$ (M + H)⁺ 432.2387, found 432.2380 (+1.5 ppm error). The stereochemistry of *anti*-**136** and *syn*-**136** was assigned by analogy with related examples.

Lab book reference: **AH-1-38**

tert-Butyl(3-hydroxy-3-methylbutan-2-yl)imino-λ⁶-sulfanone *anti*-137
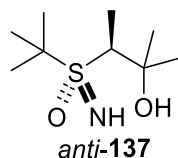
anti-**137**

TBAF (0.23 mL of a 1 M solution in THF, 0.23 mmol, 2.0 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine *anti*-**133** (52 mg, 0.12 mmol, 1.0 eq.) in THF (1 mL) at rt under Ar. The resulting solution was stirred at rt for 64 h. The solvent was evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with EtOAc as eluent gave alcohol *anti*-**137** (20 mg, 80%) as a white solid, mp 150–152 °C (dec); R_F (9:1 EtOAc-MeOH) 0.43; IR (ATR) 3445 (OH), 3276 (NH), 2988, 2937, 1467, 1391, 1184, 1070, 635, 578, 505 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 5.04 (s, 1H, OH), 3.51 (q, *J* = 7.0 Hz, 1H, SCH), 2.35 (s, 1H, NH), 1.50 (s, 3H, C(*Me*)OH), 1.42 (s, 9H, SCMe₃), 1.40 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.29 (s, 3H, C(*Me*)OH); ¹³C NMR (100.6 MHz, CDCl₃) δ 73.5 (COH), 63.3 (*C*Me₃), 61.4 (SCH), 30.0 (C(*Me*)OH), 24.3 (C(*Me*)OH), 23.9 (C*Me₃*), 16.1 (SCH*Me*); MS (ESI) *m/z* 208 [(M + H)⁺] HRMS (ESI) *m/z* calcd for $C_9H_{21}NO_2S$ (M + H)⁺ 208.1366, found 208.1369 (−1.6 ppm error).

Lab book reference: **AH-1-77**

4-Bromo-*N*-[*tert*-butyl(3-hydroxy-3-methylbutan-2-yl)oxo-λ⁶-sulfanylidene]benzamide *anti*-138
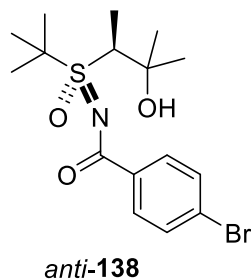
anti-**138**

Et₃N (0.02 mL, 0.15 mmol, 1.3 eq.) was added dropwise to a stirred solution of NH sulfoximine *anti*-**137** (23 mg, 0.11 mmol, 1.0 eq.) and 4-bromobenzoyl chloride (25 mg, 0.15 mmol, 1.3 eq.) in CH₂Cl₂ (1 mL) at 0 °C under Ar. The resulting solution was stirred at 0 °C for 1 h and then stirred at rt for 64 h. Then, water (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH₂Cl₂ (3 × 20 mL). The combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with EtOAc as eluent gave impure alcohol *anti*-**138** (25 mg of a 70:30 mixture of 4-bromobenzoic acid and *anti*-**138** i.e. 11 mg (26%) of *anti*-**138**) as a white solid, R_F (EtOAc) 0.58; IR (ATR) 2976, 1785 (C=O), 1720 (C=O), 1632, 1586, 1480, 1395, 1288, 1169, 1067, 1010, 793, 757, 737, 676, 626, 465 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) for *anti*-**138** δ 7.96 (d, *J* = 8.5 Hz, 2H, Ar), 7.53 (d, *J* = 8.5 Hz, 2H, Ar), 4.24 (s, 1H, OH), 3.80 (q, *J* = 7.0 Hz, 1H, SCH), 1.70 (s, 3H, C(*Me*)OH), 1.60 (s, 9H, CMe₃), 1.47 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.40 (s, 3H, C(*Me*)OH); ¹³C NMR (100.6 MHz, CDCl₃) for *anti*-**138** δ 172.5 (C=O), 131.8 (*ipso*-Ar), 131.4 (Ar), 131.0 (Ar), 126.9 (*ipso*-Ar), 74.1 (COH), 65.8 (SCH), 64.7 (*C*Me₃), 30.8 (C(*Me*)OH), 26.0 (C(*Me*)OH), 23.4 (C*Me*₃), 14.7 (SCH*Me*); MS (ESI) *m/z* 412 [(M (⁷⁹Br) + Na)⁺] HRMS (ESI) *m/z* calcd for C₁₆H₂₄⁷⁹BrNO₃S (M + Na)⁺ 412.0552, found 412.0555 (−0.5 ppm error). The stereochemistry of *anti*-**138** was assigned by X-ray crystallography.

X-ray crystal structure determination of *anti*-**138**

C₁₆H₂₄BrNO₃S, *M* = 390.33, orthorhombic, *a* = 9.71496(17), *b* = 10.5508(2), *c* = 35.0348(7) Å, *β* = 90°, *U* = 3591.10(12) Å³, *T* = 110.00(10) K, space group Pbca, Z = 8, μ(CuKα) = 4.302 mm⁻¹, 7848 reflection measured, 3209 unique (R$_{int}$ = 0.0177) which were used in calculation. The final R1 was 0.0241 (I≥2σ) and wR2 was 0.0628 (all data).

Lab book reference: **AH-1-80**

Attempted synthesis *tert*-Butyl(3-hydroxy-3-methyl-1-phenylbutan-2-yl)imino-λ⁶-sulfanone *anti*-139
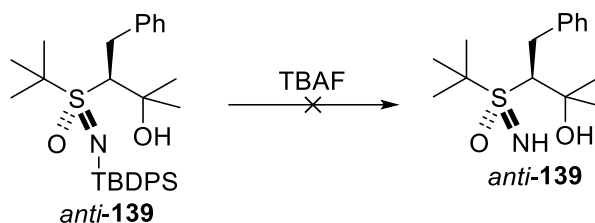
anti-**139**

anti-**139**

TBAF (0.42 mL of a 1 M solution in THF, 0.42 mmol, 2.0 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine *anti*-**134** (110 mg, 0.21 mmol, 1.0 eq.) in THF (2 mL) at rt under Ar. The resulting solution was stirred at rt for 64 h. The solvent was evaporated under reduced pressure to give the crude product which contained none of the desired product *anti*-**139** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with EtOAc as eluent gave none of the desired product *anti*-**139** (by ^{1}H NMR spectroscopy).

Lab book reference: **AH-1-78**

_N_-Methoxy-_N_-methylpyridine-3-carboxamide 141

141
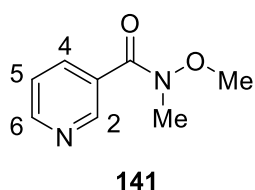
Et$_3$N (3.14 mL, 22.5 mmol, 3.0 eq.) was added to a stirred solution of *N,O*-dimethylhydroxylamine hydrochloride (730 mg, 7.5 mmol, 1.0 eq.) in CH$_2$Cl$_2$ (10 mL) at rt under Ar. The resulting solution was cooled to 0 °C and nicotinoyl chloride hydrochloride **140** (1.34 g, 7.5 mmol, 1.0 eq.) was added. The resulting solution was allowed to warm to rt and stirred at rt for 2 h. Saturated NH$_4$Cl$_{(aq)}$ (20 mL) and saturated NaHCO$_{3(aq)}$ (20 mL) were added. The two layers were separated and the aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 50 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product. Purification

by flash column chromatography on silica with EtOAc as eluent gave pyridinyl Weinreb amide **141** (800 mg, 64%) as a clear oil, R_F (EtOAc) 0.26; IR (ATR) 2938, 1636 (C=O), 1590, 1413, 1383, 978, 726 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.94 (d, J = 1.5 Hz, 1H, 2-py), 8.67 (dd, J = 5.0, 1.5 Hz, 1H, 6-py), 8.01 (ddd, J = 8.0, 1.5, 1.5 Hz, 1H, 4-py), 7.35 (dd, J = 8.0, 5.0 Hz, 1H, 5-py), 3.55 (s, 3H, OMe), 3.38 (s, 3H, NMe); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 167.6 (C=O), 151.5 (Ar), 149.4 (Ar), 136.3 (Ar), 130.0 (*ipso*-Ar), 123.1 (Ar), 61.4 (OMe), 33.3 (NMe); MS (ESI) *m/z* 167 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_8$H$_{10}$N$_2$O$_2$ (M + H)$^+$ 167.0815, found 167.0814 (+0.9 ppm error). Spectroscopic data are consistent with those reported in the literature.[64]

Lab book reference: **AH-1-4**

***tert*-Butyl[(*tert*-butyldiphenylsilyl)imino](1-oxo-1-phenylpropan-2-yl)-λ^6-sulfanone *anti*-142 and *syn*-142**

anti-**142**   *syn*-**142**
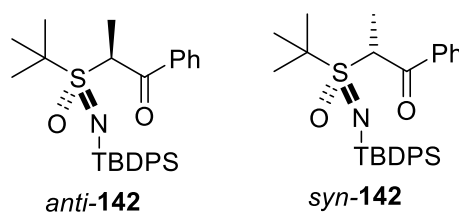
Using general procedure C, *N*-TBDPS sulfoximine **118** (1.16 g, 3.0 mmol, 1.0 eq.), *n*-BuLi (2.20 mL of a 1.5 M solution in hexanes, 3.3 mmol, 1.1 eq.) and *N*-methoxy-*N*-methylbenzamide (0.60 mL, 3.9 mmol, 1.3 eq.) in THF (30 mL) at −78 °C for 1 h gave the crude product which contained a 97:3 mixture of ketones *anti*-**142** and *syn*-**142** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave a 96:4 mixture of ketones *anti*-**142** and *syn*-**142** (1.28 g, 87%) as a white solid, mp 90–92 °C; R_F (6:4 hexane-Et$_2$O) 0.50, 0.52; IR (ATR) 3070, 2931, 2856, 1684 (C=O), 1322, 1298, 1134, 1108, 948, 821, 734, 703, 501 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.88 (dd, J = 7.5, 1.0 Hz, 1.92H, Ph), 7.78–7.86 (m, 1.92H, Ph), 7.79 (dd, J = 7.5, 1.0 Hz, 0.08 Hz, Ph), 7.75 (dd, J = 7.5, 1.0 Hz, 1.92H, Ph), 7.72 (dd, J = 7.5, 1.0 Hz, 0.08H, Ph), 7.66 (dd, J = 7.5, 1.0 Hz, 0.08H, Ph), 7.55–7.48 (m, 1H, Ph), 7.44–7.28 (m, 8H, Ph), 5.21 (q, J = 7.0 Hz, 0.96H, SCH), 4.42 (q, J = 7.0 Hz, 0.04H, SCH), 1.62 (d, J = 7.0 Hz, 2.88H, SCH*Me*), 1.52 (d, J = 7.0 Hz, 0.12H, SCH*Me*), 1.40 (s, 0.36H, SCMe$_3$), 1.30 (s, 8.44H, SCMe$_3$), 1.09 (s, 8.44H, SiCMe$_3$), 1.05 (s, 0.36H, SiCMe$_3$); ^{13}C NMR

(100.6 MHz, CDCl$_3$) for *anti*-**142** δ 194.0 (C=O), 137.8 (*ipso*-Ph), 136.6 (*ipso*-Ph), 136.4 (*ipso*-Ph), 136.1 (Ph), 136.0 (Ph), 133.2 (Ph), 129.04 (Ph), 128.97 (Ph), 128.8 (Ph), 128.7 (Ph), 127.4 (Ph), 127.3 (Ph), 66.5 (SCMe$_3$), 60.9 (SCH), 27.3 (SiCMe_3), 24.9 (SCMe_3), 19.9 (SiCMe$_3$), 16.3 (SCHMe); MS (ESI) *m/z* 492 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{29}$H$_{37}$NO$_2$SSi (M + H)$^+$ 492.2387, found 492.2371 (+3.3 ppm error). The stereochemistry of *anti*-**142** and *syn*-**142** was assigned by analogy with related examples.

Lab book reference: **AH-2-43**

[(*tert*-Butyldiphenylsilyl)imino](ethyl)(1-oxo-1-phenylpropan-2-yl)-λ⁶-sulfanone
***syn*-143 and *anti*-143**

syn-**143**   *anti*-**143**

Using general procedure C, *N*-TBDPS sulfoximine **86** (2.10 g, 6.0 mmol, 1.0 eq.), *n*-BuLi (2.87 mL of a 2.3 M solution in hexanes, 6.6 mmol, 1.1 eq.) and *N*-methoxy-*N*-methylbenzamide (1.19 mL, 7.8 mmol, 1.3 eq.) in THF (60 mL) at −78 °C for 1 h gave the crude product which contained a 55:45 mixture of ketones *syn*-**143** and *anti*-**143** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O gave ketone *syn*-**143** (1.45 g, 52%) as a white solid, mp 98–100 °C; R_F (8:2 hexane-Et$_2$O) 0.27; IR (ATR) 3069, 2931, 2856, 1675 (C=O), 1427, 1448, 1298, 1143, 1109, 947, 821, 739, 702, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.85–7.75 (m, 4H, Ph), 7.55–7.49 (m, 3H, Ph), 7.46–7.38 (m, 6H, Ph), 7.35 (dd, *J* = 7.5, 7.5 Hz, 2H, Ph), 4.36 (q, *J* = 7.5 Hz, 1H, SCH(Me)COPh), 3.20–3.03 (m, 2H, SCH$_2$), 1.52 (d, *J* = 7.5 Hz, 3H, SCHMe), 1.38 (t, *J* = 7.5 Hz, 3H, SCH$_2$$Me$), 1.09 (s, 9H, C$Me_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 195.3 (C=O), 136.6 (*ipso*-Ph), 136.3 (*ipso*-Ph), 136.1 (Ph), 135.9 (Ph), 134.1 (*ipso*-Ph), 133.8 (Ph), 129.5 (Ph), 129.4 (Ph), 128.6 (Ph), 127.8 (Ph), 127.7 (Ph), 65.8 (SCH), 45.7 (SCH$_2$), 27.4 (CMe_3), 18.9 (CMe_3), 14.1 (SCHMe), 5.6 (SCH$_2$$Me$) (one Ph resonance not resolved); MS (ESI) *m/z* 464 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{27}$H$_{33}$NO$_2$SSi (M + H)$^+$ 464.2074, found 464.2074 (−0.0 ppm error) and a 93:7 mixture (by ^{1}H NMR spectroscopy) of ketones *anti*-**143** and *syn*-**143** (262 mg, 9%) as a white

solid, mp 124–126 °C; R_F (8:2 hexane-EtOAc) 0.16; IR (ATR) 3069, 2932, 2855, 1677, (C=O), 1584, 1449, 1427, 1301, 1144, 1108, 949, 821, 740, 702, 613, 503 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) for *anti*-**143** δ 7.75 (dd, *J* = 8.0, 1.5 Hz, 2H, Ph), 7.60–7.53 (m, 4H, Ph), 7.48 (t, *J* = 8.0 Hz, 1H, Ph), 7.37–7.23 (m, 8H, Ph), 4.85 (q, *J* = 7.0 Hz, 1H, SC*H*(Me)COPh), 3.16 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 3.08 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 1.66 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.16 (t, *J* = 7.0 Hz, 3H, SCH$_2$*Me*), 0.90 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) for *anti*-**143** δ 195.4 (C=O), 136.42 (*ipso*-Ph), 136.37 (*ipso*-Ph), 136.1 (*ipso*-Ph), 135.71 (Ph), 135.65 (Ph), 133.9 (Ph), 129.3 (Ph), 129.1 (Ph), 129.0 (Ph), 128.8 (Ph), 127.44 (Ph), 127.40 (Ph), 66.9 (SCH), 47.8 (SCH$_2$), 27.1 (C*Me$_3$*), 19.4 (*C*Me$_3$), 14.8 (SCH*Me*), 6.7 (SCH$_2$*Me*); MS (ESI) *m/z* 464 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{23}$H$_{33}$NO$_2$SSi (M + H)$^+$ 464.2074, found 464.2073 (+0.3 ppm error) and a 75:25 mixture of ketones *anti*-**143** and *syn*-**143** (1.22 g, 32%) as a white solid. The stereochemistry of *syn*-**143** was assigned by X-ray crystallography.

X-ray crystal structure determination of *syn*-**143**

C$_{27}$H$_{33}$NO$_2$SSi, *M* = 463.69, orthorhombic, *a* = 29.3814(2), *b* = 14.75100(10), *c* = 11.78790(10) Å, *β* = 90°, *U* = 5108.94(7) Å^3, *T* = 110.00(10) K, space group Pccn, Z = 8, *μ*(CuKα) = 1.749 mm^{-1}, 35804 reflection measured, 4931 unique (R$_{int}$ = 0.0226) which were used in calculation. The final R1 was 0.0280 (I≥2σ) and wR2 was 0.0761 (all data).

Lab book reference: **AH-1-25**

[(*tert*-Butyldiphenylsilyl)imino](ethyl)[1-oxo-1-(pyridin-3-yl)propan-2-yl]-λ⁶-sulfanone *syn*-145 and *anti*-145
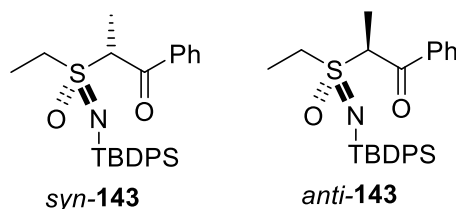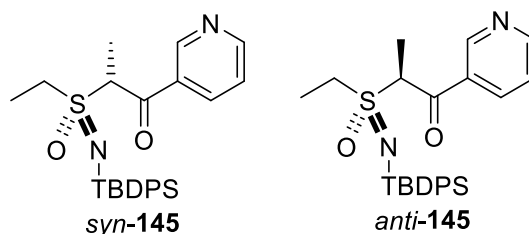

syn-**145**   *anti*-**145**

Using general procedure C, *N*-TBDPS sulfoximine **86** (180 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and *N*-methoxy-*N*-methylpyridine-3-carboxamide (166 mg, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 65:35 mixture of ketones *syn*-**145** and *anti*-

145 (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 75:25 hexane-EtOAc as eluent gave a 70:30 mixture (by ^{1}H NMR spectroscopy) of ketones *syn*-**145** and *anti*-**145** (153 mg, 66%) as a white solid. Further purification by flash column chromatography on silica with 9:1 and then 8:2 hexane-EtOAc gave a 90:10 mixture of ketones *syn*-**145** and *anti*-**145** (51 mg, 22 %) as a white solid, R_F (8:2 hexane-EtOAc) 0.32, 0.18; IR (ATR) 2931, 2855, 1679 (C=O), 1584, 1426, 1304, 1143, 1108, 943, 775, 601, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.97 (d, *J* = 1.5 Hz, 0.1H, Ar), 8.79 (d, *J* = 1.5 Hz, 0.9H, Ar), 8.71 (dd, *J* = 5.0, 1.5 Hz, 0.9H, Ar), 8.65 (dd, *J* = 5.0, 1.5 Hz, 0.1H, Ar), 7.93 (ddd, *J* = 8.0, 1.5, 1.5 H, 0.1H, Ar), 7.80 (ddd, *J* = 8.0, 8.0, 1.5 Hz, 3.6H, Ar), 7.72 (ddd, *J* = 8.0, 1.5, 1.5 H, 0.9H, Ar), 7.60–7.55 (m, 0.4H, Ar), 7.50–7.40 (m, 5.4H, Ar), 7.39–7.33 (m, 0.6H, Ar), 7.33–7.22 (m, 0.9H, Ar), 7.22–7.13 (m, 0.1H, Ar), 4.79 (q, *J* = 8.0 Hz, 0.1H, SC*H*(Me)COPy), 4.26 (q, *J* = 8.0 Hz, 0.9H, SC*H*(Me)COPy), 3.21–2.97 (m, 2H, SCH$_2$), 1.68 (d, *J* = 8.0 Hz, 0.3H, SCH*Me*), 1.53 (d, *J* = 8.0 Hz, 2.7H, SCH*Me*), 1.40 (t, *J* = 8.0 Hz, 2.7H, SCH$_2$*Me*), 1.22 (t, *J* = 8.0 Hz, 0.3H, SCH$_2$*Me*), 1.11 (s, 8.1H, CMe$_3$), 0.93 (s, 0.9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 194.3 (C=O), 153.8 (Ar, *anti*-**145**), 153.7 (Ar, *syn*-**145**), 150.4 (Ar, *syn*-**145**), 150.3 (Ar, *anti*-**145**), 136.7 (Ar, *syn*-**145**), 136.5 (Ar, *anti*-**145**), 136.3 (*ipso*-Ar, *syn*-**145**), 136.0 (*ipso*-Ar, *syn*-**145**), 135.9 (Ar, *syn*-**145**), 135.8 (Ar, *syn*-**145**), 135.6 (Ar, *anti*-**145**), 135.5 (*ipso*-Ar, *anti*-**145**), 134.9 (*ipso*-Ar, *anti*-**145**), 132.0 (*ipso*-Ar, *syn*-**145**), 131.8 (*ipso*-Ar, *anti*-**145**), 129.6 (Ar, *syn*-**145**), 129.5 (Ar, *syn*-**145**), 129.2 (Ar, *anti*-**145**), 129.14 (Ar, *anti*-**145**), 129.11 (Ar, *anti*-**145**), 127.8 (Ar, *syn*-**145**), 127.7 (Ar, *syn*-**145**), 127.5 (Ar, *anti*-**145**), 127.4 (Ar, *anti*-**145**), 123.5 (Ar, *anti*-**145**), 123.3 (Ar, *syn*-**145**), 66.9 (SCH, *anti*-**145**), 66.0 (SCH, *syn*-**145**), 48.1 (SCH$_2$, *anti*-**145**), 45.6 (SCH$_2$, *syn*-**145**), 27.3 (C*Me$_3$*, *syn*-**145**), 27.0 (C*Me$_3$*, *anti*-**145**), 19.5 (*C*Me$_3$, *syn*-**145**), 19.5 (*C*Me$_3$, *anti*-**145**), 14.5 (SCH*M*e, *anti*-**145**), 13.6 (SCH*M*e, *syn*-**145**), 6.8 (SCH$_2$*Me*, *anti*-**145**), 5.5 (SCH$_2$*Me*, *syn*-**145**) (one C=O resonance not resolved); MS (ESI) *m/z* 465 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{26}$H$_{32}$N$_2$O$_2$SSi (M + H)$^+$ 465.2027, found 465.2026 (+0.1 ppm error). The stereochemistry of *syn*-**145** and *anti*-**145** was assigned by analogy with related examples.

Lab book reference: **AH-1-6**

[(*tert*-Butyldiphenylsilyl)imino](ethyl)(1-hydroxy-1-phenylpropan-2-yl)-λ⁶-sulfanone *anti*,*syn*-146, *anti*,*anti*-146, *syn*,*anti*-146 and *syn*,*syn*-146
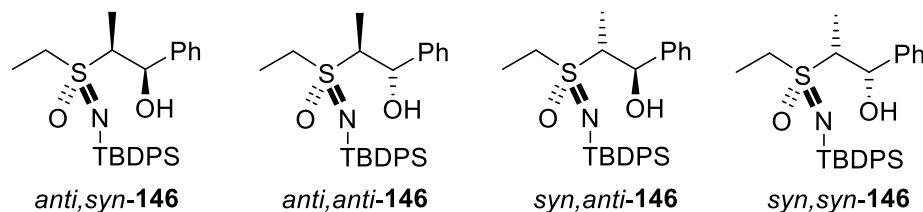
Using general procedure C, *N*-TBDPS sulfoximine **86** (180 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzaldehyde (0.10 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 55:30:15 mixture of alcohols *anti*,*anti*-**146**, *syn*,*syn*-**146** and *anti*,*syn*-**146** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 98:2 and then 95:5 hexane-EtOAc as eluent gave alcohol *anti*,*syn*-**146** (17 mg, 7%) as a colourless oil, R_F (8:2 hexane-EtOAc) 0.41; IR (ATR) 3432 (OH), 2931, 2856, 1452, 1427, 1309, 1137, 1109, 740, 702, 505 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.67 (dd, *J* = 7.0, 2.0 Hz, 2H, Ph), 7.63 (dd, *J* = 7.0, 2.0 Hz, 2H, Ph), 7.31–7.10 (m, 11H, Ph), 5.62 (s, 1H, C*H*OH), 4.15 (d, *J* = 1.0 Hz, 1H, CHO*H*), 2.91 (qd, *J* = 7.5, 1.0 Hz, 1H, SC*H*(Me)CHOH), 2.67 (qd, *J* = 15.0, 7.5 Hz, 1H, SC*H*Me), 2.50 (dq, *J* = 15.0, 7.5 Hz, 1H, SC*H*Me), 1.14 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.01–0.94 (m, 12H, C*Me*$_3$, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 140.9 (*ipso*-Ph), 136.3 (*ipso*-Ph), 135.91 (Ph), 135.85 (*ipso*-Ph), 135.7 (Ph), 129.5 (Ph), 128.5 (Ph), 127.8 (Ph), 127.73 (Ph), 127.67 (Ph), 125.9 (Ph), 69.7 (CHOH), 62.9 (SCH), 48.6 (SCH$_2$), 27.3 (C*Me*$_3$), 19.5 (*C*Me$_3$), 8.2 (SCH*Me*), 7.2 (SCH$_2$*Me*) (one Ph resonance not resolved); MS (ESI) *m/z* 466 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{27}$H$_{35}$NO$_2$SSi (M + H)$^+$ 466.2231, found 466.2231 (–0.1 ppm error) and a 60:40 mixture of alcohols *anti*,*anti*-**146** and *syn*,*syn*-**146** (186 mg, 80%) as a white solid, R_F (8:2 hexane-EtOAc) 0.32; IR (ATR) 3441 (OH), 2931, 2855, 1453, 1427, 1309, 1134, 1108, 740, 701, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.77–7.70 (m, 4H, Ph), 7.40-7.15 (m, 11H, Ph), 5.49 (s, 0.4H, C*H*OH), 5.09 (s, 0.6H, CHO*H*), 4.81 (d, *J* = 7.0 Hz, 0.6H, C*H*OH), 4.34 (s, 0.4H, CHO*H*), 3.20 (quintet, *J* = 7.0 Hz, 0.6H, SC*H*Me), 3.02 (q, *J* = 7.0 Hz, 0.4H, SC*H*(Me)CHOH), 2.96–2.78 (m, 2H, SC*H*$_2$Me), 1.24–1.07 (m, 13.2H, C*Me*$_3$, SCH$_2$*Me*, SCH*Me*), 0.87 (d, *J* = 7.0 Hz, 1.8H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 140.6 (*ipso*-Ph), 140.5 (*ipso*-Ph), 136.5 (*ipso*-Ph), 136.2 (*ipso*-Ph), 136.1 (*ipso*-Ph), 135.83 (Ph), 135.80 (Ph), 135.71 (Ph), 135.68 (Ph), 129.4 (Ph), 129.3 (Ph), 128.6 (Ph), 128.5 (Ph), 128.4 (Ph), 127.7 (Ph), 127.63 (Ph), 127.58 (Ph), 127.3 (Ph), 125.7

(Ph), 73.8 (CHOH, *anti*,*anti*-**146**), 70.0 (CHOH, *syn*,*syn*-**146**), 64.4 (SCH, *anti*,*anti*-**146**), 63.0 (SCH, *syn*,*syn*-**146**), 50.1 (SCH$_2$, *anti*,*anti*-**146**), 49.0 (SCH$_2$, *syn*,*syn*-**146**), 27.4 (C*Me*$_3$, *anti*,*anti*-**146**), 27.3 (C*Me*$_3$, *syn*,*syn*-**146**), 19.6 (*C*Me$_3$, *anti*,*anti*-**146**), 19.5 (*C*Me$_3$, *syn*,*syn*-**146**), 13.9 (SCH*Me*, *anti*,*anti*-**146**), 8.0 (SCH*Me*, *syn*,*syn*-**146**), 7.5 (SCH$_2$*Me*, *anti*,*anti*-**146**), 5.3 (SCH$_2$*Me*, *syn*,*syn*-**146**) (one *ipso*-Ph and four Ph resonances not resolved); MS (ESI) *m/z* 488 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{27}$H$_{35}$NO$_2$SSi (M + Na)$^+$ 488.2050, found 488.2042 (+1.7 ppm error). The stereochemistry of *anti*,*anti*-**146**, *syn*,*syn*-**146** and *anti*,*syn*-**146** was tentatively assigned as described in Chapter 2.2.1.

Lab book reference: **AH-1-5**

L-selectride$^®$ (0.32 mL of a 1.0 M solution in THF, 0.32 mmol, 1.5 eq.) was added dropwise to a stirred solution of ketone *syn*-**143** (100 mg, 0.22 mmol, 1.0 eq.) in THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 5.5 h. Then, MeOH (5 mL) was added dropwise (caution: vigorous effervescence). 20% Rochelle's salt$_{(aq)}$ (15 mL) and Et$_2$O (15 mL) were added and the resulting mixture was allowed to warm to rt and stirred vigorously for 2 h. The two layers were separated and the aqueous layer was extracted with Et$_2$O (3 × 20 mL). The combined organics were washed with water (20 mL), dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product which contained only alcohol *syn*,*anti*-**146** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 9:1 hexane-Et$_2$O as eluent gave alcohol *syn*,*anti*-**146** (87 mg, 85%) as a white solid, mp 98–100 °C; R_F (1:1 hexane-Et$_2$O) 0.43; IR (ATR) 3442 (OH), 2931, 2855, 1453, 1427, 1109, 740, 701, 504 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.82–7.76 (m, 4H, Ph), 7.45–7.27 (m, 11H, Ph), 5.29 (d, *J* = 2.0 Hz, 1H, CHO*H*), 4.99 (dd, *J* = 9.0, 2.0 Hz, 1H, C*H*OH), 3.18 (dq, *J* = 9.0, 7.0 Hz, 1H, SC*H*(Me)CHOH), 2.88 (dq, *J* = 14.5, 7.5 Hz, 1H, SC*H*Me), 2.59 (dq, *J* = 14.5, 7.5 Hz, 1H, SC*H*Me), 1.18 (t, *J* = 7.5 Hz, 3H, SCH$_2$*Me*), 1.12 (s, 9H, C*Me*$_3$), 0.91 (d, *J* = 7.0 Hz, 3H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 140.8 (*ipso*-Ph), 136.1 (*ipso*-Ph), 136.0 (*ipso*-Ph), 135.9 (Ph), 135.8 (Ph), 129.5 (Ph), 128.7 (Ph), 128.5 (Ph), 127.72 (Ph), 127.65 (Ph), 127.2 (Ph), 74.5 (CHOH), 63.2 (SCH), 49.3 (SCH$_2$), 27.4 (C*Me*$_3$), 19.4 (*C*Me$_3$), 12.3 (SCH*Me*), 7.9 (SCH$_2$*Me*) (one Ph resonance not resolved); MS (ESI) *m/z* 466 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{27}$H$_{35}$NO$_2$SSi (M + H)$^+$ 466.2231, found 466.2223 (+1.7 ppm error).

Lab book reference: **AH-2-33**

Red-Al® (0.07 mL of a ≥60 wt. % in toluene, 0.22 mmol, 1.0 eq.) was added dropwise to a stirred solution of ketone *syn*-**143** (100 mg, 0.22 mmol) in CH_2Cl_2 (1 mL) at 0 °C under Ar. The resulting solution was stirred at 0 °C for 4 h. Then, 20% Rochelle's salt$_{(aq)}$ (5 mL) was added and the two layers were separated and the aqueous layer was extracted with Et_2O (3 × 20 mL). The combined organics were washed with 20% Rochelle's salt$_{(aq)}$ (20 mL), dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product which contained an 80:20 mixture of alcohols *syn,anti*-**146** and *syn,syn*-**146** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 9:1 hexane-Et_2O as eluent gave an 85:15 mixture of alcohols *syn,anti*-**146** and *syn,syn*-**146** (50 mg, 49%) as a white solid.

Lab book reference: **AH-2-22**

tert-Butyl[(*tert*-butyldiphenylsilyl)imino][1-phenyl-1-(phenylamino)propan-2-yl]-λ⁶-sulfanone 147
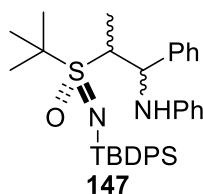
147

Using general procedure C, *N*-TBDPS sulfoximine **86** (194 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.37 mL of a 1.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) and *N*-benzylideneaniline (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 40:30:20:10 mixture of diastereomeric amines **147a**, **147b**, **147c** and **147d** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 7:3 CH_2Cl_2-hexane gave a 92:6:2 mixture of diastereomeric amines **147b**, **147d** and **147a** (78 mg, 27%) as a pale brown solid, mp 190–192 °C; R_F (1:1 CH_2Cl_2-hexane) 0.40; ^{1}H NMR (400 MHz, $CDCl_3$) for **147b** δ 7.78–7.73 (m, 4H, Ph), 7.42–7.34 (m, 2H, Ph), 7.34–7.24 (m, 4H, Ph), 7.24–7.13 (m, 3H, Ph), 7.10–7.04 (m, 2H, Ph), 7.04–6.96 (m, 2H, Ph), 6.64 (t, *J* = 7.5 Hz 1H, Ph), 6.36 (d, *J* = 7.5 Hz, 2H, Ph), 5.88 (br s, 1H, NH), 4.17 (d, *J* = 8.5 Hz, 1H, C*H*NH),

3.52 (dq, *J* = 8.5, 7.0 Hz, 1H, SC*H*), 1.38 (s, 9H, SCMe₃), 1.07 (s, 9H, SiCMe₃), 0.95 (d, *J* = 7.0 Hz, 3H, SCH*Me*); ¹³C NMR (100.6 MHz, CDCl₃) for **147b** δ 147.6 (*ipso*-Ph), 141.5 (*ipso*-Ph), 137.0 (*ipso*-Ph), 136.6 (*ipso*-Ph), 136.1 (Ph), 129.2 (Ph), 129.1 (Ph), 128.7 (Ph), 128.6 (Ph), 128.1 (Ph), 127.6 (Ph), 127.53 (Ph), 127.45 (Ph), 118.1 (Ph), 115.3 (Ph), 65.1 (S*C*Me₃), 61.5 (SCH), 59.9 (*C*HNH), 27.5 (SiC*Me₃*), 24.9 (SC*Me₃*), 19.9 (Si*C*Me₃), 17.2 (SHC*Me*) (one Ph resonance not resolved) and a mixture of impure diastereomeric amines **147**. Further purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave a 75:15:5:5 mixture of diastereomeric amines **147a**, **147d**, **147b** and **147c** (149 mg, 52%) as a pale brown solid, *R*_F (6:4 hexane-Et₂O) 0.56; IR (ATR) 3361 (NH), 3051, 2931, 2856, 1602, 1503, 1308, 1182, 1129, 1106, 909, 820, 729, 701, 603, 501 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.85–7.68 (m, 4H, Ph), 7.43–7.11 (m, 10.6H, Ph), 7.09–6.89 (m, 2.3H, Ph), 6.76 (tt, *J* = 7.5, 1.0 Hz, 0.05H, Ph), 6.71–6.59 (m, 1H, Ph), 6.56 (tt, *J* = 7.5, 1.0 Hz, 0.05H, Ph), 6.53 (s, 0.05H, NH), 6.43 (dd, *J* = 8.5, 1.0 Hz, 0.1H, Ph), 6.36 (dd, *J* = 8.5, 1.0 Hz, 0.1H, Ph), 6.34 (dd, *J* = 8.5, 1.0 Hz, 1.5H, Ph), 6.14 (dd, *J* = 8.5, 1.0 Hz, 0.3H, Ph), 5.89 (s, 0.05H, NH), 5.70 (s, 0.15H, NH), 5.20 (dd, *J* = 4.0, 2.5 Hz, 0.75H, C*H*NH), 5.09 (d, *J* = 2.5 Hz, 0.15H, C*H*NH), 4.60 (d, *J* = 4.0 Hz, 0.75H, NH), 4.31 (dd, *J* = 10.0, 2.5 Hz, 0.05H, C*H*NH), 4.16 (d, *J* = 8.5 Hz, 0.05H, C*H*NH), 3.69–3.46 (m, 0.95H, SC*H*), 2.56 (dq, *J* = 10.0, 7.5 Hz, 0.05H, SC*H*), 1.46 (s, 0.45H, SCMe₃), 1.38 (s, 0.45H, SCMe₃), 1.37 (d, *J* = 7.0 Hz, 0.45H, SCH*Me*), 1.30 (s, 6.75H, SCMe₃), 1.29 (s, 1.35H, SCMe₃), 1.26 (d, *J* = 7.0 Hz, 2.25H, SCH*Me*), 1.15 (s, 1.35H, SiCMe₃), 1.10 (s, 0.45H, SiCMe₃), 1.08 (s, 6.75H, SiCMe₃), 1.06 (s, 0.45H, SiCMe₃), 0.99-0.93 (m, 0.3H, SCH*Me*); ¹³C NMR (100.6 MHz, CDCl₃) δ 146.8 (*ipso*-Ph, **147a**), 146.7 (*ipso*-Ph), 146.5 (*ipso*-Ph), 142.8 (*ipso*-Ph), 141.2 (*ipso*-Ph, **147a**), 140.4 (*ipso*-Ph), 136.7 (*ipso*-Ph, **147a**), 136.7 (*ipso*-Ph, **147a**), 136.3 (Ph), 136.4 (Ph), 136.1 (*ipso*-Ph), 136.02 (Ph, **147a**), 135.99 (Ph, **147a**), 135.9 (*ipso*-Ph), 129.23 (Ph), 129.16 (Ph, **147a**), 129.11 (Ph, **147a**), 129.94 (Ph, **147a**), 129.88 (Ph, **147a**), 128.79 (Ph), 128.76 (Ph), 128.7 (Ph), 128.1 (Ph), 127.7 (Ph), 127.6 (Ph), 127.52 (Ph, **147a**), 127.50 (Ph, **147a**), 127.47 (Ph, **147a**), 127.0 (Ph, **147a**), 126.8 (Ph), 118.0 (Ph, **147a**), 117.9 (Ph), 114.71 (Ph), 114.67 (Ph, **147a**), 65.2 (S*C*Me₃), 65.0 (S*C*Me₃), 64.9 (S*C*Me₃, **147a**), 62.8 (SCH), 62.5 (SCH), 60.7 (SCH, **147a**), 59.9 (*C*HNH, **147a**), 59.7 (*C*HNH), 27.6 (SiC*Me₃*, **147a**), 27.5 (SiC*Me₃*), 25.6 (SC*Me₃*), 25.5 (SC*Me₃*), 25.0 (SC*Me₃*), 24.8 (SC*Me₃*, **147a**), 20.08 (Si*C*Me₃, **147a**), 20.05 (Si*C*Me₃), 11.0 (SCH*Me*, **147a**), 8.1 (SHC*Me*); MS (ESI) *m/z* 569 [(M + H)⁺] HRMS (ESI) *m/z* calcd for C₃₅H₄₄N₂OSSi (M + H)⁺ 569.3016, found 569.3006 (+1.8 ppm error).

Lab book reference: **AH-2-38**

n-BuLi (0.37 mL of a 1.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine **86** (194 mg, 0.5 mmol, 1.0 eq.) in THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 20 min. In a separate flask, BF$_3$•Et$_2$O (0.12 mL, 1.0 mmol, 1.0 eq.) was added dropwise to a stirred solution of *N*-benzylideneaniline (181 mg, 1.0 mmol, 2.0 eq.) in THF (2 mL) at −78 °C under Ar to give a 2 M solution of *N*-benzylideneaniline BF$_3$•Et$_2$O in THF. The *N*-benzylideneaniline BF$_3$•Et$_2$O solution (0.5 mL of a 2 M solution in THF, 1.0 mmol, 2.0 eq.) was added dropwise to the lithiated *N*-TBDPS sulfoximine. The resulting solution was stirred at −78 °C for 1 h then allowed to warm to rt. Then, water (5.0 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 20 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product which contained a 35:30:25:10 mixture of diastereomeric amines **147b**, **147a**, **147d** and **147c** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 CH$_2$Cl$_2$-Et$_2$O gave a 35:30:25:10 mixture of diastereomeric amines **147b**, **147a**, **147d** and **147c** (175 mg, 62%) as a pale brown solid.

Lab book reference: **AH-2-50**

[Adamantan-1-yl(oxo)(1-phenylpropan-2-yl)-λ⁶-sulfanylidene](*tert*-butyldiphenylsilyl)amine *anti*-148
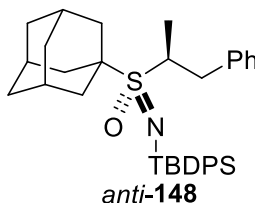
anti-**148**

Using general procedure C, *N*-TBDPS sulfoximine **107** (212 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzyl bromide (0.12 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained only *anti*-**148** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave sulfoximine *anti*-**148**

(191 mg, 69%) as a white solid, mp 128–130 °C; R_F (8:2 hexane-Et$_2$O) 0.30; IR (ATR) 2910, 2853, 1454, 1320, 1285, 1253, 1142, 1106, 1043, 908, 820, 729, 698, 646, 605, 498 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.88–7.84 (m, 4H, Ph), 7.42–7.35 (m, 6H, Ph), 7.25–7.20 (m, 2H, Ph), 7.19–7.14 (m, 1H, Ph), 6.90 (d, *J* = 7.0 Hz, 2H, Ph), 3.39–3.31 (m, 1H, SCH), 3.28 (dd, *J* = 13.0, 3.0 Hz, 1H, C*H*Ph), 2.16–2.10 (m, 3H, CH), 2.09–2.04 (m, 6H, CH$_2$), 1.80 (dd, *J* = 13.0, 11.5 Hz, 1H, C*H*Ph), 1.74–1.66 (m, 3H, CH), 1.66–1.58 (m, 3H, CH), 1.14 (s, 9H, CMe$_3$), 1.03 (d, *J* = 7.0 Hz, 3H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 139.2 (*ipso*-Ph), 137.5 (*ipso*-Ph), 137.4 (*ipso*-Ph), 136.20 (Ph), 136.17 (Ph), 129.4 (Ph), 129.1 (Ph), 129.0 (Ph), 128.5 (Ph), 127.44 (Ph), 127.41 (Ph), 126.4 (Ph), 65.3 (SC), 56.4 (SCH), 36.2 (CH$_2$), 36.1 (CH$_2$), 35.4 (*C*H$_2$Ph), 29.0 (CH), 27.7 (C*Me$_3$*), 20.0 (*C*Me$_3$), 16.7 (SCH*Me*); MS (ESI) *m/z* 556 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{435}$H$_{45}$NOSSi (M + H)$^+$ 556.3064, found 556.3060 (+0.2 ppm error). The stereochemistry of *anti*-**148** was assigned by conversion into *anti*-**153**.

Lab book reference: **AH-2-7**

tert-Butyl[(*tert*-butyldiphenylsilyl)imino](1-phenylpropan-2-yl)-λ⁶-sulfanone *anti*-149 and *syn*-149
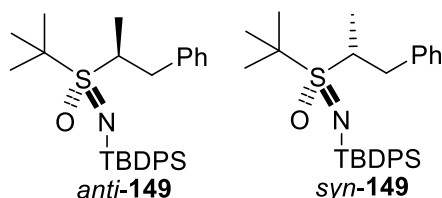
anti-**149**   *syn*-**149**

Using general procedure C, *N*-TBDPS sulfoximine **118** (194 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.25 mL of a 2.2 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzyl bromide (0.12 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 97:3 mixture of sulfoximines *anti*-**149** and *syn*-**149** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave a 97:3 mixture of sulfoximines *anti*-**149** and *syn*-**149** (228 mg, 96%) as a white solid, mp 102–104 °C; R_F (8:2 hexane-Et$_2$O) 0.37; IR (ATR) 3069, 2930, 2855, 1445, 1290, 1129, 1107, 820, 742, 699, 661, 599, 499 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) for *anti*-**149** δ 7.87–7.80 (m, 4H, Ph), 7.44–7.34 (m, 6H, Ph), 7.22 (dd, *J* = 7.5, 7.5 Hz, 2H, Ph), 7.18 (t, *J* = 7.5 Hz, 1H, Ph), 6.89 (d, *J* = 7.5 Hz, 2H, Ph), 3.43–3.33 (m, 1H, SCH), 3.29 (dd, *J* = 13.5, 3.0 Hz, 1H, C*H*Ph), 1.80 (dd, *J* = 13.5, 12.0 Hz, 1H, C*H*Ph),

121

1.43 (s, 9H, SCMe₃), 1.13 (s, 9H, SiCMe₃), 1.04 (d, J = 7.0 Hz, 3H, SCHMe); ¹³C NMR (100.6 MHz, CDCl₃) for *anti*-**149** δ 139.1 (*ipso*-Ph), 137.3 (*ipso*-Ph), 137.2 (*ipso*-Ph), 136.2 (Ph), 136.1 (Ph), 129.3 (Ph), 129.1 (Ph), 129.0 (Ph), 128.6 (Ph), 127.5 (Ph), 127.4 (Ph), 126.4 (Ph), 63.7 (SCMe₃), 57.8 (SCH), 35.6 (CH₂Ph), 27.6 (SiCMe₃), 25.1 (SCMe₃), 20.0 (SiCMe₃), 16.5 (SCHMe); MS (ESI) m/z 478 [(M + H)⁺] HRMS (ESI) m/z calcd for C₂₉H₃₉NOSSi (M + H)⁺ 478.2594, found 478.2591 (+0.7 ppm error). The stereochemistry of *anti*-**149** and *syn*-**149** was assigned by analogy with related examples.

Lab book reference: **AH-1-49**

Using general procedure C, *N*-TBDPS sulfoximine **119** (3.47 g, 7.5 mmol, 1.0 eq.), *n*-BuLi (3.32 mL of a 2.5 M solution in hexanes, 8.3 mmol, 1.1 eq.) and methyl iodide (0.87 mL, 14.0 mmol, 2.0 eq.) in THF (75 mL) at –78 °C for 1 h gave the crude product which contained a 98:2 mixture of sulfoximines *syn*-**149** and *anti*-**149** (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica with 9:1 hexane-Et₂O as eluent gave a 98:2 mixture of sulfoximines *syn*-**149** and *anti*-**149** (3.46 g, 96%) as a white solid, mp 116–118 °C; R_F (8:2 hexane-Et₂O) 0.31; IR (ATR) 3070, 2931, 2855, 1455, 1427, 1299, 1187, 1128, 1106, 909, 820, 731, 698, 598, 497 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) for *syn*-**149** δ 7.83–7.92 (m, 4H, Ph), 7.48–7.36 (m, 6H, Ph), 7.29–7.16 (m, 3H, Ph), 6.92 (d, J = 7.0 Hz, 2H, Ph), 3.48–3.37 (m, 1H, SCH), 3.33 (dd, J = 13.5, 3.5 Hz, 1H, CHPh), 2.30 (dd, J = 13.5, 12.0 Hz, 1H, CHPh), 1.51 (s, 9H, SCMe₃), 1.16 (s, 9H, SiCMe₃), 0.96 (d, J = 7.0 Hz, 3H, SCHMe); ¹³C NMR (100.6 MHz, CDCl₃) for *syn*-**149** δ 138.7 (*ipso*-Ph), 137.2 (*ipso*-Ph), 136.1 (Ph), 136.0 (Ph), 129.1 (Ph), 129.0 (Ph), 128.6 (Ph), 127.4 (Ph), 126.6 (Ph), 63.9 (SCMe₃), 57.9 (SCH), 39.3 (CH₂Ph), 27.6 (SiCMe₃), 25.1 (SCMe₃), 20.0 (SiCMe₃), 13.5 (SCHMe) (one *ipso*-Ph and two Ph resonances not resolved); MS (ESI) m/z 500 [(M + H)⁺] HRMS (ESI) m/z calcd for C₂₉H₃₉NOSSi (M + Na)⁺ 500.2414, found 500.2412 (+0.4 ppm error). The stereochemistry of *syn*-**149** and *anti*-**149** was assigned by analogy with related examples.

Lab book reference: **AH-1-61**

n-BuLi (0.22 mL of a 2.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.) in

THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 20 min and then saturated NH$_4$Cl$_{(aq)}$ (5 mL) was added. The resulting solution was stirred at −78 °C for 1 h and then allowed to warm to rt. Then, water (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 20 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product which contained a 90:10 mixture of sulfoximines *syn*-**149** and *anti*-**149** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave a 90:10 mixture of sulfoximines *syn*-**149** and *anti*-**149** (112 mg, 47%) as a white solid. The stereochemistry of *syn*-**149** and *anti*-**149** was assigned by analogy with related examples.

Lab book reference: **AH-1-68**

[(*tert*-Butyldiphenylsilyl)imino](isopropyl)(1-phenylpropan-2-yl)-λ⁶-sulfanone *anti*-150 and *syn*-150
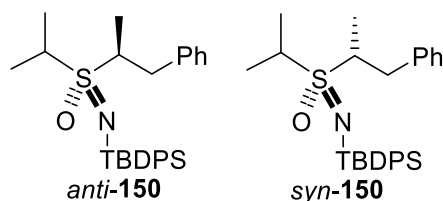
Using general procedure C, *N*-TBDPS sulfoximine **104** (187 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzyl bromide (0.12 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 70:30 mixture of sulfoximines *anti*-**150** and *syn*-**150** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave a 70:30 mixture of sulfoximines *anti*-**150** and *syn*-**150** (218 mg, 94%) as a colourless oil, R_F (8:2 hexane-Et$_2$O) 0.30; IR (ATR) 3069, 2931, 2855, 1456, 1427, 1323, 1142, 1107, 821, 700, 601, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.87–7.84 (m, 0.6H, Ph), 7.83–7.78 (m, 3.4H, Ph), 7.44–7.31 (m, 6H, Ph), 7.27–7.15 (m, 3H, Ph), 6.98 (dd, *J* = 7.0, 3.0 Hz, 1.4H, Ph), 6.83 (dd, *J* = 7.0, 3.0 Hz, 0.6H, Ph), 3.34 (dd, *J* = 13.0, 3.0 Hz, 0.7H, C*H*Ph), 3.30–3.11 (m, 2.3H, C*H*Ph, SC*H*(Me)CH$_2$Ph, SC*H*Me$_2$), 2.44 (dd, *J* = 13.0, 11.0 Hz, 0.3H, C*H*Ph), 2.31 (dd, *J* = 13.0, 11.0 Hz, 0.7H, C*H*Ph), 1.32–1.21 (m, 6H, SCH*Me*$_2$), 1.13–1.06 (m, 12H, C*Me*$_3$, SCH(*Me*)CH$_2$Ph); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 138.4 (*ipso*-Ph, *anti*-**150**), 138.1 (*ipso*-Ph, *syn*-**150**), 137.2 (*ipso*-Ph, *syn*-**150**),

137.1 (*ipso*-Ph, *anti*-**150**), 137.0 (*ipso*-Ph, *anti*-**150**), 136.7 (*ipso*-Ph, *syn*-**150**), 136.0 (Ph), 135.93 (Ph, *anti*-**150**), 135.89 (Ph, *anti*-**150**), 135.8 (Ph), 129.4 (Ph, *anti*-**150**), 129.3 (Ph), 129.07 (Ph), 129.06 (Ph), 128.7 (Ph), 128.6 (Ph, *anti*-**150**), 127.6 (Ph), 127.49 (Ph, *anti*-**150**), 127.46 (Ph, *anti*-**150**), 126.7 (Ph), 59.3 (SCH, *anti*-**150**), 59.2 (SCH, *syn*-**150**), 53.5 (S*C*HMe$_2$, *anti*-**150**), 53.0 (S*C*HMe$_2$, *syn*-**150**), 35.4 (*C*H$_2$Ph, *syn*-**150**), 35.0 (*C*H$_2$Ph, *anti*-**150**), 27.5 (*C*Me$_3$, *anti*-**150**), 27.4 (*C*Me$_3$, *syn*-**150**), 20.0 (*C*Me$_3$, *syn*-**150**), 19.9 (*C*Me$_3$, *anti*-**150**), 16.7 (SCH*M*e, *syn*-**150**), 16.6 (SCH*M*e, *anti*-**150**), 16.0 (SCH*M*e, *anti*-**150**), 15.4 (SCH*M*e, *syn*-**150**), 13.7 (SCH(*Me*)CH$_2$Ph, *anti*-**150**), 12.9 (SCH(*Me*)CH$_2$Ph, *syn*-**150**) (four Ph resonances not resolved); MS (ESI) *m/z* 464 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{28}$H$_{37}$NOSSi (M + H)$^+$ 464.2438, found 464.2444 (+0.4 ppm error). The stereochemistry of *anti*-**150** and *syn*-**150** was assigned by analogy with related examples.

Lab book reference: **AH-1-13**

(*tert*-Butyldiphenylsilyl)[oxo(phenyl)(1-phenylpropan-2-yl)-λ⁶-sulfanylidene]amine *anti*-151 and *syn*-151

Using general procedure C, *N*-TBDPS sulfoximine **87** (204 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzyl bromide (0.12 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 60:40 mixture of sulfoximines *anti*-**151** and *syn*-**151** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 9:1 hexane-Et$_2$O as eluent gave a 60:40 mixture of sulfoximines *anti*-**151** and *syn*-**151** (209 mg, 84%) as a colourless oil, R_F (9:1 hexane-Et$_2$O) 0.21; IR (ATR) 3067, 2930, 2855, 1427, 1295, 1148, 1106, 1109, 733, 699, 603, 499 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.94–7.84 (m, 4H, Ph), 7.84–7.78 (m, 2H, Ph), 7.55–7.49 (m, 1H, Ph), 7.46–7.20 (m, 11H, Ph), 7.04 (d, *J* = 7.0 Hz, 0.8H, Ph), 7.02 (d, *J* = 7.0 Hz, 1.2H, Ph), 3.56 (dd, *J* = 13.0, 3.0 Hz, 0.4H, C*H*Ph), 3.48 (dd, *J* = 13.0, 3.0 Hz, 0.6H, C*H*Ph), 3.29–3.17 (m, 1H, SCH), 2.49 (dd, *J* = 13.0, 12.0 Hz, 0.4H, C*H*Ph), 2.40 (dd, *J* = 13.0, 12.0 Hz, 0.6H, C*H*Ph), 1.21 (s, 9H,

C*Me*₃), 1.17 (d, *J* = 7.0 Hz, 1.8H, SCH*Me*), 1.10 (d, *J* = 7.0 Hz, 1.2H, SCH*Me*); ¹³C NMR (100.6 MHz, CDCl₃) δ 140.73 (*ipso*-Ph), 140.71 (*ipso*-Ph), 138.1 (*ipso*-Ph), 138.0 (*ipso*-Ph), 136.7 (*ipso*-Ph), 136.6 (*ipso*-Ph), 136.5 (*ipso*-Ph), 136.4 (*ipso*-Ph), 135.8 (Ph, *anti*-**151**), 135.7 (Ph), 132.3 (Ph), 129.1 (Ph, *anti*-**151**), 129.0 (Ph), 128.9 (Ph), 128.83 (Ph), 128.76 (Ph), 128.6 (Ph, *anti*-**151**), 127.4 (Ph, *anti*-**151**), 127.3 (Ph, *anti*-**151**), 126.6 (Ph), 65.1 (SCH, *anti*-**151**), 65.0 (SCH, *syn*-**151**), 36.0 (*C*H₂Ph, *syn*-**151**), 35.9 (*C*H₂Ph, *anti*-**151**), 27.4 (C*Me*₃), 19.7 (*C*Me₃), 13.4 (SCH*Me*, *anti*-**151**), 13.0 (SCH*Me*, *syn*-**151**) (one C*Me*₃, one *C*Me₃ and twelve Ph resonances not resolved); MS (ESI) *m/z* 498 [(M + H)⁺] HRMS (ESI) *m/z* calcd for C₃₁H₃₅NOSSi (M + H)⁺ 498.2281, found 498.2280 (+0.3 ppm error). The stereochemistry of *anti*-**151** and *syn*-**151** was assigned by analogy with related examples.
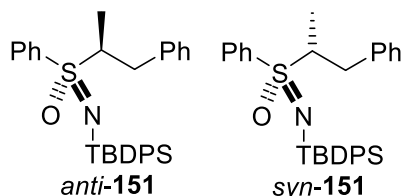
Lab book reference: **AH-1-10**

Using general procedure C, *N*-TBDPS sulfoximine **117** (242 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and methyl iodide (0.06 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 65:35 mixture of sulfoximines *syn*-**151** and *anti*-**151** (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave a 65:35 mixture of sulfoximines *syn*-**151** and *anti*-**151** (201 mg of a 54:42 mixture of **151** and toluene i.e. 176 mg (71%) of **151**) as a yellow oil.

Lab book reference: **AH-1-15**

Adamantan-1-yl(imino)(1-phenylpropan-2-yl)-λ⁶-sulfanone *anti*-152

anti-**152**
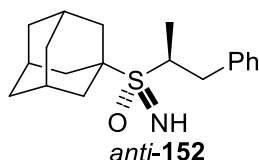
TBAF (0.34 mL of a 1 M solution in THF, 0.34 mmol, 2.0 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine *anti*-**148** (95 mg, 0.17 mmol, 1.0 eq.) in THF (1 mL) at rt under Ar. The resulting solution was stirred at rt for 48 h. The solvent was evaporated under reduced pressure to give the crude product. Purification by flash column

chromatography on silica with 1:1 hexane-EtOAc as eluent gave sulfoximine *anti*-**152** (50 mg, 93%) as a yellow oil, R_F (EtOAc) 0.37; IR (ATR) 3272 (NH), 2907, 2851, 1453, 1195, 1180, 1103, 950, 750, 730, 703, 598, 546, 506, 459 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.31 (dd, J = 7.0, 7.0 Hz, 2H, Ph), 7.24 (t, J = 7.0 Hz, 1H, Ph), 7.20 (d, J = 7.0 Hz, 2H, Ph), 3.55 (dd, J = 13.5, 3.0 Hz 1H, C*H*Ph), 3.46–3.34 (m, 1H, SCH), 2.64 (dd, J = 13.5, 11.5 Hz 1H, C*H*Ph), 2.25 (s, 1H, NH), 2.23–2.17 (m, 3H, CH), 2.15–2.10 (m, 6H, CH), 1.79–1.66 (m, 6H, CH), 1.27 (d, J = 7.0 Hz, 3H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 138.3 (*ipso*-Ph), 129.5 (Ph), 128.8 (Ph), 126.9 (Ph), 64.1 (SC), 54.9 (SCH), 36.1 (CH$_2$), 35.99 (CH$_2$), 35.96 (*C*H$_2$Ph), 28.8 (CH), 15.9 (SCH*Me*); MS (ESI) *m/z* 318 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{19}$H$_{27}$NOS (M + H)$^+$ 318.1886, found 318.1885 (+0.2 ppm error).

Lab book reference: **AH-2-19**

N-[Adamantan-1-yl(oxo)(1-phenylpropan-2-yl)-λ⁶-sulfanylidene]-4-bromobenzamide *anti*-153
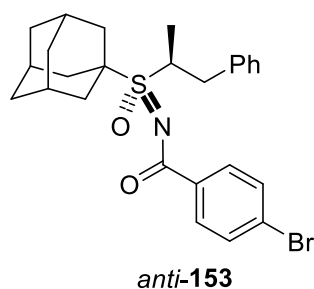
anti-**153**

Et$_3$N (0.03 mL, 0.21 mmol, 1.3 eq.) was added dropwise to a stirred solution of NH sulfoximine *anti*-**152** (50 mg, 0.16 mmol, 1.0 eq.) and 4-bromobenzoyl chloride (42 mg, 0.21 mmol, 1.3 eq.) in CH$_2$Cl$_2$ (1 mL) at 0 °C under Ar. The resulting solution was stirred at 0 °C for 1 h and then stirred at rt for 64 h. Then, water (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 20 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product. Purification by flash column chromatography on silica with 9:1 hexane-EtOAc as eluent gave sulfoximine *anti*-**153** (67 mg, 84%) as a white solid, mp 156–158 °C; R_F (8:2 hexane-EtOAc) 0.36; IR (ATR) 2910, 2854, 1623 (C=O), 1586, 1454, 1308, 1281, 1197, 1167, 1136, 1011, 829, 757, 735, 701, 592, 544 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.02 (d, J = 8.5 Hz, 2H, Ar), 7.54 (d, J = 8.5 Hz, 2H, Ar), 7.33 (dd,

J = 7.0, 1.5 Hz, 2H, Ar), 7.28–7.22 (m, 3H, Ar), 3.87–3.80 (m, 1H, SCH), 3.77 (dd, *J* = 13.5, 3.0 Hz 1H, C*H*Ph), 3.14 (dd, *J* = 13.5, 11.5 Hz 1H, C*H*Ph), 2.31–2.23 (m, 6H, CH), 2.22–2.15 (m, 3H, CH), 1.85–1.71 (m, 6H, CH), 1.34 (d, *J* = 7.0 Hz, 3H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 173.9 (C=O), 138.7 (*ipso*-Ar), 135.5 (*ipso*-Ar), 131.3 (Ar), 131.1 (Ar), 129.5 (Ar), 128.9 (Ar), 127.0 (Ar), 126.7 (*ipso*-Ar), 65.2 (SC), 56.4 (SCH), 37.5 (CH$_2$), 35.9 (CH$_2$), 35.1 (*C*H$_2$Ph), 28.7 (CH), 15.8 (SCH*Me*); MS (ESI) *m/z* 500 [(M (^{79}Br) + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{26}$H$_{30}$^{79}BrNO$_2$S (M + H)$^+$ 500.1253, found 500.1254 (−0.1 ppm error). The stereochemistry of *anti*-**153** was assigned by X-ray crystallography.

X-ray crystal structure determination of *anti*-**153**

C$_{26}$H$_{30}$NO$_2$SBr, *M* = 500.48, monoclinic, *a* = 10.6638(4), *b* = 22.7301(5), *c* = 11.0915(4) Å, *β* = 118.538(5)°, *U* = 2361.80(16) Å^3, *T* = 110.00(10) K, space group P2$_1$/c, Z = 4, *μ*(CuKα) = 3.372 mm^{-1}, 8750 reflection measured, 4210 unique (R$_{int}$ = 0.0175) which were used in calculation. The final R1 was 0.0233 (I≥2σ) and wR2 was 0.0601 (all data).

Lab book reference: **AH-2-25**

[(*tert*-Butyldiphenylsilyl)imino](ethyl)(1-phenylpropan-2-yl)-λ⁶-sulfanone *anti*-154 and *syn*-154 and [(*tert*-Butyldiphenylsilyl)imino]bis(1-phenylpropan-2-yl)-λ⁶-sulfanone 155
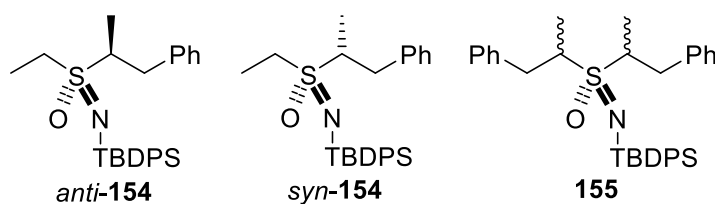
anti-**154**   *syn*-**154**   **155**

Using general procedure C, *N*-TBDPS sulfoximine **86** (180 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzyl bromide (0.12 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an unquantifiable mixture of products (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-EtOAc as eluent gave an unknown mixture of diastereomeric *N*-TBDPS sulfoximines **155** (70 mg, 26%) as a white solid, *R*$_F$ (8:2 hexane-EtOAc) 0.49; IR (ATR) 3027, 2932, 2855, 1455, 1427, 1331, 1145, 1107, 821, 744, 700, 501 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.94–7.77 (m,

4H, Ph), 7.45–7.33 (m, 6H, Ph), 7.31–7.16 (m, 6H, Ph), 7.07–6.83 (m, 4H, Ph), 3.48–3.16 (m, 4H, C*H*Ph), 2.62–2.34 (m, 2H, SCH), 1.22–1.10 (m, 15H, C*Me*$_3$, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 138.23 (*ipso*-Ph), 138.18 (*ipso*-Ph), 138.1 (*ipso*-Ph), 137.2 (*ipso*-Ph), 137.0 (*ipso*-Ph), 136.7 (*ipso*-Ph), 136.0 (Ph), 135.93 (Ph), 135.86 (Ph), 129.5 (Ph), 129.4 (Ph), 129.3 (Ph), 129.2 (Ph), 129.1 (Ph), 128.70 (Ph), 128.66 (Ph), 127.7 (Ph), 127.64 (Ph), 127.59 (Ph), 127.5 (Ph), 126.7 (Ph), 60.0 (SCH), 59.9 (SCH), 59.40 (SCH), 59.36 (SCH), 35.9 (*C*H$_2$Ph), 35.8 (*C*H$_2$Ph), 34.9 (*C*H$_2$Ph), 34.6 (*C*H$_2$Ph), 27.51 (C*Me*$_3$), 27.46 (C*Me*$_3$), 20.0 (*C*Me$_3$), 19.9 (*C*Me$_3$), 13.8 (SCH*Me*), 13.6 (SCH*Me*), 13.4 (SCH*Me*), 12.6 (SCH*Me*); MS (ESI) *m/z* 540 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{34}$H$_{41}$NOSSi (M + H)$^+$ 540.2751, found 540.2743 (+1.4 ppm error) and a 75:25 mixture of sulfoximines *anti*-**154** and *syn*-**154** (102 mg, 45%) as a white solid, R_F (8:2 hexane-EtOAc) 0.40; IR (ATR) 2931, 2855, 1456, 1427, 1314, 1145, 1108, 821, 738, 701, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.89–7.80 (m, 4H, Ph), 7.48–7.37 (m, 6H, Ph), 7.36–7.23 (m, 2H, Ph), 7.11 (d, *J* = 7.5 Hz, 0.5H, Ph), 7.08 (d, *J* = 7.5 Hz, 1.5H, Ph), 3.55–3.42 (m, 1H, C*H*Ph), 3.21–3.09 (m, 1H, SCH), 2.96–2.73 (m, 2H, SCH$_2$), 2.63 (dd, *J* = 13.5, 11.0 Hz, 0.25H, C*H*Ph), 2.52 (dd, *J* = 13.5, 11.0 Hz, 0.75H, C*H*Ph), 1.30–1.22 (m, 6H, SMe, SCH*Me*), 1.17 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 138.13 (*ipso*-Ph, *anti*-**154**), 138.08 (*ipso*-Ph, *syn*-**154**), 137.1 (*ipso*-Ph, *anti*-**154**), 136.9 (*ipso*-Ph, *syn*-**154**), 136.84 (*ipso*-Ph, *syn*-**154**), 136.80 (*ipso*-Ph, *anti*-**154**), 135.83 (Ph, *anti*-**154**), 135.79 (Ph), 135.76 (Ph, *anti*-**154**), 129.33 (Ph, *anti*-**154**), 129.26 (Ph, *syn*-**154**), 129.1 (Ph), 128.74 (Ph, *syn*-**154**), 128.69 (Ph, *anti*-**154**), 127.5 (Ph, *anti*-**154**), 126.8 (Ph, *syn*-**154**), 126.7 (Ph), 60.8 (SCH, *anti*-**154**), 60.5 (SCH, *syn*-**154**), 47.9 (*C*H$_2$Ph, *syn*-**154**), 47.8 (*C*H$_2$Ph, *anti*-**154**), 36.1 (SCH$_2$, *syn*-**154**), 35.0 (SCH$_2$, *anti*-**154**), 27.4 (C*Me*$_3$), 19.6 (*C*Me$_3$), 13.8 (SCH*Me*, *anti*-**154**), 12.7 (SCH*Me*, *syn*-**154**), 7.7 (SCH$_2$*Me*, *syn*-**154**), 7.4 (SCH$_2$*Me*, *anti*-**154**) (C*Me*$_3$, *C*Me$_3$ and seven Ph resonances not resolved); MS (ESI) *m/z* 450 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{27}$H$_{35}$NOSSi (M + H)$^+$ 450.2281, found 450.2278 (+0.8 ppm error). The stereochemistry of *anti*-**154** and *syn*-**154** was assigned by analogy with related examples.

Lab book reference: **AH-1-3**

tert-Butyl[(tert-butyldiphenylsilyl)imino](1-phenylbutan-2-yl)-λ⁶-sulfanone *anti*-158 and *syn*-158

anti-**158**   *syn*-**158**
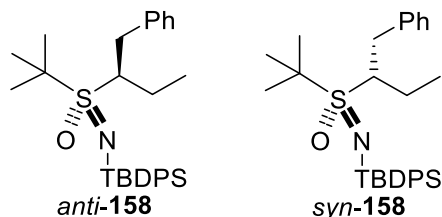
Using general procedure C, *N*-TBDPS sulfoximine **119** (200 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and ethyl iodide (0.08 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 97:3 mixture of sulfoximines *anti*-**158** and *syn*-**158** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave a 97:3 mixture of sulfoximines *anti*-**158** and *syn*-**158** (115 mg, 47%) as a pale orange solid, mp 126–128 °C; R_F (8:2 hexane-Et$_2$O) 0.43, IR (ATR) 3069, 2931, 2855, 1454, 1427, 1294, 1130, 1106, 909, 820, 730, 698, 657, 598, 497 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) for *anti*-**158** δ 7.88–7.82 (m, 4H, Ph), 7.44–7.35 (m, 6H, Ph), 7.29–7.23 (m, 2H, Ph), 7.22–7.17 (m, 1H, Ph), 6.98 (d, *J* = 7.5 Hz, 2H, Ph), 3.34–3.23 (m, 2H, SCH, C*H*Ph), 2.36 (dd, *J* = 15.0, 12.0 Hz, 1H, C*H*Ph), 1.74 (ddq, *J* = 14.0, 7.5, 7.5 Hz, 1H, C*H*Me), 1.46 (s, 9H, SC*Me₃*), 1.33–1.22 (m, 1H, C*H*Me), 1.15 (s, 9H, SiC*Me₃*), 0.73 (t, *J* = 7.5 Hz, 3H, CH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) for *anti*-**158** δ 139.1 (*ipso*-Ph), 137.3 (*ipso*-Ph), 137.2 (*ipso*-Ph), 136.14 (Ph), 136.09 (Ph), 129.04 (Ph), 128.98 (Ph), 128.9 (Ph), 128.7 (Ph), 127.4 (Ph), 126.6 (Ph), 63.7 (SCMe$_3$), 63.1 (SCH), 38.7 (*C*H$_2$Ph), 27.7 (SiC*Me₃*), 24.8 (SC*Me₃*), 21.6 (*C*H$_2$Me), 20.0 (SiC*Me₃*), 13.4 (CH$_2$*Me*) (one Ph resonance not resolved); MS (ESI) *m/z* 492 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{30}$H$_{41}$NOSSi (M + H)$^+$ 492.2751, found 492.2752 (−0.1 ppm error). Diagnostic signals for alcohol *syn*-**158**: ^{1}H NMR (400 MHz, CDCl$_3$) δ 2.10 (dd, *J* = 14.0, 8.0 Hz, 1H, C*H*Ph), 0.65 (t, *J* = 7.5 Hz, 3H, CH$_2$*Me*). The stereochemistry of *anti*-**158** and *syn*-**158** was assigned by analogy with related examples.

Lab book reference: **AH-1-76**

tert-Butyl[(*tert*-butyldiphenylsilyl)imino](1-²H₁)ethyl-λ⁶-sulfanone 118-d
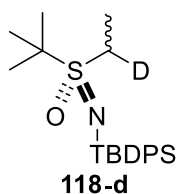
118-d

n-BuLi (0.42 mL of a 1.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine **118** (194 mg, 0.5 mmol, 1.0 eq.) in THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 20 min. Then, CD_3OD (0.04 mL, 1.0 mmol, 2.0 eq.) was added. Then, water (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH_2Cl_2 (3 × 50 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give a 60:40 mixture of sulfoximines **118-d** (176 mg, 91%) as a white solid, R_F (6:4 hexane-Et_2O) 0.30; IR (ATR) 3070, 2930, 2855, 1427, 1306, 1138, 1106, 820, 736, 700, 608, 501 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.88–7.82 (m, 2H, Ph), 7.82–7.75 (m, 2H, Ph), 7.43–7.32 (m, 6H, Ph), 2.88 (br q, J = 7.5 Hz, 0.4H, SCH), 2.78 (br q, J = 7.5 Hz, 0.6H, SCH), 1.43 (s, 9H, SiCMe$_3$), 1.10 (s, 9H, SCMe$_3$), 1.01 (d, J = 7.5 Hz, 3H, SCH*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 137.2 (*ipso*-Ph), 136.9 (*ipso*-Ph), 135.9 (Ph), 135.7 (Ph), 129.0 (Ph), 127.43 (Ph), 127.39 (Ph), 61.4 (SCMe$_3$), 43.9 (1:1:1 triplet, J = 21.0 Hz, SHCD), 27.4 (SiCMe$_3$), 24.3 (SCMe$_3$), 19.9 (SiCMe$_3$), 6.8 (SCH*Me*) (one Ph resonance not resolved); MS (ESI) *m/z* 411 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{22}$H$_{32}$DNOSSi (M + Na)$^+$ 411.2007, found 411.1998 (+2.1 ppm error).

Lab book reference: **AH-2-35**

3-Benzyl-4-*tert*-butyl-2,2,7,7-tetramethyl-6,6-diphenyl-4λ⁶-thia-5-aza-2,6-disilaoct-4-en-4-one *anti*-159
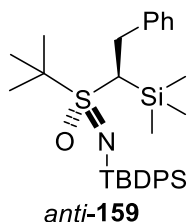
anti-**159**

Using general procedure C, *N*-TBDPS sulfoximine **119** (232 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.25 mL of a 2.2 M solution in hexanes, 0.55 mmol, 1.1 eq.) and TMS−Cl (0.13 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained only sulfoximine *anti*-**159** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave sulfoximine *anti*-**159** (242 mg, 90%) as a colourless oil, R_F (8:2 hexane-Et$_2$O) 0.51; IR (ATR) 3070, 2959, 2856, 1472, 1392, 1313, 1248, 1132, 1107, 846, 762, 700, 524, 498 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.89–7.79 (m, 4H, Ph), 7.45–7.34 (m, 6H, Ph), 7.29–7.15 (m, 3H, Ph), 7.10 (d, *J* = 7.0 Hz, 2H, Ph), 3.58 (dd, *J* = 16.0, 4.5 Hz, 1H, C*H*Ph), 3.41 (dd, *J* = 7.0, 4.5 Hz, 1H, SCH), 2.87 (dd, *J* = 16.0, 7.0 Hz, 1H, *CH*Ph), 1.21–1.13 (m, 18H, SiCMe$_3$, SCMe$_3$), 0.14 (s, 9H, SiMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 140.8 (*ipso*-Ph), 137.2 (*ipso*-Ph), 137.1 (*ipso*-Ph), 136.31 (Ph), 136.27 (Ph), 128.99 (Ph), 128.95 (Ph), 128.5 (Ph), 128.4 (Ph), 127.4 (Ph), 127.3 (Ph), 126.3 (Ph), 64.3 (S*C*Me$_3$), 52.1 (SCH) 34.4 (*C*H$_2$Ph), 27.9 (SiC*Me$_3$*), 24.4 (SC*Me$_3$*), 20.1 (Si*C*Me$_3$), 0.04 (SiMe$_3$); MS (ESI) *m/z* 536 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{31}$H$_{45}$NOSSi$_2$ (M + H)$^+$ 536.2833, found 536.2814 (+0.2 ppm error). The stereochemistry of *anti*-**159** was assigned by analogy with related examples.

Lab book reference: **AH-1-52**

4-Ethyl-2,2,3,7,7-pentamethyl-6,6-diphenyl-4λ⁶-thia-5-aza-2,6-disilaoct-4-en-4-one

***anti*-160 and *syn*-160 and 4-Ethyl-2,2,3,7,7-pentamethyl-6,6-diphenyl-3-(trimethylsilyl)-4λ⁶-thia-5-aza-2,6-disilaoct-4-en-4-one 161**
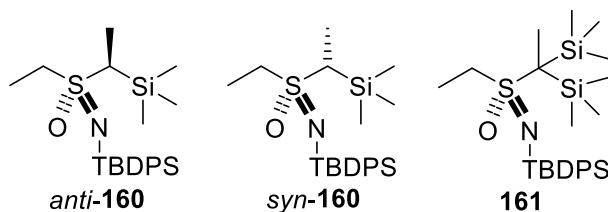
anti-**160**   *syn*-**160**   **161**

Using general procedure C, *N*-TBDPS sulfoximine **86** (180 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and TMS−Cl (0.13 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 67:33 mixture of monosubstituted sulfoximines **160** (80:20 mixture of *anti*-**160** and *syn*-**160**) and disubstituted sulfoximine **161** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 98:2 and then 95:5 hexane-EtOAc as eluent gave an 80:20 mixture of monosubstituted *N*-TBDPS sulfoximines *anti*-**160** and *syn*-**160** (128 mg, 59%) as a white solid, R_F (8:2 hexane-EtOAc) 0.47; IR (ATR) 3070, 2932, 2855, 1427, 1292, 1248, 1136, 1106, 841, 770, 729, 700, 626, 603, 566, 498 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.82 (dd, J = 7.5, 2.0 Hz, 2H, Ph), 7.76 (dd, J = 7.5, 2.0 Hz, 2H, Ph), 7.42–7.31 (m, 6H, Ph), 2.88 (dq, J = 14.0, 7.5 Hz, 0.2H, SC*H*Me), 2.69 (dq, J = 14.0, 7.5 Hz, 0.8H, SC*H*Me), 2.61 (q, J = 7.5 Hz, 0.8H, SC*H*(Me)SiMe$_3$), 2.52 (q, J = 7.5 Hz, 0.2H, SC*H*(Me)SiMe$_3$), 2.34–2.18 (m, 1H, SC*H*Me), 1.40 (d, J = 7.5 Hz, 2.4H, SCH*Me*), 1.30 (d, J = 7.5 Hz, 0.6H, SCH*Me*), 1.09 (s, 9H, C*Me*$_3$), 1.04 (t, J = 7.5 Hz, 3H, SCH$_2$*Me*), 0.30 (s, 7.2H SiMe$_3$), 0.24 (s, 1.8H SiMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 137.4 (*ipso*-Ph, *anti*-**160**), 137.1 (*ipso*-Ph, *syn*-**160**), 136.92 (*ipso*-Ph, *anti*-**160**), 136.90 (*ipso*-Ph, *syn*-**160**), 136.0 (Ph, *anti*-**160**), 135.9 (Ph), 135.8 (Ph, *anti*-**160**), 129.1 (Ph, *syn*-**160**), 129.02 (Ph), 128.98 (Ph), 127.5 (Ph, *anti*-**160**), 127.43 (Ph, *anti*-**160**), 127.39 (Ph), 49.9 (SCH$_2$, *anti*-**160**), 49.5 (SCH$_2$, *syn*-**160**), 48.0 (SCH, *syn*-**160**), 47.3 (SCH, *anti*-**160**), 27.6 (C*Me*$_3$, *syn*-**160**), 27.4 (C*Me*$_3$, *anti*-**160**), 19.6 (*C*Me$_3$, *anti*-**160**), 19.5 (*C*Me$_3$, *syn*-**160**), 12.7 (SCH*Me*, *anti*-**160**), 11.7 (SCH*Me*, *syn*-**160**), 9.2 (SCH$_2$*Me*, *anti*-**160**), 8.1 (SCH$_2$*Me*, *syn*-**160**), −0.9 (SiMe$_3$, *syn*-**160**), −1.0 (SiMe$_3$, *anti*-**160**) (three Ph resonances not resolved); MS (ESI) *m/z* 432 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{23}$H$_{37}$NOSSi$_2$ (M + H)$^+$ 432.2207, found 432.2209 (−1.2 ppm error) and disubstituted *N*-TBDPS sulfoximine **161** (60 mg, 24%) as a colourless oil, R_F (8:2 hexane-EtOAc) 0.58;

IR (ATR) 3071, 2955, 2855, 1427, 1246, 1136, 1105, 834, 785, 732, 700, 615, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.83 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.75 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.40–7.29 (m, 6H, Ph), 2.87 (dq, *J* = 14.0, 7.5 Hz, 1H, SC*H*Me), 2.72 (dq, *J* = 14.0, 7.5 Hz, 1H, SC*H*Me), 1.39 (s, 3H, SCMe), 1.08 (s, 9H, C*Me*$_3$), 0.92 (t, *J* = 7.5 Hz, 3H, SCH$_2$*Me*), 0.26 (s, 9H SiMe$_3$), 0.25 (s, 9H SiMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 137.4 (*ipso*-Ph), 137.1 (*ipso*-Ph), 136.3 (Ph), 136.1 (Ph), 128.91 (Ph), 128.86 (Ph), 127.3 (Ph), 127.2 (Ph), 52.1 (SCH$_2$), 51.3 (S*C*Me), 27.7 (C*Me*$_3$), 19.9 (*C*Me$_3$), 15.9 (SC*Me*), 7.8 (SCH$_2$*Me*), 1.0 (SiMe$_3$), 0.9 (SiMe$_3$); MS (ESI) *m/z* 504 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{26}$H$_{45}$NOSSi$_3$ (M + H)$^+$ 504.2602, found 504.2602 (+1.9 ppm error). The stereochemistry of *anti*-**160** and *syn*-**160** was assigned by analogy with related examples.

Lab book reference: **AH-1-16**

[(*tert*-Butyldiphenylsilyl)imino](2-hydroxy-1,2-diphenylethyl)methyl-λ⁶-sulfanone 44
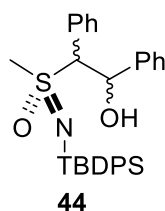

44

Using general procedure C, *N*-TBDPS sulfoximine **43** (204 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.37 mL of a 1.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzaldehyde (0.10 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 2 h gave the crude product which contained a 70:25:5 mixture of diastereomeric alcohols **44a**, **44b** and **44c** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave alcohol **44b** (33 mg, 13%) as a white solid, mp 126–128 °C; R_F (6:4 hexane-EtOAc) 0.33; IR (ATR) 3431 (OH), 3068, 2929, 2855, 1427, 1316, 1288, 1133, 1108, 1060, 820, 738, 697, 596, 500 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.80–7.74 (m, 4H, Ph), 7.44–7.27 (m, 10H, Ph), 7.25–7.20 (m, 1H, Ph), 7.15–7.11 (m, 3H, Ph), 6.95–6.89 (m, 2H, Ph), 6.08 (dd, *J* = 2.0, 2.0 Hz, 1H, C*H*OH), 4.02 (d, *J* = 2.0 Hz, 1H, SCH), 3.98 (d, *J* = 2.0 Hz, 1H, CHO*H*), 2.46 (s, 3H, SMe), 1.16 (s, 9H, C*Me*$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 140.2 (*ipso*-Ph), 136.1 (*ipso*-Ph), 135.9 (*ipso*-Ph), 135.8 (Ph), 135.7 (Ph), 130.4 (*ipso*-Ph), 131.4 (Ph), 129.5 (Ph), 128.9 (Ph), 128.3 (Ph), 128.1 (Ph),

127.82 (Ph), 127.76 (Ph), 127.6 (Ph), 126.1 (Ph), 78.4 (SCH), 70.9 (CHOH), 44.1 (SMe), 27.3 (C*Me₃*), 19.5 (*C*Me₃) (one Ph resonance not resolved); MS (ESI) *m/z* 466 [(M + Na)⁺] HRMS (ESI) *m/z* calcd for $C_{31}H_{35}NO_2SSi$ (M + Na)⁺ 536.2050, found 536.2049 (+0.2 ppm error) and a 95:5 mixture of alcohols **44a** and **44c** (103 mg, 40%) as a white solid, mp 110–112 °C; R_F (6:4 hexane-EtOAc) 0.21, IR (ATR) 3389 (OH), 3052, 2930, 2857, 1427, 1265, 1142, 1109, 820, 734, 697, 599, 547, 501 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) for **44a** δ 7.87–7.78 (m, 4H, Ph), 7.49–7.32 (m, 7H, Ph), 7.28–7.18 (m, 3H, Ph), 7.18–7.06 (m, 6H, Ph), 6.18 (d, *J* = 1.0 Hz, 1H, CHO*H*), 5.81 (d, *J* = 9.5 Hz, 1H, C*H*OH), 4.42 (d, *J* = 9.5 Hz, 1H, SCH), 2.29 (s, 3H, SMe), 1.19 (s, 9H, C*Me₃*); ¹³C NMR (100.6 MHz, CDCl₃) for **44a** δ 140.13 (*ipso*-Ph), 135.9 (Ph), 135.7 (Ph) 135.6 (*ipso*-Ph), 135.3 (*ipso*-Ph), 132.0 (*ipso*-Ph), 130.3 (Ph), 129.62 (Ph), 129.58 (Ph), 128.7 (Ph), 128.5 (Ph), 128.1 (Ph), 127.93 (Ph), 127.86 (Ph), 127.8 (Ph), 127.5 (Ph), 77.8 (SCH), 74.4 (CHOH), 43.6 (SMe), 27.2 (C*Me₃*), 19.3 (*C*Me₃); MS (ESI) *m/z* 514 [(M + H)⁺] HRMS (ESI) *m/z* calcd for $C_{31}H_{35}NO_2SSi$ (M + H)⁺ 514.2231, found 514.2233 (−0.4 ppm error). Diagnostic signals for alcohol **44c**: ¹H NMR (400 MHz, CDCl₃) δ 5.67 (dd, *J* = 9.5, 1.0 Hz, 1H, C*H*OH), 4.57 (d, *J* = 9.5 Hz, 1H, SCH), 2.52 (s, 3H, SMe), 1.15 (s, 9H, C*Me₃*).

Lab book reference: **AH-2-30**

[(*tert*-Butyldiphenylsilyl)imino][1,2-diphenyl-2-(phenylamino)ethyl]methyl-λ⁶-sulfanone 46
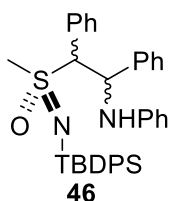

Using general procedure C, *N*-TBDPS sulfoximine **43** (204 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.37 mL of a 1.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) and *N*-benzylideneaniline (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 50:35:10:5 mixture of amines **46a, 46b, 46c** and **46d** (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et₂O gave amine **46b** (23 mg, 8%) as a pale brown oil, R_F (6:4 hexane- Et₂O) 0.47; IR (ATR) 3348 (NH), 3030, 2929, 2856, 1602,

1499, 1427, 1316, 1287, 1132, 1109, 910, 821, 740, 700, 503 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.70 (dd, J = 8.0, 1.0 Hz, 2H, Ph), 7.66 (dd, J = 8.0, 1.0 Hz, 2H, Ph), 7.42–7.27 (m, 6H, Ph), 7.25–7.14 (m, 7H, Ph), 7.13–6.98 (m, 5H, Ph), 6.65 (t, J = 7.5 Hz, 1H, Ph), 6.56 (d, J = 7.5 Hz, 2H, Ph), 6.37 (s, 1H, NH), 5.30 (d, J = 9.0 Hz, 1H, CHNH), 4.36 (d, J = 9.0 Hz, 1H, SCH), 2.26 (s, 3H, SMe), 1.12 (s, 9H, CMe$_3$); ^{1}H NMR (400 MHz, d$_6$-acetone) δ 7.73-7.65 (m, 4H, Ph), 7.41–7.30 (m, 6H, Ph), 7.29–7.22 (m, 4H, Ph), 7.21–7.11 (m, 3H, Ph), 7.09–6.93 (m, 5H, Ph), 6.70 (d, J = 7.5 Hz, 2H, Ph), 6.59 (t, J = 7.5 Hz, 1H, Ph), 6.14 (d, J = 8.0 Hz, 1H, NH), 5.58 (dd, J = 9.0, 8.0 Hz, 1H, CHNH), 4.80 (d, J = 9.0 Hz, 1H, SCH), 2.77 (s, 3H, SMe), 1.09 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.2 (*ipso*-Ph), 135.9 (Ph), 135.8 (Ph), 133.4 (*ipso*-Ph), 130.4 (Ph), 129.4 (Ph), 129.1 (Ph), 128.9 (Ph), 128.7 (Ph), 128.3 (Ph), 127.83 (Ph), 127.78 (Ph), 127.7 (Ph), 127.5 (Ph), 118.0 (Ph), 114.3 (Ph), 78.3 (SCH), 60.2 (CHNH), 44.5 (SMe), 27.4 (CMe_3), 19.5 (*C*Me$_3$) (three *ipso*-Ph and one Ph resonances not resolved); ^{13}C NMR (100.6 MHz, d$_6$-acetone) δ 146.8 (*ipso*-Ph), 141.2 (*ipso*-Ph), 136.6 (*ipso*-Ph), 136.4 (*ipso*-Ph), 135.9 (Ph), 135.8 (Ph), 133.0 (*ipso*-Ph), 131.2 (Ph), 129.1 (Ph), 129.0 (Ph), 128.9 (Ph), 128.24 (Ph), 128.15 (Ph), 127.9 (Ph), 127.8 (Ph), 127.5 (Ph), 127.4 (Ph), 126.9 (Ph), 117.6 (Ph), 114.3 (Ph), 77.4 (SCH), 59.6 (CHNH), 46.5 (SMe), 26.9 (CMe_3), 19.2 (*C*Me$_3$); (ESI) m/z 589 [(M + H)$^+$] HRMS (ESI) m/z calcd for C$_{37}$H$_{40}$N$_2$OSSi (M + H)$^+$ 589.2703, found 589.2698 (+1.0 ppm error) and a mixture of impure diastereomeric amines **46**. Further purification by flash column chromatography on silica with 1:1 hexane-CH$_2$Cl$_2$ as eluent gave an 80:15:5 mixture of diastereomeric amines **46a**, **46c** and **46d** (111 mg, 38%) as a pale brown solid, R_F (1:1 CH$_2$Cl$_2$-hexane) 0.43; IR (ATR) 3375 (NH), 3051, 2929, 2856, 1601, 1498, 1314, 1264, 1124, 1109, 820, 735, 698, 643, 501 cm^{-1}; ^{1}H NMR (400 MHz, d$_6$-acetone) δ 7.74–7.86 (m, 0.2H, Ph), 7.73–7.57 (m, 4.2H, Ph), 7.57–7.43 (m, 1.6H, Ph), 7.42–7.12 (m, 12H, Ph), 7.11–6.96 (m, 4H, Ph), 6.71–6.55 (m, 3H, Ph), 6.43 (d, J = 4.0 Hz, 0.8H, NH), 5.86–5.77 (m, 0.2H, CHNH, NH), 5.72–5.63 (m, 0.2H, CHNH, NH), 5.44 (dd, J = 10.0, 4.0 Hz, 0.8H, CHNH), 4.84–4.75 (m, 1H, SCH), 2.47 (s, 0.15H, SMe), 2.44 (s, 0.45H, SMe), 2.41 (s, 2.4H, SMe), 1.07-0.98 (m, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, d$_6$-acetone) for **46a** and **46c** δ 148.13 (*ipso*-Ph, **46a**), 148.08 (*ipso*-Ph, **46c**), 142.1 (*ipso*-Ph, **46a**), 142.0 (*ipso*-Ph, **46c**), 137.4 (*ipso*-Ph, **46a**), 137.2 (*ipso*-Ph, **46c**), 137.14 (*ipso*-Ph, **46a**), 137.08 (*ipso*-Ph, **46c**), 136.5 (Ph, **46a**), 136.5 (Ph, **46a**), 135.6 (*ipso*-Ph, **46c**), 134.5 (*ipso*-Ph, **46a**), 132.9 (Ph, **46c**), 132.5 (Ph), 132.24 (Ph), 132.19 (Ph), 131.5 (Ph), 129.92 (Ph, **46a**), 129.87 (Ph), 129.8 (Ph, **46a**), 129.60 (Ph), 129.58 (Ph, **46a**), 129.4 (Ph, **46a**), 129.00 (Ph, **46a**), 128.98 (Ph, **46a**), 128.88 (Ph), 128.75 (Ph, **46a**), 128.39 (Ph),

128.35 (Ph), 128.3 (Ph, **46a**), 128.2 (Ph), 128.13 (Ph, **46a**), 128.05 (Ph, **46c**), 127.8 (Ph, **46a**), 118.6 (Ph, **46c**), 118.2 (Ph), 118.1 (Ph, **46a**), 115.29 (Ph), 115.26 (Ph, **46c**), 114.8 (Ph, **46a**), 77.2 (SCH, **46a**), 77.1 (SCH, **46c**), 60.8 (C*H*NH, **46a**), 58.3 (C*H*NH, **46c**), 46.2 (SMe, **46a**), 44.8 (SMe, **46c**), 27.6 (C*Me*$_3$, **46c**), 27.5 (C*Me*$_3$, **46a**), 19.8 (*C*Me$_3$, **46c**), 19.8 (*C*Me$_3$, **46a**); MS (ESI) *m/z* 589 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{37}$H$_{40}$N$_2$OSSi (M + H)$^+$ 589.2703, found 589.2707 (−0.5 ppm error).

Lab book reference: **AH-2-23**

n-BuLi (0.37 mL of a 1.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine **43** (204 mg, 0.5 mmol, 1.0 eq.) in THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 20 min. In a separate flask, BF$_3$•Et$_2$O (0.12 mL, 1.0 mmol, 1.0 eq.) was added dropwise to a stirred solution of *N*-benzylideneaniline (181 mg, 1.0 mmol, 2.0 eq.) in THF (2 mL) at −78 °C under Ar to give a 2 M solution of *N*-benzylideneaniline BF$_3$•Et$_2$O in THF. The *N*-benzylideneaniline BF$_3$•Et$_2$O solution (0.5 mL of a 2 M solution in THF, 1.0 mmol, 2.0 eq.) was added dropwise to the lithiated *N*-TBDPS sulfoximine. The resulting solution was stirred at −78 °C for 1 h then allowed to warm to rt. Then, water (5.0 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 20 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product which contained a 50:20:15:15 mixture of amines **46c**, **46b**, **46d** and **46a** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 1:1 CH$_2$Cl$_2$-hexane gave a 90:5:5 mixture of amines **46d**, **46a** and **46c** (52 mg, 18%) as a brown oil R_F (6:4 hexane- Et$_2$O) 0.34; IR (ATR) 3372 (NH), 2929, 2855, 1601, 1498, 1279, 1141, 1108, 820, 739, 698, 603, 500 cm^{-1}; ^{1}H NMR (400 MHz, d$_6$-acetone) for **46d** δ 7.77 (dd, *J* = 8.0, 1.0 Hz, 2H, Ph), 7.69 (dd, *J* = 8.0, 1.0 Hz, 2H, Ph), 7.48 (dd, *J* = 8.0, 1.0 Hz, 2H, Ph), 7.42–7.21 (m, 10H, Ph), 7.20–7.12 (m, 4H, Ph), 7.06–6.97 (m, 2H, Ph), 6.69–6.52 (m, 3H, Ph), 5.85–5.78 (m, 1H, C*H*NH), 5.67 (d, *J* = 4.0 Hz, 1H, NH), 4.77 (d, *J* = 4.0 Hz, 1H, SCH), 2.47 (s, 3H, SMe), 1.05 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, d$_6$-acetone) for **46d** δ 148.3 (*ipso*-Ph), 141.9 (*ipso*-Ph), 136.6 (Ph), 136.5 (Ph), 132.4 (*ipso*-Ph), 132.3 (Ph), 130.0 (Ph), 129.9 (Ph), 129.63 (*ipso*-Ph), 129.56 (Ph), 129.4 (Ph), 129.1 (Ph), 128.9 (Ph), 128.4 (Ph), 128.23 (Ph), 128.15 (Ph), 128.1 (Ph), 120.2 (*ipso*-Ph), 118.5 (Ph), 115.3 (Ph), 77.1 (SCH), 57.7 (C*H*NH), 44.8

(SMe), 27.6 (C*Me₃*), 19.9 (C*Me₃*); MS (ESI) *m/z* 589 [(M + Na)⁺] HRMS (ESI) *m/z* calcd for $C_{37}H_{40}N_2OSSi$ (M + Na)⁺ 611.2523, found 611.2513 (+0.7 ppm error) and a 75:25 mixture of diastereomeric amines **46** (75:25 mixture of **46c** and **46a)** and starting sulfoximine **46** (154 mg of a 75:25 mixture of **46** and starting material **43** i.e. 128 mg (44%) of **46**) as a brown oil.

Lab book reference: **AH-2-49**

Benzyl[(*tert*-butyldiphenylsilyl)imino](2-hydroxy-2,2-diphenylethyl)-λ⁶-sulfanone 165
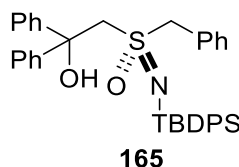
165

Using general procedure C, *N*-TBDPS sulfoximine **43** (204 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product. Purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave starting sulfoximine **43** (74 mg, 36%) as a white solid, impure alcohol **165** and no desired alcohol **164**. Further purification of impure alcohol **165** by flash column chromatography on silica with 1:1 hexane-CH₂Cl₂ as eluent gave impure alcohol **165** (7 mg of a 70:30 mixture of **165** and *tert*-butyldiphenylsilanol i.e. 5.9 mg (2%) of **165**) as a white solid, R_F (1:1 hexane-CH₂Cl₂) 0.14; IR (ATR) 3292 (OH), 3069, 2930, 2856, 1427, 1265, 1240, 1110, 821, 740, 699, 607, 505 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) for **165** δ 7.61 (dd, *J* = 8.0, 1.5 Hz, 2H, Ph), 7.49 (dd, *J* = 8.0, 1.5 Hz, 4H, Ph), 7.43–7.30 (m, 6H, Ph), 7.30–7.25 (m, 7H, Ph), 7.24–7.18 (m, 4H, Ph), 7.02 (d, *J* = 7.0 Hz, 2H, Ph), 3.74 (d, *J* = 14.5 Hz, 1H, C*H*Ph), 3.66 (d, *J* = 14.5 Hz, 1H, C*H*Ph), 3.42 (s, 2H, SC*H₂*COH), 0.98 (s, 9H, C*Me₃*); ¹³C NMR (100.6 MHz, CDCl₃) for **165** δ 145.4 (*ipso*-Ph), 144.6 (*ipso*-Ph), 136.0 (Ph), 135.7 (*ipso*-Ph), 135.5 (*ipso*-Ph), 131.1 (Ph), 129.8 (Ph), 129.4 (Ph), 129.1 (Ph), 128.7 (Ph), 128.6 (Ph), 128.43 (Ph), 128.41 (Ph), 127.82 (Ph), 127.75 (Ph), 127.6 (Ph), 127.5 (Ph), 126.7 (Ph), 126.1 (Ph), 65.3 (COH), 62.7 (*C*H₂Ph), 31.1 (S*C*H₂COH), 27.1 (C*Me₃*), 19.2 (*C*Me₃) (one *ipso*-Ph resonance not

resolved); MS (ESI) *m/z* 590 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{37}$H$_{39}$NO$_2$SSi (M + H)$^+$ 590.2544, found 590.2548 (−0.8 ppm error).

Lab book reference: **AH-2-10**

[(*tert*-Butyldiphenylsilyl)imino](methyl)(1-phenylethyl)-λ^6-sulfanone *syn*-166 and *anti*-166 and [(*tert*-Butyldiphenylsilyl)imino](ethyl)(1-phenylethyl)-λ^6-sulfanone 167
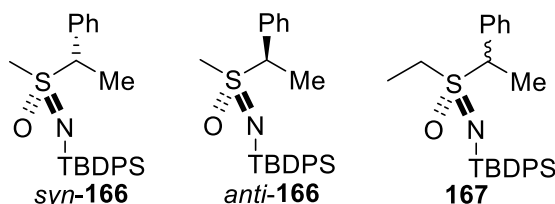

Using general procedure C, *N*-TBDPS sulfoximine **43** (204 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.39 mL of a 1.4 M solution in hexanes, 0.55 mmol, 1.1 eq.) and methyl iodide (0.06 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 2 h gave the crude product which contained an 85:15 mixture of monosubstituted sulfoximines **166** (as a 90:10 mixture of *syn*-**166** and *anti*-**166**) and disubstituted sulfoximines **167** (as a 60:40 mixture of **167a** and **167b**) (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 9:1 hexane-Et$_2$O as eluent gave sulfoximine **167a** (18 mg, 8%) as a colourless oil, R_F (6:4 hexane-Et$_2$O) 0.46; IR (ATR) 3069, 2931, 2855, 1427, 1310, 1146, 1108, 821, 778, 740, 700, 501 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.75 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.72 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.44–7.29 (m, 11H, Ph), 4.14 (q, *J* = 7.5 Hz, 1H, SC*H*(Me)Ph), 2.55 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 2.47 (dq, *J* = 14.0, 7.0 Hz, 1H, SC*H*Me), 1.68 (d, *J* = 7.5 Hz, 3H, SCH*Me*), 1.06 (s, 9H, C*Me*$_3$), 1.02 (t, *J* = 7.0 Hz, 3H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.77 (*ipso*-Ph), 136.75 (*ipso*-Ph), 136.1 (*ipso*-Ph), 135.7 (Ph), 134.9 (Ph), 129.3 (Ph), 129.0 (Ph), 128.7 (Ph), 128.6 (Ph), 127.8 (Ph), 127.44 (Ph), 127.42 (Ph), 65.1 (SCH), 47.9 (SCH$_2$), 27.3 (C*Me*$_3$), 19.6 (*C*Me$_3$), 14.4 (SCH*Me*), 7.9 (SCH$_2$*Me*); MS (ESI) *m/z* 458 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{26}$H$_{33}$NOSSi (M + Na)$^+$ 458.1944, found 458.1941 (+0.8 ppm error), a 94:6 mixture of *syn*-**166** and **167b** (155 mg, i.e. 146 mg (69%) of *syn*-**166** and 9 mg (4%) of **167b**) as a colourless oil, R_F (6:4 hexane-Et$_2$O) 0.34; IR (ATR) 3068, 2930, 2855, 1427, 1315, 1295, 1144, 1107, 945, 821, 781, 738, 697, 604, 528, 499 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.76–7.65 (m, 4H, Ph), 7.46–7.29 (m, 11H, Ph), 4.20 (q, *J* = 7.0 Hz,

0.06H, SC*H*(Me)Ph), 4.14 (q, *J* = 7.0 Hz, 0.94H, SC*H*(Me)Ph), 2.63–2.54 (m, 0.12H, SC*H*Me), 2.38 (s, 2.82H, SMe), 1.80 (d, *J* = 7.0 Hz, 2.82H, SCH*Me*), 1.72 (d, *J* = 7.0 Hz, 0.18H, SCH*Me*), 1.09 (s, 8.46H, CMe$_3$), 1.08 (s, 0.54H, CMe$_3$), 1.04 (t, *J* = 7.0 Hz, 0.18H, SCH$_2$*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.7 (*ipso*-Ph, *syn*-**166**), 136.5 (*ipso*-Ph, *syn*-**166**), 135.9 (Ph, **167b**), 135.82 (Ph, *syn*-**166**), 135.79 (Ph, *syn*-**166**), 135.7 (Ph, *syn*-**166**), 129.6 (Ph, **167b**), 129.5 (Ph, *syn*-**166**), 129.2 (Ph, *syn*-**166**), 129.1 (Ph, *syn*-**166**), 129.03 (Ph, **167b**), 129.01 (Ph, **167b**), 128.74 (Ph, *syn*-**166**), 128.70 (Ph, *syn*-**166**), 128.63 (Ph, **167b**), 128.56 (Ph, **167b**), 127.6 (Ph, *syn*-**166**), 127.5 (Ph, **167b**), 127.40 (Ph, **167b**), 127.38 (Ph, **167b**), 68.3 (SCH, *syn*-**166**), 64.8 (SCH, **167b**), 48.0 (SCH$_2$, **167b**), 41.6 (SMe, *syn*-**166**), 27.34 (C*Me$_3$*, **167b**), 27.25 (C*Me$_3$*, *syn*-**166**), 19.6 (*C*Me$_3$, **167b**), 19.5 (*C*Me$_3$, *syn*-**166**), 14.5 (SCH*Me*, *syn*-**166**), 14.2 (SCH*Me*, **167b**), 7.7 (SCH$_2$*Me*, **167b**) (four *ipso*-Ph resonances not resolved); MS (ESI) *m/z* 444 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{25}$H$_{31}$NOSSi (M + Na)$^+$ 444.1788, found 444.1789 (−0.2 ppm error) and sulfoximine *anti*-**166** (20 mg, 10%) as a white solid, mp 78–80 °C; R_F (6:4 hexane-Et$_2$O) 0.26; IR (ATR) 3069, 2929, 2855, 1427, 1316, 1292, 1142, 1108, 947, 821, 773, 742, 700, 501 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.64 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.59 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.45–7.39 (m, 2H, Ph), 7.39–7.26 (m, 9H, Ph), 4.18 (q, *J* = 7.0 Hz, 1H, SC*H*(Me)Ph), 2.38 (s, 3H, SMe), 1.78 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.05 (s, 9H, CMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 136.7 (*ipso*-Ph), 136.5 (*ipso*-Ph), 136.1 (*ipso*-Ph), 135.84 (Ph), 135.76 (Ph), 129.7 (Ph), 129.14 (Ph), 129.08 (Ph), 128.8 (Ph), 128.6 (Ph), 127.49 (Ph), 127.47 (Ph), 67.7 (SCH), 41.8 (SMe), 27.3 (C*Me$_3$*), 19.5 (*C*Me$_3$), 13.9 (SCH*Me*); MS (ESI) *m/z* 444 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{25}$H$_{31}$NOSSi (M + Na)$^+$ 444.1788, found 444.1784 (+0.9 ppm error). The stereochemistry of *anti*-**166** was assigned by X-ray crystallography.

X-ray crystal structure determination of *anti*-**166**

C$_{25}$H$_{31}$NOSiS, *M* = 421.66, monoclinic, *a* = 9.4105(2), *b* = 35.5159(9), *c* = 7.4138(2) Å, *β* = 111.167(3)°, *U* = 2310.68(11) Å^3, *T* = 110.00(10) K, space group Pc, Z = 4, *μ*(CuKα) = 1.850 mm^{-1}, 12399 reflection measured, 5722 unique (R$_{int}$ = 0.0408) which were used in calculation. The final R1 was 0.0708 (I≥2σ) and wR2 was 0.1891 (all data).

Lab book reference: **AH-2-21**

tert-Butyl[(*tert*-butyldiphenylsilyl)imino][phenyl(²H₁)methyl]-λ⁶-sulfanone 110-d
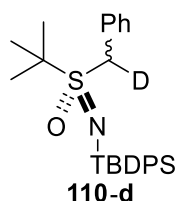

110-d

Using general procedure C, *N*-TBDPS sulfoximine **110** (225 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and CD₃OD (0.04 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 65:35 mixture of diastereomeric sulfoximines **110-da** and **110-db** (222 mg, 99%) as a white solid, R_F (9:1 hexane-EtOAc) 0.37; IR (ATR) 3069, 2930, 2855, 1427, 1302, 1196, 1131, 1107, 820, 742, 699, 502 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.75 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.68 (dd, *J* = 7.5, 1.5 Hz, 2H, Ph), 7.45–7.30 (m, 6H, Ph), 7.29–7.17 (m, 5H, Ph), 4.19 (br s, 0.65H, SCH), 4.01 (br s, 0.35H, SCH), 1.35 (s, 9H, SC*Me*₃), 1.02 (s, 9H, SiC*Me*₃); ¹³C NMR (100.6 MHz, CDCl₃) δ 137.1 (*ipso*-Ph), 136.8 (*ipso*-Ph), 135.91 (Ph), 135.89 (Ph), 131.5 (Ph), 129.7 (*ipso*-Ph), 129.0 (Ph), 128.9 (Ph), 128.4 (Ph), 128.3 (Ph), 127.40 (Ph), 127.37 (Ph), 63.1 (SC*Me*₃), 57.4 (triplet 1:1:1, *J* = 21.5 Hz, SCHD, **110-db**), 57.3 (triplet 1:1:1, *J* = 20.0 Hz, SCHD, **110-da**), 27.4 (SiC*Me*₃), 24.6 (SC*Me*₃), 19.7 (SiC*Me*₃); MS (ESI) *m/z* 451 [(M + H)⁺] HRMS (ESI) *m/z* calcd for C₂₇H₃₄DNOSSi (M + H)⁺ 451.2344, found 451.2335 (+2.1 ppm error).

Lab book reference: **AH-2-15**

tert-Butyl[(*tert*-butyldiphenylsilyl)imino](2-hydroxy-1,2-diphenylethyl)-λ⁶-sulfanone *anti*,*anti*-170 and *syn*,*syn*-170

anti,*anti*-**170**   *syn*,*syn*-**170**
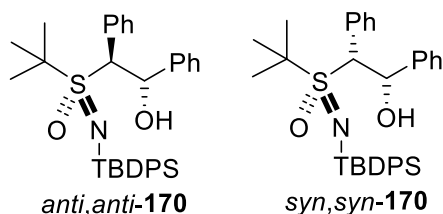
Using general procedure C, *N*-TBDPS sulfoximine **110** (225 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.42 mL of a 1.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzaldehyde (0.10 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 2 h gave the crude product

which contained an 85:15 mixture of alcohols *anti,anti*-**170** and *syn,syn*-**170** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-EtOAc as eluent gave alcohol *anti,anti*-**170** (213 mg, 77%) as a white solid, mp 148–150 °C; R_F (6:4 hexane-EtOAc) 0.59; IR (ATR) 3428 (OH), 3053, 2932, 2858, 1308, 1264, 1103, 733, 698, 667, 501 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.00–7.93 (m, 2H, Ph), 7.87–7.79 (m, 2H, Ph), 7.50–7.35 (m, 7H, Ph), 7.03 (tt, *J* = 7.5, 1.5 Hz, 1H, Ph), 7.00–6.90 (m, 6H, Ph), 6.80–6.75 (m, 2H, Ph), 5.59 (s, 1H, CHO*H*), 4.90 (d, *J* = 9.5 Hz, 1H, C*H*OH), 4.66 (d, *J* = 9.5 Hz, 1H, SCH), 1.22 (s, 9H, SC*Me$_3$*), 1.20 (s, 9H, SiC*Me$_3$*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 139.9 (*ipso*-Ph), 136.6 (*ipso*-Ph), 136.4 (Ph), 136.1 (Ph), 136.0 (*ipso*-Ph), 133.4 (*ipso*-Ph), 130.7 (Ph), 129.6 (Ph), 129.4 (Ph), 128.0 (Ph), 127.8 (Ph), 127.7 (Ph), 127.6 (Ph), 127.51 (Ph), 127.48 (Ph), 74.2 (CHOH), 73.0 (SCH), 66.8 (S*C*Me$_3$), 27.7 (SiC*Me$_3$*), 24.8 (SC*Me$_3$*), 20.2 (Si*C*Me$_3$) (one Ph resonance not resolved); MS (ESI) *m/z* 556 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{34}$H$_{41}$NO$_2$SSi (M + H)$^+$ 556.2700, found 556.2692 (+1.5 ppm error) and alcohol *syn,syn*-**170** (18 mg, 6%) as a white solid, mp 126–128 °C; R_F (6:4 hexane-EtOAc) 0.59, IR (ATR) 3551 (OH), 3069, 2930, 2855, 1427, 1321, 1187, 1124, 1107, 820, 701, 603, 503 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 8.03–7.96 (m, 2H, Ph), 7.96–7.90 (m, 2H, Ph), 7.49–7.44 (m, 3H, Ph), 7.38–7.44 (m, 3H, Ph), 7.19–7.27 (m, 4H, Ph), 7.14 (t, *J* = 7.5 Hz, 1H, Ph), 6.99 (tt, *J* = 7.5, 1.0 Hz, 1H, Ph), 6.95–6.88 (m, 2H, Ph), 6.36 (d, *J* = 7.5 Hz, 2H, Ph), 5.70 (dd, *J* = 2.0, 2.0 Hz, 1H, C*H*OH), 4.10 (d, *J* = 2.0 Hz, 1H, SCH), 3.18 (d, *J* = 2.0 Hz, 1H, CHO*H*), 1.16 (s, 9H, SC*Me$_3$*), 1.12 (s, 9H, SiC*Me$_3$*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 140.0 (*ipso*-Ph), 136.5 (*ipso*-Ph), 136.0 (Ph), 135.9 (Ph), 135.7 (*ipso*-Ph), 131.9 (Ph), 131.4 (*ipso*-Ph), 129.6 (Ph), 129.5 (Ph), 128.4 (Ph), 127.89 (Ph), 127.86 (Ph), 127.8 (Ph), 127.6 (Ph), 127.1 (Ph), 126.0 (Ph), 73.5 (SCH), 70.8 (CHOH), 66.8 (S*C*Me$_3$), 27.3 (SiC*Me$_3$*), 25.2 (SC*Me$_3$*), 20.3 (Si*C*Me$_3$); MS (ESI) *m/z* 578 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{34}$H$_{41}$NO$_2$SSi (M + Na)$^+$ 578.2519, found 578.2532 (+1.5 ppm error). The stereochemistry of *anti,anti*-**170** and *syn,syn*-**170** was assigned by X-ray crystallography.

X-ray crystal structure determination of *anti,anti*-**170**

C$_{34}$H$_{41}$NO$_2$SSi, *M* = 555.83, triclinic, *a* = 9.8480(4), *b* = 10.3406(5), *c* = 16.8725(6) Å, *β* = 92.595(3)°, *U* = 1570.44(12) Å^3, *T* = 110.05(10) K, space group P-1, Z = 2, *μ*(CuKα) = 1.503 mm^{-1}, 10170 reflection measured, 5608 unique (R$_{int}$ = 0.0175) which were used in calculation. The final R1 was 0.0319 (I≥2σ) and wR2 was 0.0828 (all data).

X-ray crystal structure determination of *syn,syn*-**170**

$C_{34}H_{41}NO_2SSi$, M = 555.83, monoclinic, a = 10.52130(10), b = 14.25640(10), c = 20.4833(2) Å, β = 95.5430(10)°, U = 3058.04(5) Å^3, T = 109.9(2) K, space group P2$_1$/c, Z = 4, μ(CuKα) = 1.544 mm^{-1}, 20253 reflection measured, 5465 unique (R_{int} = 0.0240) which were used in calculation. The final R1 was 0.0309 (I≥2σ) and wR2 was 0.0841 (all data).

Lab book reference: **AH-2-29**

Attempted synthesis of *tert*-Butyl[(*tert*-butyldiphenylsilyl)imino](2-hydroxy-1,2,2-triphenylethyl)-λ⁶-sulfanone 171
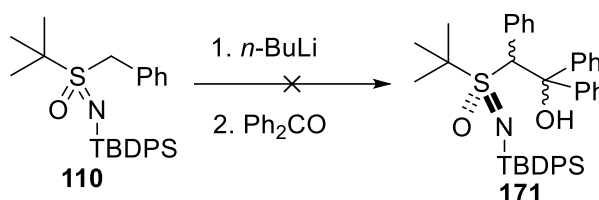
Using general procedure C, *N*-TBDPS sulfoximine **110** (225 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained only starting sulfoximine **110** and none of the desired product **171** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave starting sulfoximine **171** (202 mg, 85%) as a white solid and none of the desired product **171**.
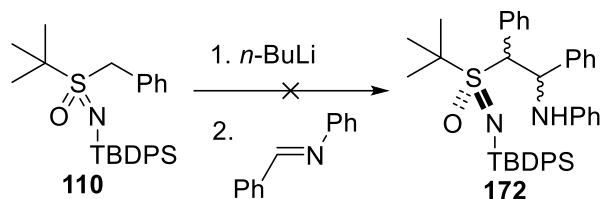
Lab book reference: **AH-2-3**

Attempted synthesis of *tert*-Butyl[(*tert*-butyldiphenylsilyl)imino][1,2-diphenyl-2-(phenylamino)ethyl]-λ⁶-sulfanone 172

Using general procedure C, *N*-TBDPS sulfoximine **110** (225 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.37 mL of a 1.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) and *N*-benzylideneaniline (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at –78 °C for 1 h gave the crude product which contained none of the desired product **172** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 1:1 CH$_2$Cl$_2$-hexane gave none of the desired product **172**.

Lab book reference: **AH-2-31**

***tert*-Butyl[(*tert*-butyldiphenylsilyl)imino](1-phenylethyl)-λ⁶-sulfanone 173**
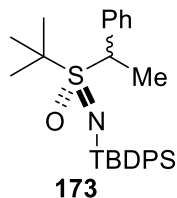
Using general procedure C, *N*-TBDPS sulfoximine **110** (225 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.39 mL of a 1.4 M solution in hexanes, 0.55 mmol, 1.1 eq.) and methyl iodide (0.06 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at –78 °C for 2 h gave the crude product which contained a 50:50 mixture of sulfoximines **173a** and **173b** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 9:1 CH$_2$Cl$_2$-hexane as eluent gave sulfoximine **173a** (109 mg, 47%) as a colourless oil, R_F (9:1 CH$_2$Cl$_2$-hexane) 0.46; IR (ATR) 3069, 2930, 2855, 1427, 1308, 1196, 1136, 1105, 909, 820, 770, 699, 502 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.86 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.78 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.42–7.32 (m, 6H, Ph), 7.31–7.22 (m, 5H, Ph), 4.35 (q, *J* = 7.0 Hz, 1H, SCH), 1.50 (d, *J* = 7.0 Hz, 3H, SCH*Me*), 1.22 (s, 9H, SCMe$_3$), 1.06 (s, 9H, SiCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 137.3 (*ipso*-Ph), 137.1 (*ipso*-Ph), 136.9 (*ipso*-Ph), 136.0 (Ph), 135.9 (Ph), 129.6 (Ph), 128.97 (Ph), 128.96 (Ph), 128.4 (Ph),

128.2 (Ph), 127.41 (Ph), 127.39 (Ph), 64.8 (SCMe_3), 63.2 (SCH), 27.5 (SiCMe_3), 25.2 (SCMe_3), 20.1 (SiCMe$_3$), 18.0 (SCHMe); MS (ESI) *m/z* 464 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{28}$H$_{37}$NOSSi (M + H)$^+$ 464.2438, found 464.2428 (+2.2 ppm error) and a 96:4 mixture of sulfoximines **173b** and **173a** (95 mg, 41%) as a white solid, mp 98–100 °C; R_F (9:1 CH$_2$Cl$_2$-hexane) 0.38; IR (ATR) 3070, 2931, 2855, 1427, 1297, 1122, 1107, 909, 820, 729, 698, 608, 492 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) for **173b** δ 7.86 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.82 (dd, *J* = 7.5, 2.0 Hz, 2H, Ph), 7.42–7.32 (m, 8H, Ph), 7.30–7.20 (m, 3H, Ph), 4.38 (q, *J* = 7.0 Hz, 1H, SCH), 1.45 (d, *J* = 7.0 Hz, 3H, SCHMe), 1.12 (s, 9H, SCMe_3), 1.09 (s, 9H, SiCMe_3); ^{13}C NMR (100.6 MHz, CDCl$_3$) for **173b** δ 138.1 (*ipso*-Ph), 136.9 (*ipso*-Ph), 136.8 (*ipso*-Ph), 136.3 (Ph), 136.2 (Ph), 129.3 (Ph), 129.0 (Ph), 128.5 (Ph), 128.3 (Ph), 127.8 (Ph), 127.4 (Ph), 127.3 (Ph), 64.9 (SCMe_3), 63.2 (SCH), 27.6 (SiCMe_3), 25.1 (SCMe_3), 20.2 (SiCMe$_3$), 16.9 (SCHMe); MS (ESI) *m/z* 464 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{28}$H$_{37}$NOSSi (M + H)$^+$ 464.2438, found 464.2440 (−0.5 ppm error).

Lab book reference: **AH-2-20**

***tert*-Butyl[(*tert*-butyldiphenylsilyl)imino][1-phenyl(2-²H)propan-2-yl]-λ⁶-sulfanone *syn*-149-d and *anti*-149-d**

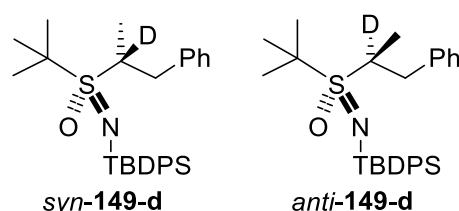*syn*-**149-d**   *anti*-**149-d**

Using general procedure C, *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and CD$_3$OD (0.04 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained an 85:15 mixture of sulfoximines *syn*-**149-d** and *anti*-**149-d** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 and then 9:1 hexane-Et$_2$O as eluent gave an 85:15 mixture of sulfoximines *syn*-**149-d** and *anti*-**149-d** (212 mg, 89%) as a white solid, R_F (8:2 hexane-Et$_2$0) 0.27; IR (ATR) 2931, 2855, 1455, 1427, 1296, 1136, 1106, 1090, 908, 820, 730, 698, 649, 497 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.92–7.84 (m, 4H, Ph), 7.46–7.36 (m, 6H, Ph), 7.28–7.16 (m, 3H, Ph),

6.92 (d, J = 7.0 Hz, 2H, Ph), 3.33 (d, J = 13.5 Hz, 1H, C*H*Ph), 2.30 (d, J = 13.5 Hz, 0.85H, C*H*Ph), 1.85 (d, J = 13.5 Hz, 0.15H, C*H*Ph), 1.51 (s, 7.65H, SC*Me*$_3$), 1.46 (s, 1.35H, SC*Me*$_3$), 1.17 (s, 9H, SiCMe$_3$), 1.08 (s, 0.45H, SCD*Me*), 0.96 (s, 2.55H, SCD*Me*); ^{13}C NMR (100.6 MHz, CDCl$_3$) δ 139.0 (*ipso*-Ph, *anti*-**149-d**), 138.7 (*ipso*-Ph, *syn*-**149-d**), 137.3 (*ipso*-Ph, *anti*-**149-d**), 137.19 (*ipso*-Ph, *syn*-**149-d**), 137.16 (*ipso*-Ph, *anti*-**149-d**), 136.14 (Ph), 136.11 (Ph, *syn*-**149-d**), 136.0 (Ph, *syn*-**149-d**), 134.9 (Ph, *anti*-**149-d**), 129.3 (Ph), 129.1 (Ph), 129.0 (Ph, *syn*-**149-d**), 128.6 (Ph, *syn*-**149-d**), 128.5 (Ph), 127.7 (Ph, *anti*-**149-d**), 127.4 (Ph, *syn*-**149-d**), 126.6 (Ph), 126.4 (Ph, *anti*-**149-d**), 63.9 (S*C*Me$_3$, *syn*-**149-d**), 63.6 (S*C*Me$_3$, *anti*-**149-d**), 57.5 (1:1:1 triplet, J = 20.5 Hz, SCD), 39.2 (*C*H$_2$Ph, *anti*-**149-d**), 39.1 (*C*H$_2$Ph, *syn*-**149-d**), 27.6 (SiC*Me*$_3$), 25.1 (SC*Me*$_3$, *syn*-**149-d**), 25.0 (SC*Me*$_3$, *anti*-**149-d**), 20.0 (Si*C*Me$_3$), 13.5 (SCD*Me*, *anti*-**149-d**), 13.4 (SCD*Me*, *syn*-**149-d**) (one SCD, one SiC*Me*$_3$, one Si*C*Me$_3$, one *ipso*-Ph and five Ph resonances not resolved); MS (ESI) *m/z* 479 [(M + H)$^+$] HRMS (ESI) *m/z* calcd for C$_{29}$H$_{38}$DNOSSi (M + H)$^+$ 479.2657, found 479.2657 (−0.1 ppm error). The stereochemistry of *anti*-**149-d** and *syn*-**149-d** was assigned by analogy with *anti*-**149** and *syn*-**149**.

Lab book reference: **AH-1-67**

Attempted synthesis of *tert*-Butyl[(*tert*-butyldiphenylsilyl)imino](1-hydroxy-2-methyl-1,1,3-triphenylpropan-2-yl)-λ^6-sulfanone 175
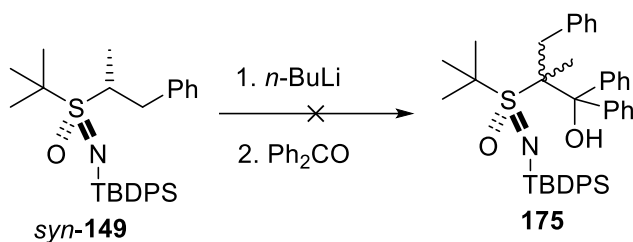

Using general procedure C, *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 1 h gave the crude product which contained a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (118 mg, 49%) as a white solid and none of the desired product **175**.

Lab book reference: **AH-1-64**

n-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.) in THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 20 min. Then, benzophenone (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) was added. The resulting solution was allowed to warm to rt and stirred for 16 h. Then, water (5.0 mL) was added and the two layers were separated. The aqueous layer was extracted with CH₂Cl₂ (3 × 20 mL). The combined organic layers were dried (MgSO₄) and evaporated under reduced pressure to give the crude product which contained a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica with 97:3 hexane-Et₂O as eluent gave a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (165 mg, 69%) as a white solid and none of the desired product **175**.

Lab book reference: **AH-1-66**

Attempted synthesis of (2-Benzyl-1-oxo-1-phenylpropan-2-yl)(*tert*-butyl)[(*tert*-butyldiphenylsilyl)imino]-λ⁶-sulfanone 176
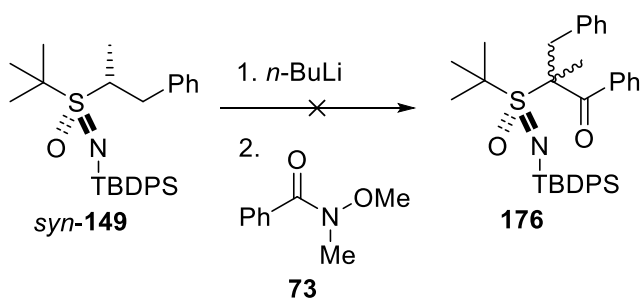

Using general procedure C, *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and *N*-Methoxy-*N*-methylbenzamide (0.10 mL, 0.65 mmol, 1.3 eq.) in THF (5 mL) at −78 °C for 2 h gave the crude product which contained a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (179 mg, 75%) as a white solid and none of the desired product **176**.

Lab book reference: **AH-1-70**

Attempted synthesis of *tert*-Butyl[(*tert*-butyldiphenylsilyl)imino](2-fluoro-1-phenylpropan-2-yl)-λ⁶-sulfanone 177

Using general procedure C, *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and *N*-fluorobenzenesulfonimide (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 3 h gave the crude product which contained a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et$_2$O as eluent gave an impure 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** (124 mg) as a yellow solid and none of the desired product **177**.

Lab book reference: **AH-1-91**

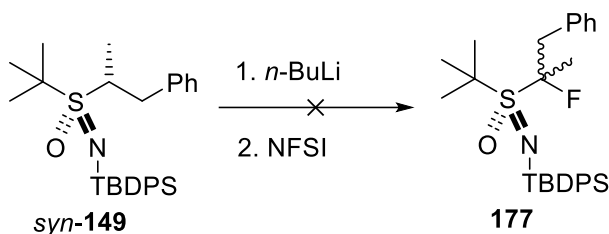*n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.) in THF (5 mL) at −78 °C under Ar. The resulting solution was stirred at −78 °C for 20 min. Then, *N*-fluorobenzenesulfonimide (0.25 mL of a 4 M solution in THF, 1.0 mmol, 2.0 eq.) was added. The resulting solution was allowed to warm to rt and stirred for 16 h. Then water (5.0 mL) was added and the two layers were separated. The aqueous layer was extracted with CH$_2$Cl$_2$ (3 × 20 mL). The combined organic layers were dried (MgSO$_4$) and evaporated under reduced pressure to give the crude product which contained a 65:35 mixture of starting sulfoximines *syn*-**149** and *anti*-**149** as a brown solid and none of the desired product **177** (by ^{1}H NMR spectroscopy).

Lab book reference: **AH-2-5**

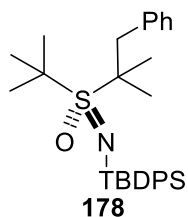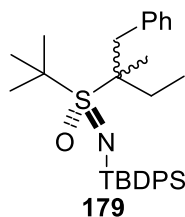**tert-Butyl[(*tert*-butyldiphenylsilyl)imino](2-methyl-1-phenylpropan-2-yl)-λ⁶-sulfanone 178**

Using general procedure C, *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.22 mL of a 2.5 M solution in hexanes, 0.55 mmol, 1.1 eq.) and methyl iodide (0.06 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 2 h gave the crude product which contained an 80:20 mixture of sulfoximine **178** and starting sulfoximines *syn*-**149** and *anti*-**149** (as an 85:15 mixture of diastereomers) (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 98:2 hexane-Et$_2$O as eluent gave an 80:20 mixture of sulfoximine **178** and starting sulfoximines *syn*-**149** and *anti*-**149** (as an 85:15 mixture of diastereomers) (245 mg of a 80:20 mixture of **178** and starting sulfoximines *syn*-**149** and *anti*-**149** i.e. 196 mg (80%) of **178**) as a white solid, R_F (8:2 hexane-Et$_2$O) 0.74; IR (ATR) 3070, 2931, 2855, 1441, 1105, 908, 820, 731, 699, 664, 599, 484 cm^{-1}; ^{1}H NMR (400 MHz, CDCl$_3$) for **178** δ 7.97–7.86 (m, 5H, Ph), 7.48–7.37 (m, 6H, Ph), 7.31–7.17 (m, 3H, Ph), 6.91 (dd, *J* = 7.0, 2.5 Hz, 2H, Ph), 3.20 (d, *J* = 12.5 Hz, 1H, C*H*Ph), 3.12 (d, *J* = 12.5 Hz, 1H, C*H*Ph), 1.55 (s, 9H, SCMe$_3$), 1.32 (s, 3H, SCMe), 1.25 (s, 3H, SCMe), 1.18 (s, 9H, SiCMe$_3$); ^{13}C NMR (100.6 MHz, CDCl$_3$) for **178** δ 137.5 (*ipso*-Ph), 137.0 (*ipso*-Ph), 136.4 (*ipso*-Ph), 136.2 (Ph), 136.1 (Ph), 131.2 (Ph), 129.0 (Ph), 128.9 (Ph), 128.6 (Ph), 128.0 (Ph), 127.4 (Ph), 126.6 (Ph), 72.2 (S*C*Me$_3$), 68.8 (S*C*), 42.2 (*C*H$_2$Ph), 27.7 (SiC*Me*$_3$), 27.3 (SC*Me*$_3$), 23.0 (SC*Me*), 22.7 (SC*Me*), 20.3 (Si*C*Me$_3$); MS (ESI) *m/z* 514 [(M + Na)$^+$] HRMS (ESI) *m/z* calcd for C$_{30}$H$_{41}$NOSSi (M + Na)$^+$ 514.2570, found 514.2575 (−1.0 ppm error).

Lab book reference: **AH-1-69**

tert-Butyl[(tert-butyldiphenylsilyl)imino](2-methyl-1-phenylbutan-2-yl)-λ⁶-sulfanone 179


179

Using general procedure C, *N*-TBDPS sulfoximine *syn*-**149** (239 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and ethyl iodide (0.08 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 2 h gave the crude product which contained a 65:35 mixture of starting sulfoximines *anti*-**149** and *syn*-**149** (as a 55:45 mixture of diastereomers) and sulfoximines **179a** and **179b** (as a 75:25 mixture of diastereomers) (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave impure sulfoximine **179**. Further purification by flash column chromatography on silica with 1:1 hexane-CH₂Cl₂ gave an 80:20 mixture of diastereomeric sulfoximines **179a** and **179b** (78 mg of a 90:10 mixture of **179** and starting sulfoximine *anti*-**149** i.e. 71 mg (28%) of **179**) as a white solid, R_F (9:1 CH₂Cl₂-hexane) 0.43; IR (ATR) 2931, 2855, 1454, 1427, 1304, 1136, 1106, 909, 820, 732, 700, 600, 498 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) for **179a** and **179b** δ 7.90–7.83 (m, 4H, Ph), 7.42–7.33 (m, 6H, Ph), 7.25–7.17 (m, 3H, Ph), 6.96 (dd, J = 8.0, 2.0 Hz, 2H, Ph), 3.32 (d, J = 13.0 Hz, 0.2H, C*H*Ph), 3.22 (d, J = 13.0 Hz, 0.8H, C*H*Ph), 3.16 (d, J = 13.0 Hz, 0.8H, C*H*Ph), 3.10 (d, J = 13.0 Hz, 0.2H, C*H*Ph), 2.02–1.93 (m, 1H, C*H*Me), 1.85–1.76 (m, 0.2H, C*H*Me), 1.59–1.52 (m, 0.8H, C*H*Me), 1.49 (s, 7.2H, SC*Me₃*), 1.42 (s, 1.8H, SC*Me₃*), 1.32 (s, 2.4H, SC(*Me*)CH₂Ph), 1.18 (s, 0.6H, SC(*Me*)CH₂Ph), 1.14 (s, 7.2H, SiC*Me₃*), 1.12 (s, 1.8H, SiC*Me₃*), 0.73 (t, J = 7.5 Hz, 2.4H, CH₂*Me*), 0.72 (t, J = 7.5 Hz, 0.6H, CH₂*Me*); ¹³C NMR (100.6 MHz, CDCl₃) for **179a** and **179b** δ 137.42 (*ipso*-Ph, **179b**), 137.39 (*ipso*-Ph, **179a**), 137.17 (*ipso*-Ph, **179b**), 137.15 (*ipso*-Ph, **179a**), 137.0 (*ipso*-Ph, **179b**), 136.7 (*ipso*-Ph, **179a**), 136.21 (Ph, **179a**), 136.17 (Ph, **179a**), 136.1 (Ph), 135.92 (Ph), 135.90 (Ph), 131.1 (Ph, **179a**), 129.5 (Ph), 129.3 (Ph), 128.9 (Ph, **179a**), 128.4 (Ph), 128.1 (Ph, **179a**), 128.0 (Ph), 127.5 (Ph), 127.4 (Ph, **179a**), 127.3 (Ph), 127.2 (Ph), 126.7 (Ph), 126.6 (Ph, **179b**), 76.0 (S*C*Me₃, **179b**), 75.7 (S*C*Me₃, **179a**), 69.5 (SC, **179a**), 69.4 (SC, **179b**), 42.6 (*C*H₂Ph, **179b**), 41.6 (*C*H₂Ph, **179a**), 28.6 (*C*H₂Me, **179b**), 28.1 (*C*H₂Me, **179a**), 27.8 (SiC*Me₃*), 27.4 (SC*Me₃*), 27.3

(SiC*Me*₃), 24.4 (SC*Me*₃), 20.6 (SiC*Me*₃, **179a**), 20.3 (SC(*Me*)CH₂Ph, **179a**), 19.8 (SiC*Me*₃, **179b**), 19.4 (SC(*Me*)CH₂Ph, **179b**), 9.8 (CH₂*Me*) (one Me resonance not resolved); MS (ESI) *m/z* 528 [(M + Na)⁺] HRMS (ESI) *m/z* calcd for C₃₁H₄₃NOSSi (M + Na)⁺ 528.2727, found 528.2721 (+1.1 ppm error).

Lab book reference: **AH-1-74**

tert-Butyl[(*tert*-butyldiphenylsilyl)imino](1-hydroxy-2-methyl-1,3-diphenylpropan-2-yl)-λ⁶-sulfanone 180

180
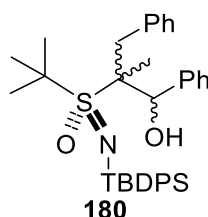
Using general procedure C, *N*-TBDPS sulfoximine *syn*-**149** (749 mg, 1.57 mmol, 1.0 eq.), *n*-BuLi (1.15 mL of a 1.5 M solution in hexanes, 1.73 mmol, 1.1 eq.) and benzaldehyde (0.32 mL, 3.14 mmol, 2.0 eq.) in THF (15 mL) at −78 °C for 2 h gave the crude product which contained a 95:5 mixture of diastereomeric alcohols **180a** and **180b** (by ¹H NMR spectroscopy). Purification by flash column chromatography on silica with 95:5 hexane-Et₂O as eluent gave impure sulfoximine **180**. Further purification by flash column chromatography on silica with 6:4 CH₂Cl₂-hexane gave a single diastereomeric alcohol **180a** (616 mg, 67%) as a white solid, mp 122–124 °C; R_F (8:2 CH₂Cl₂-hexane) 0.43; IR (ATR) 3294 (OH), 2932, 2857, 1453, 1427, 1316, 1246, 1125, 1106, 908, 819, 729, 699, 644, 599, 497 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.96 (dd, *J* = 8.0, 1.5 Hz, 2H, Ph), 7.89 (dd, *J* = 8.0, 1.5 Hz, 2H, Ph), 7.50 (dd, *J* = 8.0, 1.5 Hz, 2H, Ph), 7.46–7.36 (m, 10H, Ph), 7.12–7.02 (m, 3H, Ph), 6.73 (dd, *J* = 8.0, 1.5 Hz, 2H, Ph), 6.54 (s, 1H, CHO*H*), 5.61 (s, 1H, C*H*OH), 3.87 (d, *J* = 15.5 Hz, 1H, C*H*Ph), 3.43 (d, *J* = 15.5 Hz, 1H, C*H*Ph), 1.48 (s, 9H, SC*Me*₃), 1.24 (s, 9H, SiC*Me*₃), 1.14 (s, 3H, SC(*Me*)CHOH); ¹³C NMR (100.6 MHz, CDCl₃) δ 138.8 (*ipso*-Ph), 137.2 (*ipso*-Ph), 136.5 (Ph), 136.3 (Ph), 136.0 (*ipso*-Ph), 135.7 (*ipso*-Ph), 131.4 (Ph), 129.4 (Ph), 129.3 (Ph), 128.5 (Ph), 128.3 (Ph), 128.0 (Ph), 127.7 (Ph), 127.5 (Ph), 127.4 (Ph), 126.2 (Ph), 78.1 (*C*HOH), 71.4 (S*C*Me₃), 33.3 (*C*H₂Ph), 27.8 (SiC*Me*₃), 27.3 (SC*Me*₃), 26.7 (S*C*Me), 22.3 (SC*Me*), 20.5 (SiC*Me*₃); MS (ESI) *m/z* 606 [(M + Na)⁺] HRMS (ESI) *m/z* calcd for C₃₆H₄₅NO₂SSi (M + Na)⁺ 606.2832,

found 606.2840 (−1.2 ppm error). Alcohol **180b** was not isolated. Diagnostic signals for alcohol **180b**: ^{1}H NMR (400 MHz, CDCl$_3$) δ 6.16 (d, *J* = 7.0 Hz, 1H, CHO*H*), 5.30 (d, *J* = 7.0 Hz, 1H, C*H*OH).

Lab book reference: **AH-2-52**

Using general procedure C, *N*-TBDPS sulfoximine *anti*-**149** (239 mg, 0.5 mmol, 1.0 eq.), *n*-BuLi (0.24 mL of a 2.3 M solution in hexanes, 0.55 mmol, 1.1 eq.) and benzaldehyde (0.10 mL, 1.0 mmol, 2.0 eq.) in THF (5 mL) at −78 °C for 2 h gave the crude product which contained a 90:10 mixture of alcohols **180a** and **180b** (as a 95:5 mixture of diastereomers) and starting sulfoximine *anti*-**149** (by ^{1}H NMR spectroscopy). Purification by flash column chromatography on silica with 1:1 hexane-CH$_2$Cl$_2$ as eluent gave a 90:10 mixture of single diastereomeric alcohol **180a** and starting sulfoximine *anti*-**149** (215 mg of a 90:10 mixture of **180a** and *anti*-**149** i.e. 199 mg (68%) of **180a**) as a white solid. Alcohol **180b** was not isolated.

Lab book reference: **AH-1-87**

Attempted synthesis of *tert*-Butyl(1-hydroxy-2-methyl-1,3-diphenylpropan-2-yl)imino-λ⁶-sulfanone 181
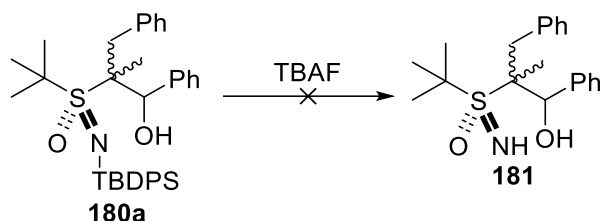
TBAF (0.35 mL of a 1 M solution in THF, 0.35 mmol, 2.0 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine **180a** (103 mg, 0.18 mmol, 1.0 eq.) in THF (2 mL) at rt under Ar. The resulting solution was stirred at rt for 64 h. The solvent was evaporated under reduced pressure to give the crude product which contained none of the desired product **181** (by ^{1}H NMR spectroscopy and mass spectrometry).
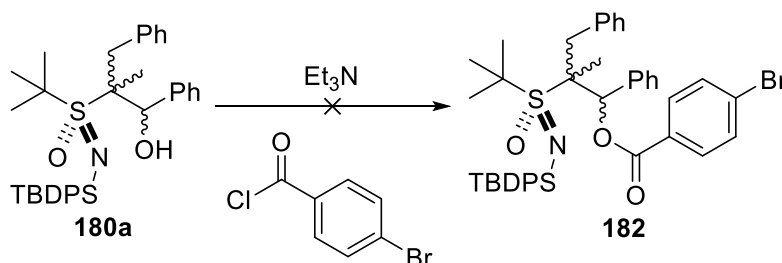
Lab book reference: **AH-2-51**

AcCl (2 µL, 0.02 mmol, 0.15 eq.) was added to a stirred solution of *N*-TBDPS sulfoximine **180a** (59 mg, 0.1 mmol, 1.0 eq.) in dry MeOH (1 mL) at 0 °C under Ar. The resulting solution was stirred at rt for 24 h. Then, saturated $NH_4Cl_{(aq)}$ (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product which contained none of the desired product **181** (by ^{1}H NMR spectroscopy and mass spectrometry).

Lab book reference: **AH-2-55**

Acetic acid (0.01 mL, 0.15 mmol, 1.5 eq.) was added to a stirred solution of *N*-TBDPS sulfoximine **180a** (59 mg, 0.1 mmol, 1.0 eq.) in THF (1 mL) at rt under Ar. Then, TBAF (0.15 mL of a 1 M solution in THF, 0.15 mmol, 1.5 eq.) was added dropwise to the solution at rt under Ar. The resulting solution was stirred at rt for 96 h. Then, brine (5 mL) was added and the two layers were separated. The aqueous layer was extracted with Et_2O (3 × 20 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product which contained none of the desired product **181** (by ^{1}H NMR spectroscopy and mass spectrometry).

Lab book reference: **AH-2-56**

Attempted synthesis of 2-Benzyl-2-{*tert*-butyl[(*tert*-butyldiphenylsilyl)imino]oxo-λ⁶-sulfanyl}-1-phenylpropyl 4-bromobenzoate 182

Et$_3$N (0.02 mL, 0.13 mmol, 1.3 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine **180a** (59 mg, 0.1 mmol, 1.0 eq.) and 4-bromobenzoyl chloride (29 mg, 0.13 mmol, 1.3 eq.) in CH_2Cl_2 (1 mL) at 0 °C under Ar. The resulting solution was stirred at 0 °C for 1 h and then stirred at rt for 96 h. Then, water (5 mL) was added and the two layers

were separated. The aqueous layer was extracted with CH_2Cl_2 (3×20 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product which contained starting sulfoximine **180a** and none of the desired product **182** (by ^{1}H NMR spectroscopy and mass spectrometry).

Lab book reference: **AH-2-53**

Et_3N (0.02 mL, 0.15 mmol, 1.5 eq.) was added dropwise to a stirred solution of *N*-TBDPS sulfoximine **180a** (59 mg, 0.1 mmol, 1.0 eq.), DMAP (3 mg, 0.025 mmol, 0.25 eq.) and 4-bromobenzoyl chloride (25 mg, 0.11 mmol, 1.1 eq.) in CH_2Cl_2 (1 mL) at 0 °C under Ar. The resulting solution was stirred at rt for 48 h. Then, water (5 mL) was added and the two layers were separated. The aqueous layer was extracted with CH_2Cl_2 (3×20 mL). The combined organic layers were dried ($MgSO_4$) and evaporated under reduced pressure to give the crude product which contained starting sulfoximine **180a** and none of the desired product **182** (by ^{1}H NMR spectroscopy and mass spectrometry).

Lab book reference: **AH-2-54**

5. References

(1)   Lücking, U. *Angew. Chem. Int. Ed.* **2013**, *52*, 9399–9408.

(2)   Zhu, F. W.; Rogers, R. B.; Huang, J. X. US 2005/0228027 A1. **2005**.

(3)   Goldberg, M.; Kettle, J. G.; Xiong, J.; Lin, D. *Tetrahedron.* **2014**, *70*, 6613–6622.

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