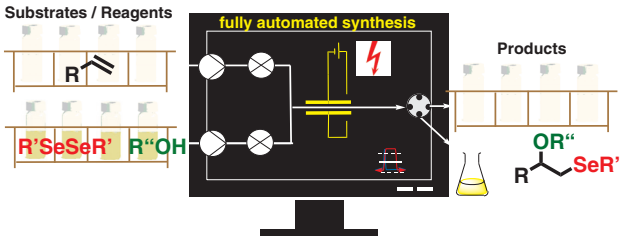
Synthesis N. Amri et al. Feature

Automated Electrochemical Selenenylations

Nasser Amri
Thomas Wirth*

School of Chemistry, Cardiff University,
Park Place, Cardiff, CF10 3AT, UK
wirth@cf.ac.uk



Received: 28.01.2020
Accepted after revision: 09.03.2020
Published online:
DOI: 10.1055/s-0039-1690868; Art ID: ss-2020-z0059-fa

Abstract Integrated electrochemical reactors in automated flow systems were utilised for selenenylation reactions. The automation allowed multiple electrochemical reactions of a programmed sequence to be performed in a fully autonomous way. Many functionalised selenenylated products were synthesised in short reaction times in good to high yields.

Key words alkenes, automated synthesis, electrolysis, flow microreactors, selenium

There have been large efforts in developing technologies in organic synthesis to enhance product output in shorter time.[1] Continuous flow syntheses[2] and electrochemical reactions[3] have played a significant role in this development. These areas of research are still actively pursued in academia and industry. We have designed and manufactured an electrochemical flow microreactor device to improve the efficiency of electrochemical flow reactions integrated with inline mass spectrometric analysis.[4] A much improved device is now commercially available.[5] The advantage of being able to remotely control flow electrochemical equipment is demonstrated here with its inclusion in a fully automated flow setup. In continuation of our efforts in the development of tools and techniques we apply electrochemistry in the selenenylation of alkenes as a modular reaction. In the automated setup, the starting alkene, the diselenide as selenenylating reagent and the nucleophile can be selected. Different combinations will lead to different product solutions, which can be collected separately. The automated sequence of different reactions with integrated cleaning cycles allows an independent operation of many reactions, which is only limited by the number of available collection vials. A schematic representation of this system is shown in Figure 1. Automation has the potential to reduce the necessary manpower, to avoid human errors, and to make a positive contribution towards sustainable and green chemistry by minimizing waste.[6]

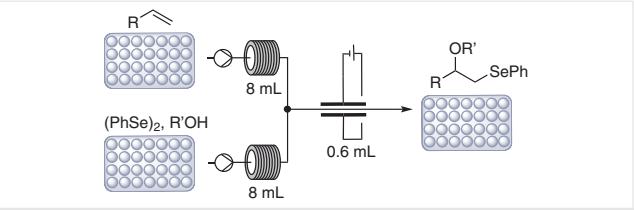
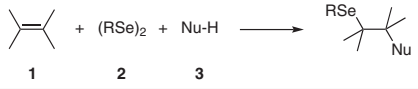


Figure 1 Automated selenenylations in flow electrochemistry

Organoselenium compounds are interesting molecules owing to their importance in medicinal and material chemistry and as reagents and catalysts.[7] We have investigated many different aspects of selenium chemistry in the past, including some batch electrochemical transformations.[8] Addition of selenium electrophiles to alkenes in the presence of nucleophiles is a general concept to access β-substituted selenides; different reaction conditions and types of oxidants are utilized to access the selenium electrophiles. As an efficient and environmentally friendly protocol for organic synthesis, electrochemical conversions have gained more and more attention, as often an excess amount of conventional chemical oxidants and reducing reagents can be avoided.[9] The electrochemical synthesis of β-substituted selenides is a very promising approach, as shown also in recent publications.[10] These methods are efficient, but to develop robust reliable reaction conditions, much effort is still required. We here describe the use of an automated electrochemical flow system for the synthesis of different β-substituted selenides in a continuous process. To the best of our knowledge, this is the first use of a flow electrochemical reactor integrated in an automated system.

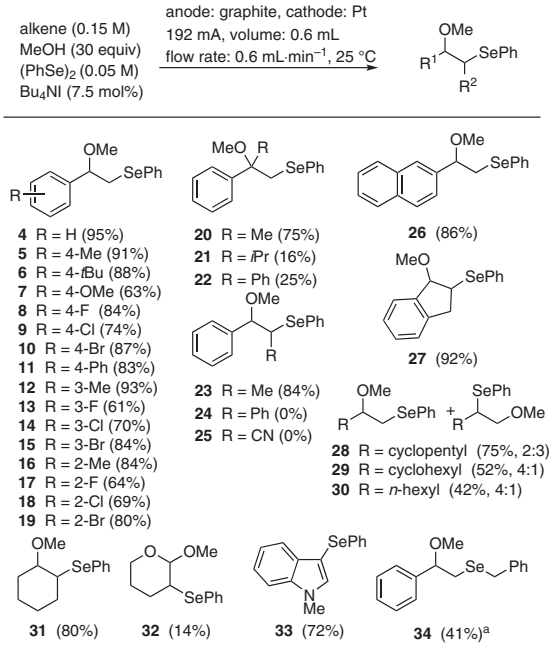
Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

We initiated our studies to identify optimal reaction conditions for the three-component reaction using alkenes, diphenyl diselenide, and different alcohols as nucleophiles (Scheme 1). We used a Vapourtec automated flow system with an integrated Ion electrochemical microflow reactor to rapidly and automatically screen different reaction variables. The software allowed the setup of a number of reactions, applying different reaction conditions and collecting the individual reaction products in an automated way even during overnight operation.



Scheme 1 Selenenylation of alkenes

As a model reaction, styrene (0.15 M), diphenyl diselenide (0.05 M), and MeOH (30 equiv) in MeCN were allowed to react in the presence of graphite (Gr) as anode and platinum (Pt) as cathode, with a flow rate of 0.1 mL·min^{-1}, and 5 mM tetrabutylammonium tetrafluoroborate (Bu_4NBF_4) as the supporting electrolyte (Scheme 2). With a residence time of 6 minutes and a current of 16 mA (2.0 F) at room temperature, only 32% of the desired product **4** was obtained. Theoretically, only 2.0 F electricity is required for the two-electron oxidation. However, it was observed that increasing the current from 16 mA to 32 mA (4 F) increases the yield from 32% to 66% with recovery of starting materials. A further increase of the current beyond 4.0 F led to a decrease of the yield of the desired product **4**.



Scheme 2 Scope and limitations of the electrochemical methoxyselenenylations of alkenes. [a] Dibenzyl diselenide used instead of diphenyl diselenide.

Different parameters for the flow electrochemical reactions were studied such as solvents, electrolytes, flow rates, and electrode materials. Different solvents and solvent mixtures such as acetonitrile, tetrahydrofuran, methanol, and

Biographical Sketches

Nasser Amri was born in Jazan, Saudi Arabia in 1990. He received his B.S. degree in chemistry in 2012 at Jazan University. Subsequently, he started his work at the same university. Later he moved to the USA and obtained his M.S. degree in 2016 at Emporia State University. In 2017 he started his PhD work under the supervision of Prof. T. Wirth at Cardiff University in the area of flow electrochemistry.

Thomas Wirth is professor of organic chemistry at Cardiff University. After receiving his PhD from TU Berlin, he went to Kyoto University as a JSPS fellow. Then he worked independently at the University of Basel before taking up his current position at Cardiff University in 2000. He was awarded the Werner Prize by the New Swiss Chemical Society, the Wolfson Research Merit Award by the Royal Society, and the Bader Award by the Royal Society of Chemistry. In 2016 he was elected as a fellow of The Learned Society of Wales. His main research interests concern stereoselective electrophilic reactions, oxidative transformations with hypervalent iodine reagents, and flow chemistry performed in microreactors.

mixtures of acetonitrile/tetrahydrofuran were screened. It was found that acetonitrile was the optimal solvent for this reaction (see Supporting Information, SI). Lei and co-authors reported an oxyselenenylation using styrene in a batch electrochemical process using stoichiometric amounts of tetrabutylammonium tetrafluoroborate (Bu_4NBF_4) as a supporting electrolyte.[10b] We discovered that under flow conditions only catalytic amounts of Bu_4NBF_4 were necessary to obtain identical results in a shorter reaction time. Without any addition of electrolyte, the reaction in the electrochemical flow reactor still led to a yield of 32%. The presence of electrolyte has a significant influence on the yield. Different electrolytes such as Bu_4NBF_4, Bu_4NOTs, Et_4NCl, Bu_4NBr, KI, and Bu_4NI were screened in catalytic amounts, and Bu_4NI showed the highest yield of 87% (see SI). From cyclic voltammetry studies (see SI) we presume that, at the anode, iodide is oxidised sequentially from iodide to the iodine radical to the iodine cation: $I^- \rightarrow I^\bullet \rightarrow I^+$.[10c] The iodine cation is known to activate the diselenide by generating PhSeI and another reactive $PhSe^+$ that reacts to form the desired product.

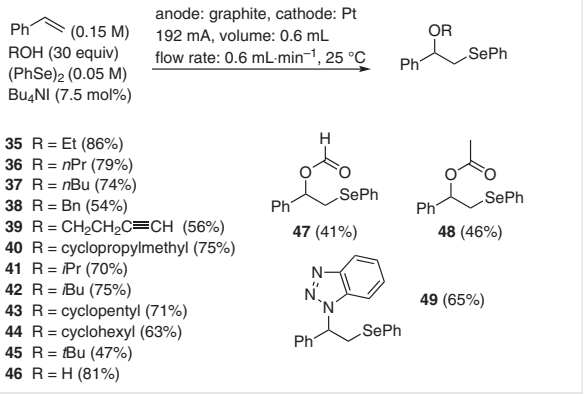
The effect of flow rate/residence time on product yield was studied to determine the optimal flow rate to avoid mass-transfer limitations.[11] Surprisingly, increasing the flow rate to 0.2–0.4 mL·min^{-1} led to full conversion with >99% yield. A further increase to flow rates above 0.4 mL·min^{-1} resulted in a drop in yield. This may be due to a decreased conductivity at higher flow rates. An increase of the electrolyte concentration from 5 mM to 7.5 mM also allowed a quantitative yield to be obtained at flow rates up to 0.6 mL·min^{-1}, corresponding to a calculated residence time of 1.0 minutes (see SI). Due to the formation of hydrogen, the actual residence time is lower. The increase in electrolyte concentration allowed a further reduction of the reaction time.

Different electrode materials were also screened[4] (see SI). Initially, platinum (Pt) was used as cathode and different anode materials such as graphite (Gr), glassy carbon (GC), boron-doped diamond (BDD), Panasonic carbon, PTFE carbon, stainless steel (Fe), and nickel (Ni) were screened. Among these, Gr as anode was found to be most efficient. Furthermore, Gr as anode was then screened against various cathodes such as Pt loaded on Nb, Pt loaded on Ti, Ni, Fe, Gr, GC, and Zn. From this screening it was found that Gr as anode and Pt as cathode constituted an optimal combination. A low-cost electrode (Pt loaded on Nb) still gave 95% yield. The same trend was observed for Gr as a cathode and anode.

With the optimised reaction conditions in hand, an investigation of the scope and general applicability of this methodology using different alkenes, alcohols, and diselenides was performed in an automated way. Loading different alkenes, alcohols and diselenides into the autosampler allowed the reaction products shown in Schemes 2 and 3 and Figure 2 to be obtained in a fully automated way without additional manual interference. The different product solutions obtained were purified by using a Biotage Isolera chromatography system. Due to the automated protocol, all reactions shown were performed using identical amounts and concentrations of reagents and 1.2 mmol alkene was used in each experiment.

Pleasingly, the electrochemical reaction of many different substituted styrene derivatives gave the desired products **4**–**27** in good to excellent yields, but for **21** and **22** the yields were low. For disubstituted alkenes (**24** and **25**), no product formation was observed (Scheme 2). Alkyl-substituted alkenes lead, as known, to regioisomeric mixtures (**28**–**30**). While 3,4-dihydro-2*H*-pyran formed product **32** in 14% yield as the only regioisomer but, as reported, in a 1:1 (*cis*/*trans*) mixture,[12] indole was selenenylated in the 3-position leading to **33**.[13] Other diselenides such as dibenzyl diselenide can also be used, as demonstrated in the synthesis of **34**, where an MeCN/THF solvent mixture (1:1) was used.

Variations of nucleophiles in the selenenylation are shown in Scheme 3. Primary, secondary, and tertiary alcohols can be used in the selenenylation reactions as shown in the formation of products **35**–**45**. Even water, formic acid, and acetic acid can be used, leading to products **46**–**48**. Benzotriazole also participated as an N-nucleophile in this reaction to form the aminoselenenylated product **49** in 65% yield.



Scheme 3 Different nucleophiles for the electrochemical selenenylation of styrene

Cyclic ethers and lactones are important cores in several natural products and important bioactive molecules. This methodology can also be expanded to intramolecular cyclizations and was found to be efficient to obtain a variety of cyclised O-heterocycles as shown in Figure 2. The lactones and ethers were obtained in moderate to good yields. Furan **50** was obtained in 73% yield. Functionalised pyrans **51** and **52** were obtained in 67 and 58% yield, respectively. Different functionalised and fused lactones **53**–**56** were obtained in good yields. Similarly, dihydroindole **57** was obtained in 33% yield. All the synthesised compounds were

fully characterised by different spectroscopic techniques. Among them, also a single crystal X-ray analysis was performed for compound **21** (see SI) that further supports the formation of the target molecules and the spectroscopic data.[14] The selenium cation necessary for the addition and cyclisation reactions described here is believed to be formed through sequential oxidation of diphenyl diselenide as already investigated by Breder, Siewert, and co-workers.[10d] The oxidation potential required for a subsequent elimination of the selenide is not reached here.

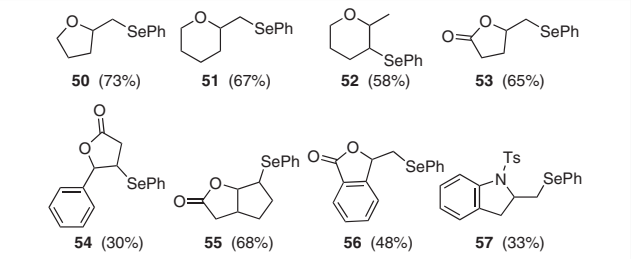


Figure 2 Electrochemical selenocyclisations

To further demonstrate the synthetic potential of this protocol, a gram-scale reaction was performed for the synthesis of product **4**, of which 1.52 g was obtained in 100 minutes, corresponding to 87% yield.

In summary, we have demonstrated that electrochemical reactions such as selenenylations of alkenes can be easily integrated in remote-controlled synthesis equipment, allowing an automated synthesis of many derivatives in a short time with minimal human interference. A library of 54 molecules resulting from alkoxy- and aza-selenenylations was obtained, including from intramolecular reactions for the synthesis of heterocyclic compounds. A gram-scale reaction was also performed to demonstrate the potential of this electrochemically integrated automated flow technology.

All solvents and reagents were used as received without purification or drying. TLC was performed on pre-coated aluminium sheets of Merck silica gel 60 F254 (0.20 mm) and visualised by UV radiation (254 nm). Automated column chromatography was performed on a Biotage® Isolera Four using Biotage® cartridges SNAP Ultra 10 g. ^{1}H, ^{13}C, and ^{19}F NMR spectra were obtained on Bruker DPX 400 or 500 apparatus and were referenced to the residual proton solvent peak (^{1}H: $CDCl_3$, δ = 7.26; DMSO-d_6, δ = 2.50) and solvent ^{13}C signal (^{13}C: $CDCl_3$, δ = 77.2; DMSO-d_6, δ = 39.5). IR spectra of neat samples (directly on the crystal of the IR machine) were recorded on a Shimadzu FTIR Affinity-1S apparatus. EI and ES mass spectrometric measurements were performed by R. Jenkins, R. Hick, T. Williams, and S. Waller at Cardiff University on a Water LCR Premier XEtof. Melting points were measured using a Gallenkamp variable heater with samples in open capillary tubes. The electrochemical reactions were carried out in a galvanostatic mode using a Vapourtec Ion Electrochemical flow reactor[5] powered by an Ion electrochemical power supply. The cyclic voltammograms (see SI) were obtained by using an Orygalys OGF500 Potentiostat/Galvanostat with OGFPWR power supply.

Electrochemical Oxyselenenylations of Alkenes; General Procedure GP1

The electrolysis was performed in an undivided cell using a Vapourtec Ion Electrochemical Flow Reactor (reactor volume 0.6 mL, spacer 0.5 mm) using a graphite (Gr) electrode as the anode and a platinum (Pt) electrode as the cathode (active surface area 2 × 12 cm^2). A solution of alkene (0.15 M in MeCN) was placed in vial A and a mixture of diphenyl diselenide (0.05 M), alcohol (30 equiv), and TBAI (0.0075 M) in MeCN was placed in vial B. Each solution was injected into an 8 mL sample loop. After that, the reactor temperature was set at 25 °C with the flow rate 0.6 mL·min^{-1} and the current was set at 192 mA to turn on automatically. Then, both solutions were pumped into a PTFE coil (1 mm internal diameter) and mixed *via* a T-piece connected to a 30 cm PTFE coil before the inlet of the electrochemical reactor. After reaching a steady state, the solution (12 mL) was collected automatically into a collection glass vial. The solvent was removed under vacuum. The crude product was purified by column chromatography (EtOAc/hexane).

Electrochemical Selenocyclisations; General Procedure GP2

The electrolysis was performed in an undivided cell using a Vapourtec Ion Electrochemical Flow Reactor (reactor volume 0.6 mL, spacer 0.5 mm) using a graphite (Gr) electrode as the anode and a platinum (Pt) electrode as the cathode (immersed surface area A 12 cm^2). A solution of alkene (0.15 M in MeCN) was placed in vial A and a mixture of diphenyl diselenide (0.05 M) and TBAI (0.0075 M) in MeCN was placed in vial B. Each solution was injected into an 8 mL sample loop. After that, the reactor temperature was set at 25 °C with the flow rate 0.6 mL·min^{-1} and the current set at 192 mA to turn on automatically. Then both solutions were pumped into a PTFE coil (1 mm internal diameter) and mixed via a T-piece connected to a 30 cm PTFE coil before the inlet of the electrochemical reactor. After reaching a steady state, the solution (12 mL) was collected automatically into a collection glass vial. The solvent was removed under vacuum. The crude product was purified by column chromatography (EtOAc/hexane).

(2-Methoxy-2-phenylethyl)(phenyl)selane (4)

Compound **4** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 165 mg (95%); colourless oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.50–7.45 (m, 2 H), 7.38–7.29 (m, 5 H), 7.26–7.22 (m, 3 H), 4.35 (dd, *J* = 8.4, 5.0 Hz, 1 H), 3.33 (dd, *J* = 12.3, 8.4 Hz, 1 H), 3.25 (s, 3 H), 3.11 (dd, *J* = 12.3, 5.0 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 141.0, 132.7, 130.8, 129.2, 128.7, 128.2, 126.9, 126.8, 83.3, 57.2, 35.5.

(2-Methoxy-2-*p*-tolylethyl)(phenyl)selane (5)

Compound **5** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 167 mg (91%); colourless oil.

The spectral data are in agreement with the literature.[15]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.49–7.44 (m, 2 H), 7.26–7.14 (m, 7 H), 4.33 (dd, *J* = 8.4, 5.1 Hz, 1 H), 3.33 (dd, *J* = 12.2, 8.4 Hz, 1 H), 3.24 (s, 3 H), 3.10 (dd, *J* = 12.2, 5.1 Hz, 1 H), 2.36 (s, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 137.7, 132.6, 130.9, 129.4, 129.1, 126.9, 126.8, 83.1, 57.0, 35.5, 21.3.

[2-(4-*tert*-Butylphenyl)-2-methoxyethyl](phenyl)selane (6)

Compound **6** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 20:1).

Yield: 184 mg (88%); yellow oil.

The spectral data are in agreement with the literature.[16]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.51–7.43 (m, 2 H), 7.40–7.38 (m, 2 H), 7.26–7.18 (m, 5 H), 4.35 (dd, *J* = 8.5, 4.9 Hz, 1 H), 3.33 (dd, *J* = 12.3, 8.5 Hz, 1 H), 3.25 (s, 3 H), 3.11 (dd, *J* = 12.3, 4.9 Hz, 1 H), 1.32 (s, 9 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 151.2, 138.0, 132.7, 130.9, 129.1, 126.9, 126.5, 125.5, 83.3, 57.2, 35.5, 34.7, 31.6.

[2-Methoxy-2-(4-methoxyphenyl)ethyl](phenyl)selane (7)

Compound **7** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 122 mg (63%); colourless oil.

The spectral data are in agreement with the literature.[15]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.49–7.43 (m, 2 H), 7.26–7.20 (m, 5 H), 6.89–6.82 (m, 2 H), 4.31 (dd, *J* = 8.2, 5.3 Hz, 1 H), 3.81 (s, 3 H), 3.33 (dd, *J* = 12.2, 8.3 Hz, 1 H), 3.22 (s, 3 H), 3.09 (dd, *J* = 12.2, 5.3 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 159.6, 133.0, 132.6, 130.9, 129.1, 128.0, 126.9, 114.0, 82.8, 56.9, 55.4, 35.5.

[2-(4-Fluorophenyl)-2-methoxyethyl](phenyl)selane (8)

Compound **8** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 156 mg (84%); colourless oil.

The spectral data are in agreement with the literature.[16]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.50–7.42 (m, 2 H), 7.29–7.20 (m, 5 H), 7.07–6.97 (m, 2 H), 4.33 (dd, *J* = 8.0, 5.5 Hz, 1 H), 3.30 (dd, *J* = 12.3, 8.0 Hz, 1 H), 3.23 (s, 3 H), 3.07 (dd, *J* = 12.3, 5.5 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 162.6 (d, *J* = 243.7 Hz), 136.7 (d, *J* = 3.7 Hz), 132.8, 129.2, 128.4 (d, *J* = 8.7 Hz), 127.0, 115.5 (d, *J* = 22.5 Hz), 82.7, 56.1, 35.4.

[2-(4-Chlorophenyl)-2-methoxyethyl](phenyl)selane (9)

Compound **9** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 144 mg (74%); colourless oil.

The spectral data are in agreement with the literature.[15]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.49–7.44 (m, 2 H), 7.32–7.28 (m, 2 H), 7.26–7.16 (m, 5 H), 4.31 (dd, *J* = 7.9, 5.5 Hz, 1 H), 3.29 (dd, *J* = 12.3, 8.0 Hz, 1 H), 3.23 (s, 3 H), 3.06 (dd, *J* = 12.3, 5.5 Hz, 1 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 139.5, 133.9, 132.8, 130.5, 129.2, 128.9, 128.2, 127.1, 82.7, 57.2, 35.2.

[2-(4-Bromophenyl)-2-methoxyethyl](phenyl)selane (10)

Compound **10** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 20:1).

Yield: 194 mg (87%); yellow oil.

The spectral data are in agreement with the literature.[16]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.49–7.43 (m, 4 H), 7.26–7.20 (m, 3 H), 7.18–7.14 (m, 2 H), 4.30 (dd, *J* = 7.9, 5.5 Hz, 1 H), 3.28 (dd, *J* = 12.4, 7.9 Hz, 1 H), 3.23 (s, 3 H), 3.06 (dd, *J* = 12.4, 5.5 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 140.0, 132.9, 131.8, 130.5, 129.2, 128.9, 127.1, 122.1, 82.7, 57.2, 35.2.

[2-(1,1′-Biphenyl-4-yl)-2-methoxyethyl](phenyl)selane (11)

Compound **11** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 184 mg (83%); pale yellow oil.

IR (neat): 3055, 2819, 1485, 1477, 1085, 732, 692 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.60–7.57 (m, 4 H), 7.50 –7.44 (m, 4 H), 7.39–7.34 (m, 3 H), 7.26–7.22 (m, 3 H), 4.41 (dd, *J* = 8.3, 5.2 Hz, 1 H), 3.37 (dd, *J* = 12.3, 8.3 Hz, 1 H), 3.30 (s, 3 H), 3.15 (dd, *J* = 12.3, 5.2 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 141.2, 140.9, 140.0, 132.8, 130.8, 129.1, 128.9, 127.4, 127.4, 127.2, 127.2, 126.9, 83.1, 57.2, 35.5.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{20}H_{17}Se$: 333.0522; found: 333.0525

(2-Methoxy-2-*m*-tolylethyl)(phenyl)selane (12)

Compound **12** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 170 mg (93%); yellow oil.

IR (neat): 2981, 2820, 1477, 1437, 1084, 731 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.50–7.44 (m, 2 H), 7.26–7.20 (m, 4 H), 7.12–7.09 (m, 3 H), 4.32 (dd, *J* = 8.5, 5.0 Hz, 1 H), 3.32 (dd, *J* = 12.2, 8.5 Hz, 1 H), 3.25 (s, 3 H), 3.10 (dd, *J* = 12.2, 5.0 Hz, 1 H), 2.35 (s, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 141.0, 138.4, 132.7, 130.9, 129.1, 129.0, 128.6, 127.4, 126.9, 123.9, 83.4, 57.2, 35.5, 21.6.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{15}H_{15}Se$: 271.0366; found: 271.0374

[2-(3-Fluorophenyl)-2-methoxyethyl](phenyl)selane (13)

Compound **13** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 114 mg (61%); yellow oil.

IR (neat): 2932, 2822, 1477, 1436, 1089, 1072, 733 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.50–7.44 (m, 2 H), 7.32–7.25 (m, 1 H), 7.24–7.21 (m, 3 H), 7.09–6.96 (m, 3 H), 4.33 (dd, *J* = 8.1, 5.2 Hz, 1 H), 3.29 (dd, *J* = 12.4, 8.2 Hz, 1 H), 3.26 (s, 3 H), 3.08 (dd, *J* = 12.4, 5.2 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 163.2 (d, *J* = 245.0 Hz), 143.9 (d, *J* = 6.2 Hz), 132.9, 130.5, 130.2 (d, *J* = 7.5 Hz), 129.2, 127.1, 122.5 (d, *J* = 2.5 Hz), 115.1 (d, *J* = 21.2 Hz), 113.7 (d, *J* = 25.0 Hz), 113.52, 82.8 (d, *J* = 2.5 Hz), 57.3, 35.2.

^{19}F NMR (471 MHz, $CDCl_3$): δ = –112.69 (s).

[2-(3-Chlorophenyl)-2-methoxyethyl](phenyl)selane (14)

Compound **14** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 138 mg (70%); yellow oil.

IR (neat): 2986, 2821, 1475, 1437, 1099, 1074, 733 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.49–7.43 (m, 2 H), 7.29–7.27 (m, 1 H), 7.27–7.21 (m, 5 H), 7.19–7.14 (m, 1 H), 4.30 (dd, *J* = 8.1, 5.3 Hz, 1 H), 3.27 (dd, *J* = 12.4, 8.1 Hz, 1 H), 3.24 (s, 3 H), 3.06 (dd, *J* = 12.4, 5.3 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 143.2, 134.7, 133.0, 130.5, 130.0, 129.2, 128.4, 127.1, 127.0, 125.0, 82.8, 57.4, 35.2.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{14}H_{12}ClSe$: 290.9820; found: 290.9810

[2-(3-Bromophenyl)-2-methoxyethyl](phenyl)selane (15)

Compound **15** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 187 mg (84%); yellow oil.

IR (neat): 2984, 2819, 1476, 1436, 1082, 1070, 732, 688 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.48–7.40 (m, 4 H), 7.26–7.18 (m, 5 H), 4.30 (dd, *J* = 8.1, 5.3 Hz, 1 H), 3.28 (dd, *J* = 12.4, 8.1 Hz, 1 H), 3.25 (s, 3 H), 3.06 (dd, *J* = 12.4, 5.3 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 143.5, 132.9, 131.3, 130.4, 130.3, 129.9, 129.2, 127.2, 125.5, 122.9, 82.8, 57.4, 35.2.

(2-Methoxy-2-*o*-tolylethyl)(phenyl)selane (16)

Compound **16** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 154 mg (84%); yellow oil.

IR (neat): 2980, 2820, 1477, 1437, 1022, 729 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.53–7.50 (m, 2 H), 7.40–7.38 (m, 1 H), 7.25–7.11 (m, 6 H), 4.60 (dd, *J* = 9.0, 4.2 Hz, 1 H), 3.31–3.17 (m, 4 H), 3.07 (dd, *J* = 12.5, 4.2 Hz, 1 H), 2.22 (s, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 139.1, 135.7, 133.2, 130.7, 130.6, 129.1, 127.8, 127.1, 126.5, 126.0, 79.7, 57.1, 34.7, 19.1.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{15}H_{15}Se$: 271.0366; found: 271.035

[2-(2-Fluorophenyl)-2-methoxyethyl](phenyl)selane (17)

Compound **17** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 120 mg (64%); pale yellow oil.

IR (neat): 3086, 2824, 1477, 1436, 1105, 1088, 734 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.51–7.48 (m, 2 H), 7.44–7.40 (m, 1 H), 7.29–7.22 (m, 4 H), 7.18–7.14 (m, 1 H), 7.04–7.00 (m, 1 H), 4.75 (dd, *J* = 8.2, 4.9 Hz, 1 H), 3.32–3.25 (m, 4 H), 3.20 (dd, *J* = 12.7, 4.6 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 160.5 (d, *J* = 245.0 Hz), 132.8, 130.6, 129.5 (d, *J* = 8.7 Hz), 129.1, 128.0 (d, *J* = 13.7 Hz), 127.7 (d, *J* = 3.7 Hz), 127.0, 124.5 (d, *J* = 3.7 Hz), 115.5 (d, *J* = 22.5 Hz), 76.6 (d, *J* = 1.3 Hz), 57.5, 34.1.

^{19}F NMR (471 MHz, $CDCl_3$) δ = –119.2.

[2-(2-Chlorophenyl)-2-methoxyethyl](phenyl)selane (18)

Compound **18** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 134 mg (69%); yellow oil.

IR (neat): 2985, 2823, 1475, 1436, 1072, 1034, 733 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.55–7.49 (m, 3 H), 7.34–7.28 (m, 2 H), 7.26–7.19 (m, 4 H), 4.85 (dd, *J* = 8.7, 3.9 Hz, 1 H), 3.29 (s, 3 H), 3.23 (dd, *J* = 12.5, 3.9 Hz, 1 H), 3.16 (dd, *J* = 12.5, 8.7 Hz, 1 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 138.6, 133.2, 133.1, 130.6, 129.7, 129.1, 127.4, 127.4, 127.0, 79.3, 57.6, 34.1.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{14}H_{12}ClSe$: 290.9820; found: 290.9812

[2-(2-Bromophenyl)-2-methoxyethyl](phenyl)selane (19)

Compound **19** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 178 mg (80%); yellow oil.

IR (neat): 3055, 2824, 1475, 1435, 1072, 1022, 732, 690 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.56–7.53 (m, 2 H), 7.52–7.47 (m, 2 H), 7.36–7.32 (m, 1 H), 7.25–7.20(m, 3 H), 7.16–7.13 (m, 1 H), 4.79 (dd, *J* = 8.9, 3.7 Hz, 1 H), 3.29 (s, 3 H), 3.22 (dd, *J* = 12.6, 3.7 Hz, 1 H), 3.13 (dd, *J* = 12.6, 8.9 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 143.5, 133.0, 131.3, 130.4, 130.3, 129.9, 129.2, 127.2, 125.5, 122.9, 82.8, 57.4, 35.2.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{14}H_{12}BrSe$: 334.9315; found: 334.9301

(2-Methoxy-2-phenylpropyl)(phenyl)selane (20)

Compound **20** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 138 mg (75%); yellow oil.

The spectral data are in agreement with the literature.[17]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.43–7.39 (m, 4 H), 7.36–7.32 (m, 2 H), 7.29–7.25 (m, 1 H), 7.20–7.16 (m, 3 H), 3.43 (d, *J* = 11.3 Hz, 1 H), 3.28 (d, *J* = 11.8 Hz, 1 H), 3.13 (s, 3 H), 1.72 (s, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 143.8, 132.8, 131.5, 129.0, 128.4, 127.5, 126.8, 126.4, 79.1, 51.2, 42.6, 23.3.

(2-Methoxy-3-methyl-2-phenylbutyl)(phenyl)selane (21)

Compound **21** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 32 mg (16%); colourless solid; mp 87–88 °C.

IR (neat): 2966, 2818, 1471, 1170, 1070, 761, 744, 705, 690 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.60–7.55 (m, 2 H), 7.36–7.24 (m, 8 H), 3.79 (d, *J* = 12.0 Hz, 1 H), 3.62 (d, *J* = 12.0 Hz, 1 H), 3.26 (s, 3 H), 2.41 (dt, *J* = 13.6, 6.8 Hz, 1 H), 0.79 (d, *J* = 6.7 Hz, 3 H), 0.75 (d, *J* = 6.9 Hz, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 139.3, 133.3, 131.0, 129.2, 128.0, 127.6, 127.1, 127.1, 83.7, 50.9, 35.4, 34.8, 18.2, 16.9.

(2-Methoxy-2,2-diphenylethyl)(phenyl)selane (22)

Compound **22** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 56 mg (25%); colourless solid; mp 76–78 °C.

The spectral data are in agreement with the literature.[18]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.44–7.34 (m, 6 H), 7.33–7.28 (m, 4 H), 7.26–7.17 (m, 5 H), 3.96 (s, 2 H), 3.16 (s, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 144.3, 133.3, 130.9, 129.0, 128.1, 127.3, 127.1, 127.0, 82.2, 50.9, 37.9.

(1-Methoxy-1-phenylpropan-2-yl)(phenyl)selane (23)

Compound **23** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 153 mg (84%); yellow oil.

The spectral data are in agreement with the literature.[19]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.56–7.53 (m, 2 H), 7.38–7.22 (m, 8 H), 4.41 (d, *J* = 4.5 Hz, 1 H), 3.48 (qd, *J* = 7.0, 4.5 Hz, 1 H), 3.30 (s, 3 H), 1.35 (d, *J* = 7.1 Hz, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 139.8, 134.7, 130.1, 129.1, 128.4, 127.9, 127.5, 127.2, 86.5, 57.7, 45.9, 16.5.

(2-Methoxy-2-naphthalen-2-ylethyl)(phenyl)selane (26)

Compound **26** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 177 mg (86%); orange oil.

IR (neat): 3050, 2931, 1477, 1437, 1101, 1022, 735 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.87–7.81 (m, 3 H), 7.75 (s, 1 H), 7.52–7.42 (m, 5 H), 7.25–7.14 (m, 3 H), 4.52 (dd, *J* = 8.3, 5.2 Hz, 1 H), 3.40 (dd, *J* = 12.3, 4.0 Hz, 1 H), 3.29 (s, 3 H), 3.19 (dd, *J* = 12.3, 5.2 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 138.5, 134.4, 133.5, 133.4, 132.9, 130.8, 129.2, 128.8, 128.2, 127.9, 127.1, 126.5, 126.4, 126.3, 124.3, 83.6, 77.3, 57.3, 35.4.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{18}H_{15}Se$: 307.0366; found: 307.0359

(1-Methoxy-2,3-dihydro-1*H*-inden-2-yl)(phenyl)selane (27)

Compound **27** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 168 mg (92%); orange oil.

The spectral data are in agreement with the literature.[16]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.62–7.57 (m, 2 H), 7.39 (d, *J* = 7.1 Hz, 1 H), 7.32–7.19 (m, 6 H), 4.76 (d, *J* = 2.8 Hz, 1 H), 4.08–3.97 (m, 1 H), 3.60 (dd, *J* = 17.0, 7.4 Hz, 1 H), 3.36 (s, 3 H), 2.94 (dd, *J* = 17.0, 3.7 Hz, 1 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 142.3, 140.9, 134.4, 129.6, 129.3, 129.1, 127.8, 127.0, 125.7, 125.3, 90.3, 57.0, 44.8, 38.4.

(2-Cyclopentyl-2-methoxyethyl)(phenyl)selane (28a) and (1-Cyclopentyl-2-methoxyethyl)(phenyl)selane (28b)

Compounds **28a** and **28b** were synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 127 mg (75%); colourless oil.

The spectral data are in agreement with the literature.[16]

IR (neat): 2947, 2866, 1577, 1475, 1436, 1095, 906, 729, 690 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.60–7.56 (**a**; m, 3 H), 7.54–7.51 (**b**; m, 2 H), 7.28–7.20 (**a** + **b**; m, 8 H), 3.59– 3.56 (**a** + **b**; m, 3 H), 3.38 (**b**; s, 3 H), 3.32 (**a**; s, 3 H), 3.32–3.22 (**a** + **b**; m, 3 H), 3.16 (**a**; dd, *J* = 12.3, 4.8 Hz, 1 H), 3.08 (**a**; dd, *J* = 12.3, 5.8 Hz, 1 H), 2.31–2.09 (**a** + **b**; m, 2.6 H), 1.94–1.15 (**a** + **b**; m, 20 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 134.6, 132.7, 131.1, 130.10, 129.2, 129.1, 127.4, 126.9, 84.4, 75.71, 58.9, 58.0, 51.85, 44.3, 42.1, 31.7, 31.5, 31.2, 29.35, 28.7, 25.7, 25.6, 25.64, 25.38.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{13}H_{17}Se$: 249.0522; found: 249.0524.

(2-Cyclohexyl-2-methoxyethyl)(phenyl)selane (29a) and (1-Cyclohexyl-2-methoxyethyl)(phenyl)selane (29b)

Compound **29** was synthesised following the GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 76 mg (43%); pale yellow oil.

IR (neat): 2974, 2920, 2850, 1577, 1475, 1436, 1097, 1083, 1022, 734, 690 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.59–7.51 (**a** + **b**; m, 3.6 H), 7.29–7.20 (**a** + **b**; m, 6 H), 3.68 (**a**; dd, *J* = 10.1, 8.5 Hz, 1 H), 3.56 (**a**; dd, *J* = 10.1, 5.1 Hz, 1 H), 3.38 (**b**; s, 3 H), 3.30 (**a**; s, 3 H), 3.26–3.22 (**a**; m, 1 H), 3.21–3.03 (**a** + **b**; m, 2.5 H), 1.89–1.40 (**a** + **b**; m, 12 H), 1.35–1.05 (**a** + **b**; m, 8 H).

^{13}C NMR (126 MHz, $CDCl_3$); δ = 134.2, 132.7, 131.1, 130.5, 129.1, 129.1, 127.2, 126.8, 85.2, 74.0, 58.7, 58.3, 53.1, 41.4, 39.3, 31.7, 30.1, 30.0, 29.0, 28.3, 26.6, 26.5, 26.54, 26.4, 26.3.

HRMS (ESI): *m*/*z* [M – OMe]$^+$ calcd for $C_{14}H_{19}Se$: 263.0679; found: 263.0685.

(2-Methoxyoctyl)(phenyl)selane (30a) and (1-Methoxyoctan-2-yl)(phenyl)selane (30b)

Compounds **30a** and **30b** were synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 75 mg (42%); colourless oil.

IR (neat): 2926, 2854, 1577, 1477, 1436, 1091, 1074, 734, 690 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.50–7.44 (**a** + **b**; m, 2 H), 7.20–7.14 (**a** + **b**; m, 4 H), 3.48 (**b**; dd, *J* = 9.9, 5.2 Hz, 1 H) , 3.42 (**b**; dd, *J* = 9.9, 7.5 Hz, 1 H), 3.33–3.27 (**a**; m, 1 H), 3.26 (**a**; s, 3 H), 3.25 (**b**; s, 3 H), 3.23–3.18 (**b**; s,1 H), 3.03 (**a**; dd, *J* = 12.2, 5.5 Hz, 1 H), 2.94 (**a**; dd, *J* = 12.2, 6.1 Hz, 1 H), 1.58–1.13 (**a** + **b**; m, 12.5 H), 0.80 (**a** + **b**; m, 3.75 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 134.9, 133.0, 132.8, 130.9, 129.2, 129.1, 127.6, 126.9, 80.6, 76.0, 58.8, 57.1, 45.0, 32.3, 32.1, 31.9, 31.8, 29.4, 29.2, 27.8, 25.4, 22.7, 14.2.

(2-Methoxycyclohexyl)(phenyl)selane (31)

Compound **31** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 130 mg (80%); yellow oil.

The spectral data are in agreement with the literature.[20]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.56–7.56 (m, 2 H), 7.28–7.23 (m, 3 H), 3.38 (s, 3 H), 3.27 (m, 1 H), 3.18 (m, 1 H), 2.15 (m, 1 H), 2.04–1.97 (m, 1 H), 1.76–1.45 (m, 3 H), 1.38–1.19 (m, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 135.5, 129.1, 128.9, 127.5, 82.4, 56.5, 47.5, 32.3, 30.4, 25.9, 23.6.

2-Methoxy-3-(phenylselanyl)tetrahydro-2*H*-pyran (32)

Compound **32** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 23 mg (14%); yellow oil.

The spectral data are in agreement with the literature.[21]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.59–7.54 (m, 2 H), 7.30–7.23 (m, 3 H), 4.51 (d, *J* = 4.9 Hz, 1 H), 3.90 (ddd, *J* = 11.2, 7.4, 3.6 Hz, 1 H), 3.58–3.49 (m, 1 H), 3.42 (s, 3 H), 3.27 (dt, *J* = 7.4, 4.6 Hz, 1 H), 2.20 (ddd, *J* = 16.9, 8.1, 3.9 Hz, 1 H), 1.86–1.68 (m, 2 H), 1.57–1.48 (m, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 134.9, 129.1, 129.0, 127.7, 103.2, 62.9, 55.7, 44.2, 27.5, 24.4.

1-Methyl-3-(phenylselanyl)-1*H*-indole (33)

Compound **33** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 9:1).

Yield: 125 mg (72%); colourless oil.

The spectral data are in agreement with the literature.[22]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.58–7.55 (m, 1 H), 7.31 (dt, *J* = 8.2, 0.9 Hz, 1 H), 7.26–6.95 (m, 8 H), 3.78 (s, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 137.6, 135.8, 134.4, 130.8, 129.0, 128.8, 125.6, 122.6, 120.6, 120.6, 109.7, 96.1, 33.2.

Benzyl(2-methoxy-2-phenylethyl)selane (34)

Compound **34** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 76 mg (41%); pale yellow oil.

The spectral data are in agreement with the literature.[16]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.38–7.33 (m, 2 H), 7.32–7.23 (m, 7 H), 7.23–7.17 (m, 1 H), 4.20 (dd, *J* = 8.0, 5.4 Hz, 1 H), 3.70 (d, *J* = 2.3 Hz, 2 H), 3.22 (s, 3 H), 2.90 (dd, *J* = 12.7, 8.0 Hz, 1 H), 2.67 (dd, *J* = 12.7, 5.4 Hz, 1 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 141.3, 139.5, 129.1, 128.6, 128.5, 128.1, 126.8, 126.8, 84.3, 57.0, 31.0, 28.0.

(2-Ethoxy-2-phenylethyl)(phenyl)selane (35)

Compound **35** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 157 mg (86%); yellow oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.56–7.43 (m, 2 H), 7.38–7.19 (m, 8 H), 4.47 (dd, *J* = 8.5, 5.1 Hz, 1 H), 3.38 (m, 3 H), 3.10 (dd, *J* = 12.2, 5.1 Hz, 1 H), 1.19 (t, *J* = 7.0 Hz, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 141.8, 132.7, 131.0, 129.1, 128.6, 128.1, 126.9, 126.7, 81.5, 64.8, 35.7, 15.4.

Phenyl(2-phenyl-2-propoxyethyl)selane (36)

Compound **36** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 152 mg (79%); yellow oil.

IR (neat): 2958, 2874, 1477, 1091, 734, 700 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.51–7.30 (m, 2 H), 7.28–7.06 (m, 8 H), 4.36 (dd, *J* = 8.6, 4.9 Hz, 1 H), 3.19 (m, 3 H), 2.99 (dd, *J* = 12.2, 4.9 Hz, 1 H), 1.58–1.39 (m, 2 H), 0.81 (t, *J* = 7.4 Hz, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 141.9, 132.6, 131.2, 129.1, 128.6, 128.1, 126.8, 126.7, 81.7, 71.2, 35.9, 23.1, 10.8.

(2-Butoxy-2-phenylethyl)(phenyl)selane (37)

Compound **37** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 148 mg (74%); yellow oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.53–7.41 (m, 2 H), 7.38–7.16 (m, 8 H), 4.46 (dd, *J* = 8.7, 4.9 Hz, 1 H), 3.40–3.23 (m, 3 H), 3.09 (dd, *J* = 12.2, 4.9 Hz, 1 H), 1.54 (m, 2 H), 1.43–1.31 (m, 2 H), 0.89 (t, *J* = 7.3 Hz, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 141.9, 132.6, 131.2, 129.1, 128.6, 128.1, 126.8, 126.7, 81.7, 69.3, 35.9, 32.0, 19.5, 14.0.

[2-(Benzyloxy)-2-phenylethyl](phenyl)selane (38)

Compound **38** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 119 mg (54%); yellow oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.48–7.42 (m, 2 H), 7.40–7.27 (m, 10 H), 7.25–7.17 (m, 3 H), 4.58 (dd, *J* = 8.4, 5.0 Hz, 1 H), 4.50 (d, *J* = 11.8 Hz, 1 H), 4.32 (d, *J* = 11.8 Hz, 1 H), 3.45–3.83 (m, 1 H), 3.12–3.18 (m, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 141.2, 138.2, 132.6, 130.9, 129.1, 128.8, 128.5, 128.3, 128.0, 127.7, 126.9, 126.9, 80.9, 71.0, 35.7.

[2-(But-3-yn-1-yloxy)-2-phenylethyl](phenyl)selane (39)

Compound **39** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 112 mg (57%); yellow oil.

IR (neat): 3057, 2868, 1477, 1437, 1095, 733, 700 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.50–7.47 (m, 2 H), 7.37–7.28 (m, 5 H), 7.25–7.20 (m, 3 H), 4.51 (dd, *J* = 8.5, 5.0 Hz, 1 H), 3.52–3.42(m, 2 H), 3.35 (dd, *J* = 12.4, 8.5 Hz, 1 H), 3.09 (dd, *J* = 12.4, 5.0 Hz, 1 H), 2.50–2.40 (m, 2 H), 1.95 (t, *J* = 2.7 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 141.2, 132.7, 130.9, 129.1, 128.7, 128.3, 126.9, 126.8, 82.1, 81.3, 69.5, 67.4, 35.5, 20.0.

HRMS (ESI): *m*/*z* [M + Na]$^+$ calcd for $C_{18}H_{18}OSeNa$: 349.0447; found: 349.0448

[2-(Cyclopropylmethoxy)-2-phenylethyl](phenyl)selane (40)

Compound **40** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 150 mg (75%); yellow oil.

The spectral data are in agreement with the literature.[17]

IR (neat): 3003, 2858, 1477, 1437, 1089, 1022, 733, 700 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.44–7.41 (m, 2 H), 7.29–7.13 (m, 8 H), 4.44 (dd, *J* = 8.4, 5.2 Hz, 1 H), 3.31 (dd, *J* = 12.2, 8.5 Hz, 1 H), 3.15–3.07 (m, 2 H), 3.04 (dd, *J* = 12.2, 5.1 Hz, 1 H), 1.03–0.93 (m, 1 H), 0.47–0.38 (m, 2 H), 0.12–0.01 (m, 2 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 141.7, 132.6, 131.0, 129.1, 128.6, 128.1, 126.8, 126.7, 81.22, 74.0, 35.8, 10.8, 3.4, 3.1.

HRMS (ESI): *m*/*z* [M + Na]$^+$ calcd for $C_{18}H_{20}OSeNa$: 351.0604; found: 351.0615

(2-Isopropoxy-2-phenylethyl)(phenyl)selane (41)

Compound **41** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 134 mg (70%); yellow oil.

The spectral data are in agreement with the literature.[17]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.54–7.40 (m, 2 H), 7.35–7.11 (m, 8 H), 4.59 (dd, *J* = 9.9, 3.6 Hz, 1 H), 3.60–3.44 (m, 1 H), 3.31 (dd, *J* = 12.1, 8.8 Hz, 1 H), 3.08 (dd, *J* = 12.1, 4.8 Hz, 1 H), 1.17 (d, *J* = 6.0 Hz, 3 H), 1.08 (d, *J* = 6.2 Hz, 3 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 142.6, 132.5, 131.2, 129.1, 128.6, 128.0, 126.7, 78.9, 69.9, 36.2, 23.4, 21.5.

(2-Isobutoxy-2-phenylethyl)(phenyl)selane (42)

Compound **42** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 150 mg (75%); yellow oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.56–7.43 (m, 2 H), 7.38–7.18 (m, 8 H), 4.46 (dd, *J* = 8.8, 4.8 Hz, 1 H), 3.36 (dd, *J* = 12.1, 8.8 Hz, 1 H), 3.16–3.01 (m, 3 H), 1.86 (m, 1 H), 0.98–0.81 (m, 6 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 142.6, 132.4, 131.2, 129.1, 128.5, 127.9, 126.7, 78.9, 69.9, 36.2, 23.4, 21.5.

[2-(Cyclopentyloxy)-2-phenylethyl](phenyl)selane (43)

Compound **43** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 148 mg (71%); yellow oil.

IR (neat): 3057, 2868, 1476, 1437, 1072, 1022, 732, 700 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.45–7.37 (m, 2 H), 7.29–7.10 (m, 8 H), 4.47 (dd, *J* = 9.2, 4.4 Hz, 1 H), 3.92–3.52 (m, 1 H), 3.22 (dd, *J* = 12.2, 9.2 Hz, 1 H), 2.99 (dd, *J* = 12.2, 4.5 Hz, 1 H), 1.74–1.34 (m, 8 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 142.5, 132.4, 131.4, 129.1, 128.6, 127.9, 126.8, 126.7, 79.6, 79.4, 36.2, 33.2, 31.7, 23.5.

[2-(Cyclohexyloxy)-2-phenylethyl](phenyl)selane (44)

Compound **44** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 135 mg (62%); yellow oil.

IR (neat): 2927, 2854, 1477, 1436, 1070, 733, 700 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.40 (m, 2 H), 7.29–7.09 (m, 8 H), 4.57 (dd, *J* = 9.0, 4.6 Hz, 1 H), 3.24 (dd, *J* = 12.1, 9.0 Hz, 1 H), 3.16–3.07 (m, 1 H), 2.99 (dd, *J* = 12.1, 4.6 Hz, 1 H), 1.68 (m, 4 H), 1.42–0.92 (m, 6 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 142.8, 132.3, 131.4, 129.1, 128.5, 127.9, 126.7, 126.6, 78.5, 75.7, 36.4, 33.5, 31.4, 25.9, 24.2, 24.0.

(2-*tert*-Butoxy-2-phenylethyl)(phenyl)selane (45)

Compound **45** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 30:1).

Yield: 93 mg (47%); yellow oil.

IR (neat): 2972, 2931, 1477, 1436, 1072, 1190, 731, 700 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.41–7.31 (m, 2 H), 7.27–7.06 (m, 8 H), 4.60 (dd, *J* = 8.6, 4.8 Hz, 1 H), 3.14 (dd, *J* = 12.1, 8.6 Hz, 1 H), 2.95 (dd, *J* = 12.1, 4.8 Hz, 1 H), 1.02 (s, 9 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 145.3, 132.2, 131.5, 129.1, 128.4, 127.4, 126.6, 126.3, 75.0, 74.2, 37.4, 28.9.

1-Phenyl-2-(phenylselanyl)ethan-1-ol (46)

Compound **46** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 9:1).

Yield: 134 mg (81%); colourless oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.60–7.51 (m, 2 H), 7.38–7.32 (m, 4 H), 7.32–7.26 (m, 4 H), 4.76 (dd, *J* = 9.4, 3.5 Hz, 1 H), 3.31 (dd, *J* = 12.8, 3.7 Hz, 1 H), 3.15 (dd, *J* = 12.8, 9.4 Hz, 1 H), 2.79 (s, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 142.6, 133.3, 129.4, 129.3, 128.7, 128.1, 127.6, 125.9, 72.4, 38.6.

1-Phenyl-2-(phenylselanyl)ethyl Formate (47)

Compound **47** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 76 mg (41%); colourless oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.00 (s, 1 H), 7.44–7.40 (m, 2 H), 7.30–7.13 (m, 8 H), 5.94 (dd, *J* = 8.9, 5.8 Hz, 1 H), 3.32 (dd, *J* = 12.9, 8.0 Hz, 1 H), 3.18 (dd, *J* = 13.2, 6.1 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 160.0, 138.8, 135.5, 133.4, 129.3, 128.8, 128.7, 127.5, 126.8, 75.1, 33.2.

1-Phenyl-2-(phenylselanyl)ethyl Acetate (48)

Compound **48** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 92 mg (46%); colourless oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.46–7.40 (m, 2 H), 7.28–7.16 (m, 8 H), 5.87 (dd, *J* = 8.0, 5.7 Hz, 1 H), 3.31 (dd, *J* = 12.8, 8.0 Hz, 1 H), 3.16 (dd, *J* = 12.8, 5.7 Hz, 1 H), 1.95 (s, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 170.1, 139.5, 133.2, 129.9, 129.2, 128.6, 128.5, 127.3, 126.7, 75.3, 33.5, 21.2.

1-[1-Phenyl-2-(phenylselanyl)ethyl]-1*H*-benzo[*d*][1,2,3]triazole (49)

Compound **49** was synthesised following GP1. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 9:1).

Yield: 147 mg (65%); colourless oil.

The spectral data are in agreement with the literature.[10a]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 8.10–7.94 (m, 1 H), 7.46–7.39 (m, 2 H), 7.38–7.19 (m, 11 H), 5.85 (dd, *J* = 9.4, 5.8 Hz, 1 H), 4.25 (dd, *J* = 13.1, 9.4 Hz, 1 H), 3.82 (dd, *J* = 13.1, 5.8 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 146.1, 138.4, 133.7, 133.1, 129.3, 129.0, 129.0, 128.8, 127.8, 127.3, 126.9, 124.0, 120.1, 109.6, 63.6, 32.6.

2-[(Phenylselanyl)methyl]tetrahydrofuran (50)

Compound **50** was synthesised following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 105 mg (73%); pale yellow oil.

The spectral data are in agreement with the literature.[25]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.59–7.50 (m, 2 H), 7.30–7.22 (m, 3 H), 4.30–4.03 (m, 1 H), 4.01–3.88 (m, 1 H), 3.84–3.66 (m, 1 H), 3.15 (dd, *J* = 12.2, 5.8 Hz, 1 H), 3.01 (dd, *J* = 12.2, 6.9 Hz, 1 H), 2.14–2.05 (m, 1 H), 2.03–1.80 (m, 2 H), 1.65 (m, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 137.4, 132.7, 129.2, 127.0, 78.4, 78.4, 33.2, 31.7, 26.1.

2-[(Phenylselanyl)methyl]tetrahydro-2*H*-pyran (51)

Compound **51** was synthesised following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 103 mg (67%); pale yellow oil.

The spectral data are in agreement with the literature.[25]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.55–7.46 (m, 2 H), 7.29–7.18 (m, 3 H), 4.04–3.95 (m, 1 H), 3.92–3.26 (m, 2 H), 3.07 (dd, *J* = 12.2, 6.9 Hz, 1 H), 2.93 (dd, *J* = 12.2, 5.7 Hz, 1 H), 1.99–1.68 (m, 2 H), 1.61–1.43 (m, 3 H), 1.37–1.26 (m, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 132.5, 130.9, 129.1, 126.8, 77.2, 68.9, 33.8, 31.9, 25.9, 23.5.

2-Methyl-3-(phenylselanyl)tetrahydro-2*H*-pyran (52)

Compound **52** was synthesised as a 1:1 mixture (*cis* : *trans*) following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 9:1).

Yield: 89 mg (58%); colourless oil.

The spectral data are in agreement with the literature.[21]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.61–7.55 (m, 4 H), 7.31–7.23 (m, 6 H), 3.96–3.86 (m, 3 H), 3.78 (dt, *J* = 9.4, 6.6 Hz, 1 H), 3.46–3.29 (m, 3 H), 2.99–2.89 (m, 1 H), 2.22–2.10 (m, 1 H), 2.09–1.99 (m, 1 H), 1.95–1.83 (m, 2 H), 1.75–1.53 (m, 4 H), 1.44 (d, *J* = 7.0 Hz, 3 H), 1.35 (d, *J* = 6.1 Hz, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 135.6, 135.3, 134.9, 129.1, 129.0, 128.2, 127.9, 127.6, 83.0, 78.4, 68.6, 68.2, 47.2, 44.4, 32.5, 30.4, 28.2, 26.3, 21.3, 18.9.

5-[(Phenylselanyl)methyl]dihydrofuran-2(3*H*)-one (53)

Compound **53** was synthesised following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 101 mg (65%); pale yellow oil.

The spectral data are in agreement with the literature.[20]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.62–7.46 (m, 2 H), 7.33–7.26 (m, 3 H), 4.69–4.61 (m, 1 H), 3.29 (dd, *J* = 12.9, 4.8 Hz, 1 H), 3.01 (dd, *J* = 12.9, 8.0 Hz, 1 H), 2.62–2.36 (m, 3 H), 2.00–1.90 (m, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 176.7, 133.4, 129.5, 128.9, 127.8, 79.5, 32.0, 28.9, 27.8.

5-Phenyl-4-(phenylselanyl)dihydrofuran-2(3*H*)-one (54)

Compound **54** was synthesised following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 58 mg (30%); colourless oil.

The spectral data are in agreement with the literature.[23]

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.55–7.52 (m, 2 H), 7.40–7.28 (m, 8 H), 5.38 (d, *J* = 6.9 Hz, 1 H), 3.79– 3.71 (m, 1 H), 3.04 (dd, *J* = 18.0, 8.3 Hz, 1 H), 2.67 (dd, *J* = 18.0, 8.4 Hz, 1 H).

^{13}C NMR (101 MHz, $CDCl_3$): δ = 174.7, 137.4, 136.3, 129.7, 129.2, 129.1, 128.9, 126.1, 125.9, 86.3, 42.38, 36.1.

6-(Phenylselanyl)hexahydro-2*H*-cyclopenta[*b*]furan-2-one (55)

Compound **55** was synthesised following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 115 mg (68%); colourless oil.

The spectral data are in agreement with the literature.[24]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.64–7.42 (m, 2 H), 7.34–7.25 (m, 3 H), 4.90 (d, *J* = 6.3 Hz, 1 H), 3.97–3.78 (m, 1 H), 3.15–3.04 (m, 1 H), 2.87–2.73 (m, 1 H), 2.34 (dd, *J* = 18.4, 2.5 Hz, 1 H), 2.28–2.18 (m, 2 H), 1.91–1.71 (m, 1 H), 1.61–1.51 (m, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 177.0, 133.8, 129.5, 128.8, 127.9, 90.7, 46.4, 37.2, 36.1, 32.6, 30.2.

3-[(Phenylselanyl)methyl]isobenzofuran-1(3*H*)-one (56)

Compound **56** was synthesised following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 87 mg (48%); colourless oil.

The spectral data are in agreement with the literature.[25]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.97–7.87 (m, 1 H), 7.60–7.45 (m, 5 H), 7.30–7.19 (m, 3 H), 5.72–5.55 (m, 1 H), 3.46 (dd, *J* = 13.2, 5.0 Hz, 1 H), 3.32 (dd, *J* = 13.2, 6.4 Hz, 1 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 169.9, 148.5, 133.8, 133.6, 129.5, 129.2, 129.0, 127.7, 126.6, 125.7, 122.4, 79.1, 31.8.

2-[(Phenylselanyl)methyl]-1-tosylindoline (57)

Compound **57** was synthesised following GP2. It was purified by column chromatography (silica gel, hexane/ethyl acetate, 4:1).

Yield: 87 mg (33%); yellow solid; mp 70–72 °C.

The spectral data are in agreement with the literature.[26]

^{1}H NMR (500 MHz, $CDCl_3$): δ = 7.65 (d, *J* = 8.1 Hz, 1 H), 7.61–7.54 (m, 2 H), 7.39–7.29 (m, 5 H), 7.23–7.18 (m, 1 H), 7.11–7.08 (m, 2 H), 7.04–7.01 (m, 2 H), 4.36–4.11 (m, 1 H), 3.65 (dd, *J* = 12.5, 3.5 Hz, 1 H), 2.96–2.81 (m, 3 H), 2.32 (s, 3 H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 144.0, 141.4, 134.7, 132.6, 131.1, 129.7, 129.4, 128.9, 127.9, 127.2, 127.1, 125.3, 124.8, 117.1, 61.7, 34.2, 33.2, 21.6.

Funding Information

The support from Cardiff University and from the Chemistry Department, Jazan University, Saudi Arabia, is appreciated.

Acknowledgment

We thank D. Guthrie and M. Nuno, Vapourtec Inc., for many discussions and for providing the equipment and support for this research. Fruitful discussions with Dr. M. N. Khan, Cardiff University, are gratefully acknowledged.

Supporting Information

Supporting information for this article is available online at https://doi.org/10.1055/s-0039-1690868.

References

(1) (a) Alcácer, V.; Cruz-Machado, V. *Eng. Sci. Technol. Int. J.* **2019**, *22*, 899. (b) Fitzpatrick, D. E.; Battilocchio, C.; Ley, S. V. *ACS Cent. Sci.* **2016**, *2*, 131. (c) Kreimeyer, A.; Eckes, P.; Fischer, C.; Lauke, H.; Schuhmacher, P. *Angew. Chem. Int. Ed.* **2015**, *54*, 3178. (d) Ley, S. V.; Fitzpatrick, D. E.; Myers, R. M.; Battilocchio, C.; Ingham, R. J. *Angew. Chem. Int. Ed.* **2015**, *54*, 10122. (e) Prieto, G.; Schüth, F. *Angew. Chem. Int. Ed.* **2015**, *54*, 3222. (f) Ley, S. V.; Fitzpatrick, D. E.; Ingham, R. J.; Myers, R. M. *Angew. Chem. Int. Ed.* **2015**, *54*, 3449.

(2) (a) *Science of Synthesis: Flow Chemistry*; Jamison, T. F.; Koch, G., Ed.; Thieme: Stuttgart, **2018**. (b) *Microreactors in Organic Synthesis and Catalysis*; Wirth, T., Ed.; Wiley-VCH: Weinheim, **2013**. (c) Yoshida, J. *Flash Chemistry: Fast Organic Synthesis in Microsystems*; Wiley-VCH: Weinheim, **2008**.

(3) (a) Jing, Q.; Moeller, K. D. *Acc. Chem. Res.* **2020**, *53*, 135. (b) Folgueiras Amador, A. A.; Wirth, T. In *Science of Synthesis: Flow Chemistry*; Jamison, T. F.; Koch, G., Ed.; Thieme: Stuttgart, **2018**, 147. (c) Pletcher, D.; Green, R. A.; Brown, R. C. D. *Chem.*

Rev. **2018**, *118*, 4573. (d) Atobe, M.; Tateno, H.; Matsumura, Y. *Chem. Rev.* **2018**, *118*, 4541. (e) Wiebe, A.; Gieshoff, T.; Möhle, S.; Rodrigo, E.; Zirbes, M.; Waldvogel, S. R. *Angew. Chem. Int. Ed.* **2018**, *57*, 5594.

(4) (a) Elsherbini, M.; Wirth, T. *Acc. Chem. Res.* **2019**, *52*, 3287. (b) Folgueiras-Amador, A. A.; Philipps, K.; Guilbaud, S.; Poelakker, J.; Wirth, T. *Angew. Chem. Int. Ed.* **2017**, *56*, 15446. (c) Amri, N.; Skilton, R. A.; Guthrie, D.; Wirth, T. *Synlett* **2019**, *30*, 1183.

(5) https://www.vapourtec.com/products/flow-reactors/ion-electrochemical-reactor-features/ (accessed January 2020).

(6) (a) Shaabani, S.; Xu, R.; Ahmadianmoghaddam, M.; Gao, L.; Stahorsky, M.; Olechno, J.; Ellson, R.; Kossenjans, M.; Helan, V.; Dömling, A. *Green Chem.* **2019**, *21*, 225. (b) Trobe, M.; Burke, M. D. *Angew. Chem. Int. Ed.* **2018**, *57*, 4192. (c) Panza, M.; Pistorio, S. G.; Stine, K. J.; Demchenko, A. V. *Chem. Rev.* **2018**, *118*, 8105. (d) Mijalis, A. J.; Thomas, D. A.; Simon, M. D.; Adamo, A.; Beaumont, R.; Jensen, K. F.; Pentelute, B. L. *Nat. Chem. Biol.* **2017**, *13*, 464. (e) Reizman, B. J.; Jensen, K. F. *Acc. Chem. Res.* **2016**, *49*, 1786. (f) Yoshida, J.; Kim, H.; Nagaki, A. *ChemSusChem* **2011**, *4*, 331. (g) Merrifield, R. B.; Stewart, J. M.; Jernberg, N. *Anal. Chem.* **1966**, *38*, 1905.

(7) (a) Singh, F. V.; Wirth, T. *Catal. Sci. Technol.* **2019**, *9*, 1073. (b) Singh, F. V.; Wirth, T. In *Organoselenium Compounds in Biology and Medicine: Synthesis, Biological and Therapeutic Treatments*; Jain, V. K.; Priyadarsini, K. I., Ed.; The Royal Society of Chemistry: London, **2018**, 77. (c) Mukherjee, A. J.; Zade, S. S.; Singh, H. B.; Sunoj, R. B. *Chem. Rev.* **2010**, *110*, 4357. (d) *Organoselenium Chemistry*; Wirth, T., Ed.; Springer: Berlin, **2000**. (e) Back, T. G. *Organoselenium Chemistry: A Practical Approach*; Oxford University Press: Oxford, **1999**.

(8) Niyomura, O.; Cox, M.; Wirth, T. *Synlett* **2006**, 251.

(9) (a) Jiang, Y.; Xu, K.; Zeng, C. *Chem. Rev.* **2018**, *118*, 4485. (b) Moeller, K. D. *Chem. Rev.* **2018**, *118*, 4817. (c) Francke, R.; Schille, B.; Roemelt, M. *Chem. Rev.* **2018**, *118*, 4631. (d) Yoshida, J.; Shimizu, A.; Hayashi, R. *Chem. Rev.* **2018**, *118*, 4702. (e) Ibanez, J. G.; Rincón, M. E.; Gutierrez-Granados, S.; Chahma, M.; Jaramillo-Quintero, O. A.; Frontana-Uribe, B. A. *Chem. Rev.* **2018**, *118*, 4731. (f) Nutting, J. E.; Rafiee, M.; Stahl, S. S. *Chem. Rev.* **2018**, *118*, 4834.

(10) (a) Yuan, Y.; Lei, A. *Acc. Chem. Res.* **2019**, *52*, 3309. (b) Sun, L.; Yuan, Y.; Yao, M.; Wang, H.; Wang, D.; Gao, M.; Chen, Y. H.; Lei, A. *Org. Lett.* **2019**, *21*, 1297. (c) Chen, J.; Mei, L.; Wang, H.; Hu, L.; Sun, X.; Shi, J.; Li, Q. *ChemistryOpen* **2019**, *7*, 1230. (d) Wilken, M.; Ortgies, S.; Breder, A.; Siewert, I. *ACS Catal.* **2018**, *8*, 10901.

(11) (a) Folgueiras-Amador, A. A.; Qian, X.-Y.; Xu, H.-C.; Wirth, T. *Chem. Eur. J.* **2018**, *24*, 487. (b) Laudadio, G.; Straathof, N. J. W.; Lanting, M. D.; Knoops, B.; Hessel, V.; Noël, T. *Green Chem.* **2017**, *19*, 4061.

(12) Kaye, A.; Neidle, S.; Reese, C. B. *Tetrahedron Lett.* **1988**, *29*, 2711.

(13) Meirinho, A. G.; Pereira, V. F.; Martins, G. M.; Saba, S.; Rafique, J.; Braga, A. L.; Mendes, S. R. *Eur. J. Org. Chem.* **2019**, 6465.

(14) CCDC-1980248 (**21**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/getstructures.

(15) Perin, G.; Santoni, P.; Barcellos, A. M.; Nobre, P. C.; Jacob, R. G.; Lenardão, E. J.; Santi, C. *Eur. J. Org. Chem.* **2018**, 1224.

(16) Yu, C.; Shi, H.; Yan, J. *ARKIVOC* **2015**, 266.

(17) Vieira, A. A.; Azeredo, J. B.; Godoi, M.; Santi, C.; Da Silva Júnior, E. N.; Braga, A. L. *J. Org. Chem.* **2015**, *80*, 2120.

(18) Bosman, C.; D'Annibale, A.; Resta, S.; Trogolo, C. *Tetrahedron Lett.* **1994**, *35*, 6525.

(19) Tiecco, M.; Testaferri, L.; Tingoli, M.; Chianelli, D.; Bartoli, D. *Tetrahedron* **1988**, *44*, 2261.

(20) Conner, E. S.; Crocker, K. E.; Fernando, R. G.; Fronczek, F. R.; Stanley, G. G.; Ragains, J. R. *Org. Lett.* **2013**, *15*, 5558.

(21) Kostić, M.; Verdía, P.; Fernández-Stefanuto, V.; Puchta, R.; Tojo, E. *J. Phys. Org. Chem.* **2019**, *32*, 1.

(22) Vásquez-Céspedes, S.; Ferry, A.; Candish, L.; Glorius, F. *Angew. Chem. Int. Ed.* **2015**, *54*, 5772.

(23) Denmark, S. E.; Collins, W. R. *Org. Lett.* **2007**, *9*, 3801.

(24) Nicolaou, K. C.; Seitz, S. P.; Sipio, W. J.; Blount, J. F. *J. Am. Chem. Soc.* **1979**, *101*, 3884.

(25) Zhang, Q. B.; Yuan, P. F.; Kai, L. L.; Liu, K.; Ban, Y. L.; Wang, X. Y.; Wu, L. Z.; Liu, Q. *Org. Lett.* **2019**, *21*, 885.

(26) Ni, Y.; Zuo, H.; Li, Y.; Wu, Y.; Zhong, F. *Org. Lett.* **2018**, *20*, 4350.

