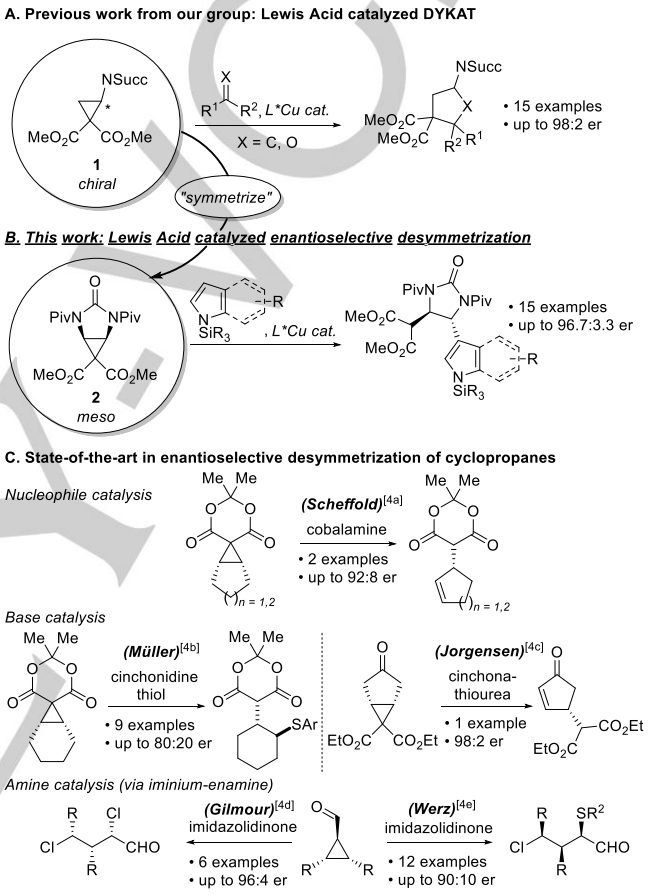
Lewis Acid Catalyzed Enantioselective Desymmetrization of Donor-Acceptor *Meso*-Diaminocyclopropanes

Daniele Perrotta, Ming-Ming Wang and Jérôme Waser*[a]

Abstract: The first example of Lewis acid catalyzed enantioselective ring-opening desymmetrization of donor-acceptor *meso*-diaminocyclopropanes is reported herein. A copper(II)-catalyzed Friedel-Crafts alkylation of indoles and a pyrrole with an unprecedented *meso*-diaminocyclopropane delivered enantioenriched diastereomerically pure urea products, which are structurally related to natural and synthetic bioactive compounds. The development of a new ligand through the investigation of an underexplored subclass of BOX ligands was essential for obtaining high enantiomeric ratios.

Donor-acceptor cyclopropanes are versatile building blocks in organic synthesis.[1] Enantiomerically enriched derivatives can be obtained by performing asymmetric transformations. Donor-acceptor cyclopropanes are often themselves chiral, leading to two possible scenarios: kinetic resolution and DYKAT (dynamic kinetic asymmetric transformation).[2] Our group applied a DYKAT for the first time to donor-acceptor aminocyclopropanes (Scheme 1, **A**).[2i] However, a major drawback of DYKAT processes lies in their complex reaction mechanism, requiring both efficient facial selection and control over racemization. In contrast, the desymmetrization of achiral *meso* substrates leads often to a more straightforward development of enantioselective transformations.[3] We therefore designed a novel *meso*-diaminocyclopropane **2** (Scheme 1, **B**). Up to now, only nucleophile, base and amine (via iminium-enamine) catalysts have been reported for the desymmetrization of donor-acceptor *meso*- cyclopropanes (Scheme 1, **C**).[4]

Herein, we present the first example of enantioselective desymmetrization of nitrogen-substituted cyclopropanes for the Friedel-Crafts alkylation of indoles using a copper catalyst bearing an unprecedented BOX (bisoxazoline) ligand (Scheme 1, **B**). The methodology delivered enantioenriched urea derivatives as products, which are highly important core structures in natural and bioactive compounds such as Tulongicin A (**3**),[5a] Biotin (**4**)[5b] or (-)-Agelastatin A (**5**)[5c-d](Figure 1).[5]



Scheme 1. DYKAT of aminocyclopropanes (**A**). This work: enantioselective desymmetrization of donor-acceptor *meso*-diaminocyclopropanes (**B**). State-of-the-art in enantioselective desymmetrization of cyclopropanes (**C**). Succ = succinyl, Piv = pivaloyl.

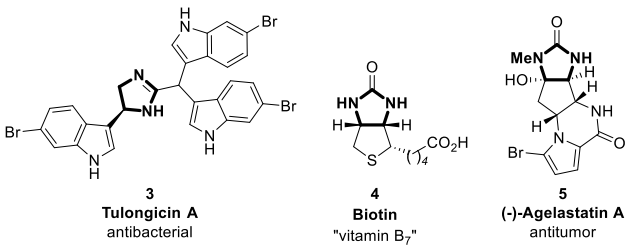


Figure 1. Occurrence of urea derivatives in synthetic and natural bioactive compounds.

The investigation of the proposed transformation required first an adequate donor-acceptor *meso*-diaminocyclopropane. Based

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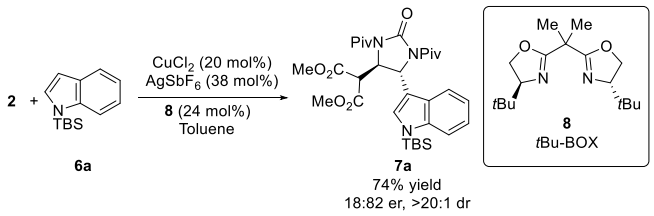
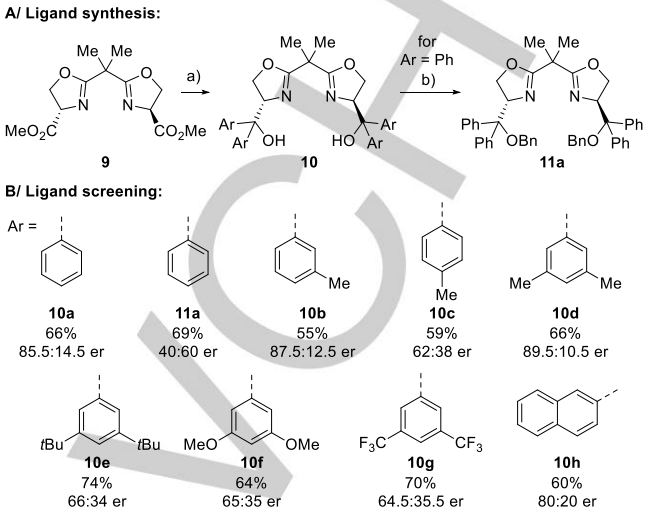
on our previous work,[2i] an imide urea functionality as the donor, and a bis-ester as the acceptor were chosen (cyclopropane **2**). The Friedel-Crafts alkylation with indoles was examined first.[2e,8] We focused our effort on copper-bisoxazoline (BOX) complexes as catalysts.[2i] Both the electron-withdrawing group on the urea and the *N*-substituent on the indole showed a strong effect on enantioselectivity (see *SI* for details). The best compromise between enantiomeric ratio (er) and solubility was achieved by using a pivaloyl group on urea **2** and *tert*-butyldimethysilyl (TBS) protected indole **6a** (Scheme 2). Copper(II) was identified as the best metal, hexafluoroantimonate(V) as the best counterion, and BOX ligands such as **8** as a promising class of ligands. In toluene as solvent, the desired product could be obtained in 74% yield and 18:82 er as a single diastereoisomer.



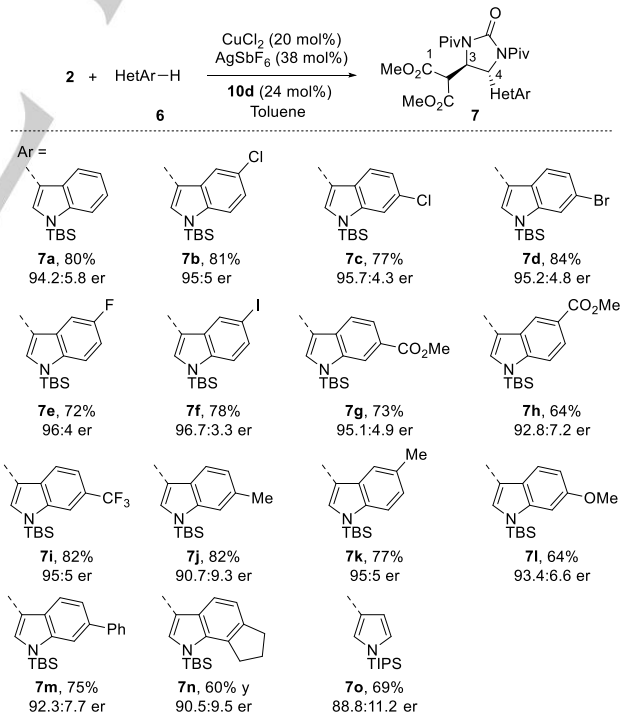
Scheme 2. Lead result for the enantioselective Friedel-Crafts alkylation of indole **6a** with cyclopropane **2**. Reaction conditions: 0.05 mmol **2**, 0.06 mmol **3a**, 0.05 M in Toluene, -20 °C, 48 h. TBS = *tert*-butyldimethylsilyl.

To improve further the er, we investigated ligand modification at the α position to the nitrogen atom. We were particularly interested in a subclass of BOX ligands bearing bulky diarylmethanol groups instead of the *tert*-butyls (Scheme 3, **A**).[9] The aryl groups can be installed by Grignard addition to the ester precursor **9**, which can be easily synthesized in two steps from serine ester.[10] Up to now, only the phenyl derivative (**10a**) has been reported.[9] It was used by Reiser and coworkers for the enantioselective 1,2- and 1,4-addition of organozincs to carbonyl compounds. The use of **10a** in the Friedel-Crafts reaction afforded a significant increase in er (Scheme 3, **B**). When the alcohol was protected as a benzyl group (**11a**), the opposite enantiomer was obtained in lower er. Subsequently, the substitution pattern on the aryl groups was investigated. Substitution in the *ortho* position could not be accessed synthetically, whereas a methyl group in *meta* gave a better er (ligand **10b**). Ligand **10c** with a methyl in *para* position led to a decrease of er. The er could be further improved to 89.5:10.5 by adding a second methyl group in *meta* position (ligand **10d**). Any further change in the *meta* positions, either by increased steric bulk (ligand **10e**) or by introducing electron-donating or withdrawing substituents (ligands **10f** and **10g**) only resulted in lower er. Replacing the benzene by a naphthalene ring was also not successful (ligand **10h**). Using 1.5 equivalents of cyclopropane **2** compared to indole **6a**, lowering the temperature to -50 °C, and diluting to 0.025 M finally afforded the desired product **7a** in 80% yield and 94.2:5.8 er on scope scale (Scheme 4).

We then investigated the scope of the reaction (Scheme 4). Indoles bearing both electron-withdrawing groups such as halides, esters, and trifluoromethyl (products **7b** to **7i**) and electron-donating groups such as methyl and methoxy (products **7j** to **7l**) delivered products in 64-84% yield and 90.7:9.3 to 96.7:3.3 er.[11] A phenyl substituent was also well-tolerated (product **7m**), as well as a fused cyclopentyl ring (product **7n**). The reaction could also be extended to pyrroles without reoptimization: TIPS-protected pyrrole **6o** gave product **7o** in good yield and promising er.[12]



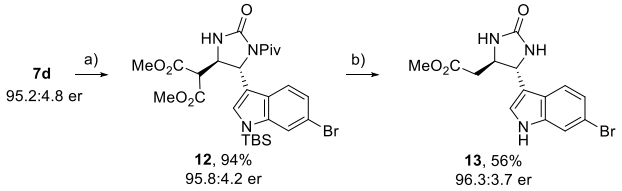
Scheme 3. Ligand synthesis (**A**). Reaction conditions: a) ArMgBr (6 equiv), 0.067 M in THF, -78 °C to rt, 24 h. b) NaH (2.4 equiv), BnBr (2.4 equiv), 0.5 M in DMF, 0 °C to rt, 16 h. Ligand screening for the alkylation of **6a** with **2** (**B**). Reaction conditions as in Scheme 2 but at rt for 16 h. >20:1 dr was observed in all cases. The yields and er's of **7a** are reported below each ligand. Bn = benzyl.



Scheme 4. Scope of the reaction. Reaction conditions: 0.15 mmol **2**, 0.1 mmol **6,** 0.025 M in Toluene, -50 °C for all the entries except **7g** and **7h** (-40 °C) and **7i** and **7o** (-30 °C). All compounds were obtained with dr > 20:1. TIPS = tri*iso*propylsilyl.

A single pivaloyl group of the product could be selectively deprotected using hydrazine to deliver **12** in excellent yield

without purification (Scheme 5). Basic hydrolysis led then to cleavage of the remaining pivaloyl group, the two methyl esters as well as the silyl protecting group, revealing the free urea. Subsequent decarboxylation/methylation of the dicarboxylic acid afforded **13** in 56% yield without erosion of enantiopurity.



Scheme 5. Product derivatizations. Reaction conditions: a) $N_2H_{4\ (aq)}$ 80% wt (1.5 equiv), rt. b) i. 0.5 M $LiOH_{(aq)}$ (8 equiv), rt; ii. MeOH, 80 °C; iii. $TMSCHN_2$ (10 equiv), 0 °C. 56% yield over three steps.

X-ray analysis of **7d** showed that the configuration was *3R*,*4R* (see Figure S1 in *SI*).[13] The *trans* relative configuration supports a SN_2-like mechanism for the ring-opening of the cyclopropane. Based on the obtained absolute configuration, a highly speculative stereochemical model can be proposed (Figure 2). We assume that the copper complex adopts a distorted square planar geometry due to hydrogen bonds between the hydroxy groups and the esters of the cyclopropane, forcing them in the more hindered quadrants and further activating them.[14,15] Indeed, rate acceleration was observed when employing ligands bearing a free hydroxy group.[16] In the resulting rigidified structure, we propose a relay of stereoinduction from the aryl groups to the pivaloyls, the latter orienting their smallest substituent (carbonyl) towards the bulky aryl groups. This results in an opposite orientation of the two carbonyl groups compared to the urea carbonyl, blocking selectively one of the electrophilic carbon of the cyclopropane with a *tert*-butyl group.

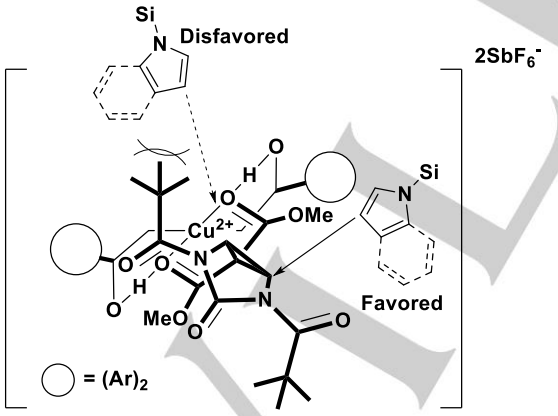


Figure 2. Speculative stereochemical model.

In summary, we have developed the first Lewis acid catalyzed enantioselective ring-opening desymmetrization of donor-acceptor cyclopropanes. The transformation displayed high enantioselectivity and complete diastereoselectivity, together with a broad scope of indoles as well as a pyrrole, delivering urea derivatives that are important scaffolds in natural and synthetic bioactive compounds. The use and further modification of an underexploited class of BOX ligands easily obtained in two steps from serine ester was essential to achieve high enantioselectivity. We believe that these ligands will be useful also in other new asymmetric transformations.

Acknowledgements

We thank the Swiss National Science Foundation (SNSF, grant nos. 200021_165788 and 200020_149494) and EPFL for financial support. Dr. Johannes Preindl of LCSO is acknowledged for helping in the synthesis of **9** and **10a**. Franck Le Vaillant of LCSO is acknowledged for helping in the characterization of ligands and products.

Keywords: enantioselective desymmetrization • Lewis acid • BOX ligands • donor-acceptor cyclopropanes • urea

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de Voogd, S. Tsukamoto, *Tetrahedron Lett.* **2011**, *52*, 5342; f) L. An, W. Song, X. Tang, N. J. de Voodg, Q. Wang, M. Chu, P. Li, G. Li, *RSC Adv.* **2017**, *7*, 14323; For further examples of alkaloids containing an indole substituted by an α,β-diamine, see: g) S. Kohmoto, Y. Kashman, O. J. McConnell, K. L. Rinehart Jr., A. Wright, F. Koehn, *J. Org. Chem.* **1988**, *53*, 3116; h) S. Tsujii, K. L. Rinehart, *J. Org. Chem.* **1988**, *53*, 5446; i) B. Bao, Q. Sun, X. Yao, J. Hong, C.-O. Lee, J.-C. Sim, K.-S. Im, J.-H. Jung, *J. Nat. Prod.* **2005**, *68*, 711; j) L. P. Patino C, C. Muniain, M. E. Knott, L. Puricelli, J. A. Palermo, *J. Nat. Prod.* **2014**, *77*, 1170; k) X. Ji, Z. Wang, J. Dong, Y. Liu, A. Lu, Q. Wang, *J. Agric. Food Chem.* **2016**, *64*, 9143.

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[11] Attemps to use C_2, C_3 and C_4 substituted indoles led to low enantiomeric excesses or low reactivity.

[12] Only very low conversion was observed using either anisole or dimethylaniline as nucleophiles.

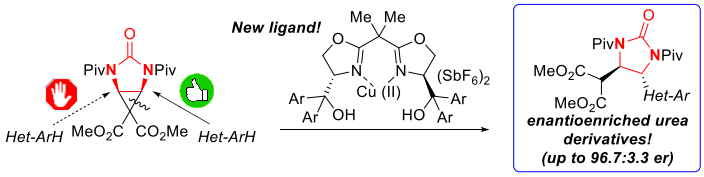
[13] Supplementary crystallographic data for this compound have been deposited at Cambridge Crystallographic Data Centre (CCDC number 1815214) and can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.

[14] G. Desimoni, G. Faita, K. A. Jørgensen, *Chem. Rev.* **2006**, *106*, 3561.

[15] K. Matsumoto, K. Jitsukawa, H. Masuda, *Tetrahedron Lett.* **2005**, *46*, 5687.

[16] When employing ligand **8**, no reactivity is observed at -30 °C, whereas with **10d**, the reaction works at -50 °C.

COMMUNICATION



Open carefully: The first Lewis acid catalyzed enantioselective ring opening desymmetrization of donor-acceptor *meso*-diaminocyclopropanes is reported herein. The transformation is catalyzed by a copper(II) complex bearing a novel BOX ligand. The ring opening of an unprecedented *meso*-diaminocyclopropane is achieved *via* Friedel-Crafts alkylation of indoles and a pyrrole, and delivers diastereomerically pure and highly enantioenriched urea derivatives.

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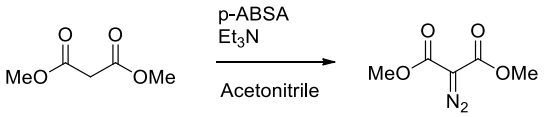
1. General methods

All reactions were carried out in oven- or flame- dried glassware under an atmosphere of nitrogen, unless stated otherwise. For quantitative flash chromatography, distilled technical grade solvents were used. THF, Et_2O, toluene, hexane and CH_2Cl_2 were dried by passage over activated alumina under nitrogen atmosphere (H_2O content < 7 ppm, Karl-Fischer titration). All chemicals were purchased and used as received unless stated otherwise. Chromatographic purification was performed as flash chromatography using Macherey-Nagel silica 40-63, 60 Å, using the solvents indicated as eluent with 0.1-0.5 bar pressure. TLC was performed on Merck silica gel 60 F254 TLC plastic or aluminium plates and visualized with UV light, permanganate CAN or p-anisaldehyde stains. Melting points were measured on a calibrated Büchi B-540 melting point apparatus using open glass capillaries. ^{1}H-NMR spectra were recorded at room temperature on a Brucker DPX-400 400 MHz spectrometer in $CDCl_3$, DMSO-d_6 or CD_3OD, all signals are reported in ppm with the internal chloroform signal at 7.26 ppm, the internal DMSO signal at 2.50 ppm and the internal methanol signal at 3.31 ppm as standard. The data is being reported as (s = singlet, d = doublet, t = triplet, q = quadruplet, p = quintet, m = multiplet or unresolved, br = broad signal, app = apparent, coupling constant(s) in Hz, integration, interpretation). ^{13}C-NMR spectra were recorded with 1H-decoupling on a Brucker DPX-400 100 MHz spectrometer in $CDCl_3$ or CD_3OD, all signals are reported in ppm with the internal chloroform signal at 77.0 ppm or CD_3OD signal at 49.0 ppm as standard. Infrared spectra were recorded on a JASCO FT-IR B4100 or a Bruker Alpha-P spectrophotometer with an ATR device and a ZnSe prism and are reported as cm-1 (w = weak, m = medium, s = strong). High resolution mass spectrometric measurements were performed by the mass spectrometry service of ISIC at the EPFL on a MICROMASS (ESI) Q-TOF Ultima API. HPLC measurements were done on a Agilent 1260 Infinity autosampler using a CHIRALPAK IA, IB, IC or IF column from DAICEL Chemical. Optical rotations were measured on a polarimeter using a 10 cm cell with a Na 589 nm filter. The specific solvents and concentrations (in g/100 mL) are indicated.

2. Preparation of the starting materials

2.1 Synthesis of the cyclopropanes

Dimethyl 2-diazomalonate (14)



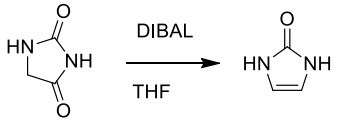
14

In a flame dried flask under N_2 atmosphere, 4-acetamidobenzenesulfonyl azide (6.82 g, 28.4 mmol, 1.5 equiv) was dissolved in acetonitrile (80 mL) and triethylamine (6.3 mL, 45 mmol, 2.4 equiv) and dimethyl malonate (2.2 mL, 19 mmol, 1 equiv) were added. The reaction mixture was stirred at room temperature for 24 hours. The solvent was evaporated and the crude product was filtered on cotton with acetonitrile (30 mL). The crude mixture was concentrated under reduced pressure and filtered on cotton one more time with DCM (30 mL) and finally purified by column chromatography (deactivated SiO_2, eluent pentane:ethyl acetate 9:1 + 1% of triethylamine) to give dimethyl 2-diazomalonate (**14**) (2.67 g, 16.9 mmol, 94% yield) as a slightly yellow oil (solid at 4 °C).

^{1}H NMR (400 MHz, $CDCl_3$) δ 3.83 (s, 6H, C*H*$_3$).

Data match the literature report.[1]

1H-imidazol-2(3H)-one (15)



15

Following a reported procedure,[2] in a flame dried flask under N_2 atmosphere, hydantoin (10.0 g, 100 mmol, 1 equiv) was suspended in 100 mL of dry tetrahydrofuran. The suspension was cooled to 0 °C with an ice/water bath. A 1.2 molar solution of DIBAL in toluene (221 mL, 265 mmol, 2.65 equiv) was added dropwise over 30 minutes, and the solution was stirred for 2 hours at 0 °C. 700 mL of a solution of 9:1 methanol/water was added carefully, and the reaction was heated at 100 °C for 18 hours. After cooling to room temperature, the reaction was filtered on celite, eluting with 500 mL of methanol, and evaporated to dryness to give 1H-imidazol-2(3H)-one (**15**) (7.00 g, 83.0 mmol, 83% yield) as an off-white solid.

^{1}H NMR (400 MHz, DMSO-d_6) δ 9.75 (s, 2H, N*H*), 6.24 (s, 2H, C*H*).
Data match the literature report.[2]

1,1'-(2-Oxo-1H-imidazole-1,3(2H)-diyl)diethanone (16)

[1] Racine, S.; Hegedus, B.; Scopelliti, R.; Waser, J., *Chem. Eur. J.* **2016**, *22*, 11997-12001.
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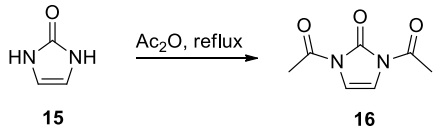
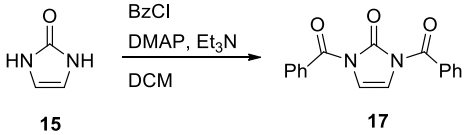


15 16

Following a reported procedure,[2] 1H-imidazol-2(3H)-one (**15**) (300 mg, 3.57 mmol, 1 equiv) was stirred in acetic anhydride (1.94 mL, 20.5 mmol, 5.8 equiv) at reflux for 90 minutes. The reaction was cooled down to room temperature and concentrated to dryness. The residue was washed with ethyl acetate to afford 1,1'-(2-oxo-1H-imidazole-1,3(2H)-diyl)diethanone (**16**) (360 mg, 2.14 mmol, 60% yield) as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.08 (s, 2H, C*H*), 2.65 (s, 6H, C*H*$_3$).
Data match the literature report.[3]

(2-Oxo-1H-imidazole-1,3(2H)-diyl)bis(phenylmethanone) (17)



15 17

Following a reported procedure,[3] in a flame dried flask under N_2 atmosphere, 1H-imidazol-2(3H)-one (**15**) (1.18 g, 6.16 mmol, 1 equiv) was added, followed by 42.4 mL of dry dichloromethane, and the suspension was cooled to 0 °C. Then, DMAP (0.171 g, 1.40 mmol, 0.1 equiv) was added, followed by a solution of benzoyl chloride (3.25 mL, 28.0 mmol, 2 equiv) in dry dichloromethane (5.6 mL) dropwise. Finally, triethylamine (3.90 mL, 2.83 mmol, 2 equiv) was added dropwise. The reaction mixture was stirred at 0 °C, letting ice melt during 24 hours. 50 mL of dichloromethane were added, and the organic layer was washed with water (60 mL). The aqueous layer was separated and extracted with dichloromethane (40 mL). The combined organic layers were washed with brine (50 mL), dried over Na_2SO_4, filtered and evaporated. The residue was purified by column chromatography (SiO_2, eluent pentane:ethyl acetate 85:15 to 0:100), to afford (2-oxo-1H-imidazole-1,3(2H)-diyl)bis(phenylmethanone) (**17**) (1.80 g, 6.16 mmol, 44% yield) as a white solid.

R_f: (SiO_2, pentane:ethyl acetate 9:1) 0.21;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 - 7.71 (m, 4H, Ar*H*), 7.58 - 7.53 (m, 2H, Ar*H*), 7.43 (t, *J* = 7.7 Hz, 4H, Ar*H*), 7.11 (s, 2H, C*H*).
Data match the literature report.[3]

1,1'-(2-Oxo-1H-imidazole-1,3(2H)-diyl)bis(2,2-dimethylpropan-1-one) (18)

15 18

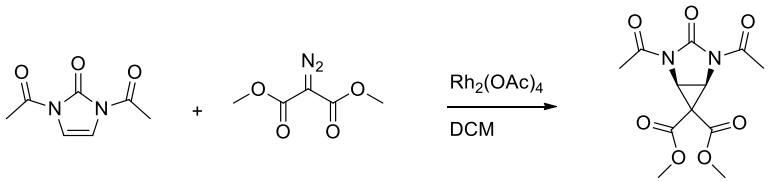
Following a modified procedure,[3] in a flame dried flask under N_2 atmosphere, 1H-imidazol-2(3H)-one (**15**) (3.00 g, 35.7 mmol, 1 equiv) was added, followed by 100 mL of dry dichloromethane, and the suspension was cooled to 0 °C. Then, DMAP (0.436 g, 3.57 mmol, 0.1 equiv) was added, followed by a solution of pivaloyl chloride (9.66 mL, 78.0 mmol, 2.2 equiv) in dry dichloromethane (35 mL) dropwise. Finally, triethylamine (10.4 mL, 74.9 mmol, 2.1 equiv) was added dropwise. The reaction

[3] Han, S.; Zard, S. Z., *Org. Lett.* **2014**, *16*, 5386-5389.

mixture was stirred at 0 °C, letting ice melt during 24 hours. 50 mL of dichloromethane were added, and the organic layer was washed with water (60 mL). The aqueous layer was separated and extracted with dichloromethane (40 mL). The combined organic layers were washed with brine (50 mL), dried over Na_2SO_4, filtered and evaporated. The residue was purified by column chromatography (SiO_2, eluent pentane:diethylether 9:1), to afford 1,1'-(2-Oxo-1H-imidazole-1,3(2H)-diyl)bis(2,2-dimethylpropan-1-one) (**18**) (6.93 g, 27.5 mmol, 77% yield) as a white solid.

R_f: (SiO_2, pentane:diethylether 94:6) 0.2;
Mp: 76-78 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.06 (s, 2H, C*H*), 1.44 (s, 18H, C(C*H*$_3$)$_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 176.5, 149.9, 111.9, 41.6, 25.8;
IR (film) $\tilde{\nu}$ 2974 (w), 1705 (s), 1483 (w), 1299 (w), 1194 (w), 911 (m), 738 (s);
HRMS (ESI) calcd. for $C_{13}H_{20}N_2NaO_3^+$ $[M+Na]^+$ 275.1366; found 275.1120.

Dimethyl 2,4-diacetyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (19)

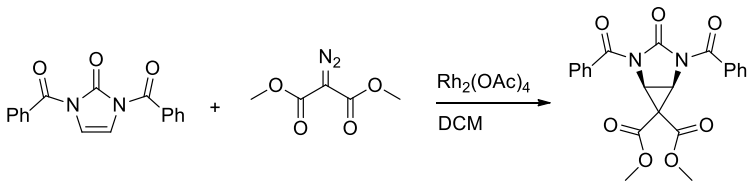


16 14 19

Following a modified procedure,[1] in a glovebox, rhodium(II) acetate dimer (32.0 mg, 71.0 µmol, 0.05 equiv) was added in a flame dried flask. The flask was closed with a septum, put under N_2 atmosphere, and cooled down to 0 °C. A solution of 1,1'-(2-oxo-1H-imidazole-1,3(2H)-diyl)diethanone (**16**) (240 mg, 1.43 mmol, 1 equiv) in dry dichloromethane (3.5 mL) was added in the flask. After 5 minutes, a solution of dimethyl 2-diazomalonate (**14**) (271 mg, 1.71 mmol, 1.2 equiv) in dry dichloromethane (3.5 mL) was added dropwise. The reaction mixture was stirred at 0 °C, letting ice melt during 15 hours. The solvent was then evaporated at the rotavap. The residue was purified by column chromatography (SiO_2, eluent pentane:ethyl acetate 65:35), to afford dimethyl 2,4-diacetyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (**19**) (210 mg, 0.704 mmol, 49% yield) as a white solid, which was stored at -20 °C in the freezer under N_2 atmosphere.

R_f: (SiO_2, pentane: ethyl acetate 7:3) 0.17;
Mp: 119-123 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.55 (s, 2H, NC*H*), 3.78 (s, 3H, CO_2C*H*$_3$), 3.71 (s, 3H, CO_2C*H*$_3$), 2.52 (s, 6H, C*H*$_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 170.0, 165.8, 163.2, 150.8, 53.4, 53.2, 38.4, 33.7, 23.7;
IR (film) $\tilde{\nu}$ 1769 (m), 1721 (s), 1440 (w), 1375 (w), 1339 (s), 1273 (m), 1231 (s), 1166 (w), 1088 (s), 981 (w), 915 (w);
HRMS (ESI) calcd. for $C_{12}H_{15}N_2O_7^+$ $[M+H]^+$ 299.0874; found 299.0882.

Dimethyl 2,4-dibenzoyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (20)

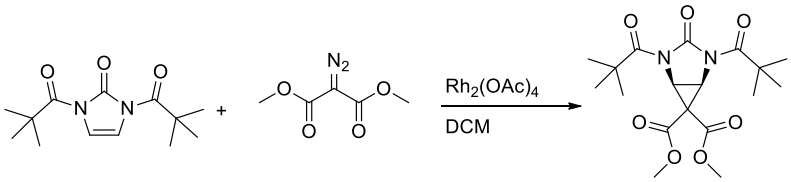


17 14 20

Following a modified procedure,[1] in a glovebox, rhodium(II) acetate dimer (113 mg, 257 µmol, 0.05 equiv) was added in a flame dried flask. The flask was closed with a septum, put under N_2 atmosphere, and cooled down to 0 °C. A solution of (2-oxo-1H-imidazole-1,3(2H)-diyl)bis(phenylmethanone) (**17**) (1.50 g, 5.13 mmol, 1 equiv) in dry dichloromethane (15 mL) was added in the flask. After 5 minutes, a solution of dimethyl 2-diazomalonate (**14**) (974 mg, 6.16 mmol, 1.2 equiv) in dry dichloromethane (15 mL) was added dropwise. The reaction mixture was stirred at 0 °C, letting ice melt during 14 hours. The solvent was then evaporated at the rotavap. The residue was purified by column chromatography (SiO_2, eluent toluene:ethyl acetate 10:1), to afford dimethyl 2,4-dibenzoyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (**20**) (1.40 g, 3.31 mmol, 65% yield) as a white solid, stored at -20 °C in the freezer under N_2 atmosphere.

R_f: (SiO_2, toluene:ethyl acetate 8:2) 0.62;
Mp: 119-123 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 – 7.58 (m, 4H, Ar*H*), 7.52 – 7.47 (m, 2H, Ar*H*), 7.40 – 7.35 (m, 4H, Ar*H*), 4.76 (s, 2H, NC*H*), 3.85 (s, 3H, CO_2CH_3), 3.79 (s, 3H, CO_2CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 169.1, 165.9, 163.5, 149.3, 132.5, 132.4, 129.0, 127.9, 53.4, 53.1, 40.0, 34.3;
IR (film) $\tilde{\nu}$ 2952 (w), 1787 (m), 1733 (s), 1691 (s), 1440 (w), 1333 (s), 1279 (s), 1225 (s), 1160 (s), 1082 (w), 915 (w), 825 (w);
HRMS (ESI) calcd. for $C_{22}H_{18}N_2NaO_7^+$ $[M+Na]^+$ 445.1006; found 445.1008.

Dimethyl 3-oxo-2,4-dipivaloyl-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (2)



18 14 2

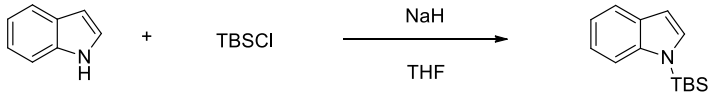
Following a modified procedure,[1] in a glovebox, rhodium(II) acetate dimer (438 mg, 991 µmol, 0.05 equiv) was added in a flame dried flask. The flask was closed with a septum, put under N_2 atmosphere, and cooled down to 0 °C. A solution of 1,1'-(2-oxo-1H-imidazole-1,3(2H)-diyl)bis(2,2-dimethylpropan-1-one) (**18**) (5.00 g, 19.8 mmol, 1 equiv) in dry dichloromethane (60 mL) was added in the flask. After 5 minutes, a solution of dimethyl 2-diazomalonate (**14**) (3.45 g, 21.8 mmol, 1.1 equiv) in dry dichloromethane (40 mL) was added dropwise. The reaction mixture was stirred at 0 °C, letting ice melt during 15 hours. The solvent was then evaporated at the rotavap. The residue was purified by column chromatography (SiO_2, eluent pentane:ethyl acetate 9:1), to afford dimethyl 3-oxo-2,4-dipivaloyl-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (**2**) (3.40 g, 8.89 mmol, 45% yield) as a white solid, stored at -20 °C in the freezer under N_2 atmosphere.

R_f: (SiO_2, pentane:ethyl acetate 7:3) 0.67;
Mp: 100-102 °C;

^{1}H NMR (400 MHz, $CDCl_3$) δ 4.50 (s, 2H, NC*H*), 3.76 (s, 3H, CO_2CH_3), 3.67 (s, 3H, CO_2CH_3), 1.37 (s, 18H, $C(CH_3)_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 178.4, 166.4, 163.2, 148.4, 53.1, 52.8, 41.4, 40.8, 33.9, 26.1;
IR (film) $\tilde{\nu}$1742 (s), 1690 (s), 1627 (w), 1371 (s), 1287 (s), 1230 (s), 1204 (m), 1167 (w), 1125 (w), 900 (w), 869 (w);
HRMS (ESI) calcd. for $C_{18}H_{27}N_2O_7^+$ $[M+H]^+$ 383.1813; found 383.1825.

2.2 Synthesis of the protected indoles

1-(*Tert*-butyldimethylsilyl)-1H-indole (**6a**)

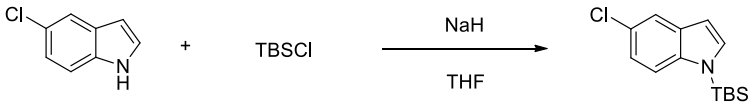


21 **6a**

Following a modified procedure[4], a solution of 1H-indole (**21**) (0.586 g, 5.00 mmol, 1 equiv) in THF (4 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.600 g, 15.0 mmol, 3 equiv) in THF (5 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.904 g, 6.00 mmol, 1.2 equiv) was added as a solution in THF (3 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 40:1) afforded 1-(Tert-butyldimethylsilyl)-1H-indole (**6a**) (1.08 g, 4.67 mmol, 93% yield) as white solid.

R_f: (SiO_2, pentane) 0.42;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 7.9 Hz, 1H, Ar*H*), 7.52 (d, *J* = 8.2 Hz, 1H, Ar*H*), 7.19 (d, *J* = 3.2 Hz, 1H, Ar*H*), 7.18 – 7.08 (m, 2H, Ar*H*), 6.62 (d, *J* = 3.1 Hz, 1H, Ar*H*), 0.94 (s, 9H, $SiC(CH_3)_3$), 0.61 (s, 6H, 2 x $SiCH_3$).
Data match the literature report.[4]

1-(*Tert*-butyldimethylsilyl)-5-chloro-1H-indole (**6b**)



22 **6b**

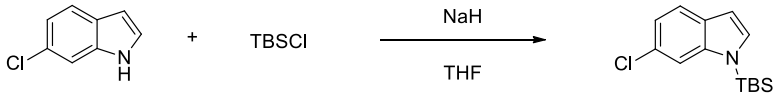
Following a modified procedure,[4] a solution of the 5-chloro-1H-indole (**22**) (0.240 g, 1.58 mmol, 1 equiv) in THF (2 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.190 g, 4.75 mmol, 3 equiv) in THF (3 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.380 g, 2.53 mmol, 1.6 equiv) was added as a solution in THF (2 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column

[4] Caramenti, P.; Nicolai, S.; Waser, J., *Chem. Eur. J.* **2017**, *23*, 14702-14706.

chromatography (SiO_2, eluent pentane) afforded 1-(Tert-butyldimethylsilyl)-5-chloro-1H-indole (**6b**) (0.375 g, 1.41 mmol, 89% yield) as pale yellow oil.

R_f: (SiO_2, pentane) 0.38;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (dd, *J* = 2.2, 0.5 Hz, 1H, Ar*H*), 7.40 (d, *J* = 8.8 Hz, 1H, Ar*H*), 7.19 (d, *J* = 3.2 Hz, 1H, Ar*H*), 7.09 (dd, *J* = 8.8, 2.2 Hz, 1H, Ar*H*), 6.55 (dd, *J* = 3.2, 0.9 Hz, 1H, Ar*H*), 0.91 (s, 9H, SiC(CH_3)$_3$), 0.60 (s, 6H, 2 x SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 139.3, 132.5, 132.4, 125.5, 121.6, 120.0, 114.7, 104.4, 26.2, 19.5, -4.0;
IR (film) $\tilde{\nu}$ 2959 (m), 2928 (m), 2860 (m), 1510 (w), 1448 (s), 1288 (m), 1257 (m), 1201 (w), 1152 (s), 986 (m), 838 (s), 794 (s);
HRMS (ESI) calcd. for $C_{14}H_{21}ClNSi^+$ $[M+H]^+$ 266.1126; found 266.1126.

1-(*Tert*-butyldimethylsilyl)-6-chloro-1H-indole (**6c**)

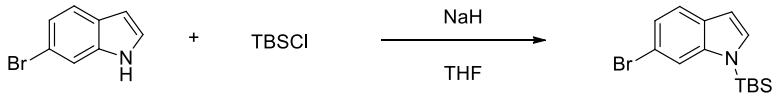


23 **6c**

Following a modified procedure,[4] a solution of the 6-chloro-1H-indole (**23**) (0.30 g, 2.0 mmol, 1.0 equiv) in THF (2 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.24 g, 6.0 mmol, 3.0 equiv) in THF (3 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0°C, tert-butylchlorodimethylsilane (0.45 g, 3.0 mmol, 1.5 equiv) was added as a solution in THF (1.5 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane: ethyl acetate 20:1) afforded 1-(Tert-butyldimethylsilyl)-6-chloro-1H-indole (**6c**) (0.46 g, 1.7 mmol, 87% yield) as yellow oil.

R_f: (SiO_2, pentane) 0.41;
Mp: 80.3-80.8 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 8.4 Hz, 1H, Ar*H*), 7.47 (s, 1H, Ar*H*), 7.16 (d, *J* = 3.2 Hz, 1H, Ar*H*), 7.08 (d, *J* = 8.3 Hz, 1H, Ar*H*), 6.58 (d, *J* = 3.1 Hz, 1H, Ar*H*), 0.93 (s, 9H, SiC(CH_3)$_3$), 0.60 (s, 6H, 2 x SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 141.4, 131.7, 129.9, 127.2, 121.3, 120.5, 113.7, 104.8, 26.2, 19.4, -4.0;
IR (film) $\tilde{\nu}$ 2959 (m), 2934 (m), 2891 (w), 2860 (m), 1602 (w), 1510 (w), 1460 (m), 1436 (m), 1318 (w), 1275 (m), 1257 (m), 1152 (s), 1084 (w), 986 (m), 905 (m), 844 (s), 813 (s), 727 (m);
HRMS (ESI) calcd. for $C_{14}H_{21}ClNSi^+$ $[M+H]^+$ 266.1126; found 266.1123.

6-bromo-1-(*tert*-butyldimethylsilyl)-1H-indole (**6d**)



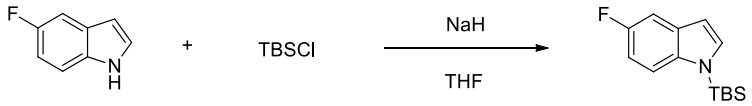
24 **6d**

Following a modified procedure,[4] a solution of the 6-bromo-1H-indole (**24**) (0.39 g, 2.0 mmol, 1.0 equiv) in THF (2 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.24 g, 6.0 mmol, 3.0 equiv) in THF (3 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling

to 0 °C, tert-butylchlorodimethylsilane (0.45 g, 3.0 mmol, 1.5 equiv) was added as a solution in THF (1.5 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane) afforded 6-bromo-1-(tert-butyldimethylsilyl)-1H-indole (**6d**) (0.56 g, 1.8 mmol, 90% yield) as white solid.

R_f: (SiO_2, pentane) 0.40;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (s, 1H, Ar*H*), 7.48 (d, *J* = 8.3 Hz, 1H, Ar*H*), 7.21 (dd, *J* = 8.4, 1.7 Hz, 1H, Ar*H*), 7.15 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.58 (d, *J* = 3.2 Hz, 1H, Ar*H*), 0.92 (s, 9H, SiC(CH_3)$_3$), 0.60 (s, 6H, 2 x SiCH_3).
Data match the literature report.[5]

1-(*Tert*-butyldimethylsilyl)-5-fluoro-1H-indole (**6e**)

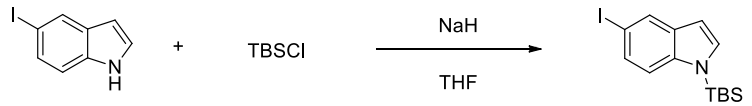


25 **6e**

Following a modified procedure,[4] a solution of 5-fluoro-1H-indole (**25**) (0.44 g, 3.3 mmol, 1.0 equiv) in THF (3 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.39 g, 9.8 mmol, 3.0 equiv) in THF (4 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.78 g, 5.2 mmol, 1.6 equiv) was added as a solution in THF (2 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane) afforded 1-(Tert-butyldimethylsilyl)-5-fluoro-1H-indole (**6e**) (0.75 g, 3.0 mmol, 92% yield) as white solid.

R_f: (SiO_2, pentane) 0.38;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (dd, *J* = 9.0, 4.4 Hz, 1H, Ar*H*), 7.28 – 7.23 (m, 1H, Ar*H*), 7.21 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.89 (td, *J* = 9.1, 2.7 Hz, 1H, Ar*H*), 6.57 (d, *J* = 3.1 Hz, 1H, Ar*H*), 0.92 (s, 9H, SiC(CH_3)$_3$), 0.60 (s, 6H, 2 x SiCH_3).
Data match the literature report.[6]

1-(*Tert*-butyldimethylsilyl)-5-iodo-1H-indole (**6f**)



26 **6f**

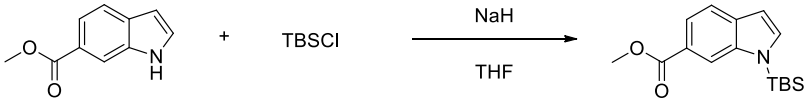
Following a modified procedure,[4] a solution of the 5-iodo-1H-indole (**26**) (0.60 g, 2.5 mmol, 1.0 equiv) in THF (3 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.30 g, 7.4 mmol, 3.0 equiv) in THF (4 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to

[5] Kawasaki, I; Yamashita, M; Ohta, S., *Chem. Pharm. Bull*. **1996**, *44*, 1831 - 1839.
[6] F.HOFFMANN-LA ROCHE AG, WO2008/152390, 2008, A1. *Thiazoliopyrimidines and their use as inhibitors of phosphatidylinositol-3 Kinase.*

room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.56 g, 3.7 mmol, 1.5 equiv) was added as a solution in THF (2 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane) afforded 1-(Tert-butyldimethylsilyl)-5-iodo-1H-indole (**6f**) (0.78 g, 2.2 mmol, 88% yield) as white solid.

R_f: (SiO_2, pentane) 0.32;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 1.8 Hz, 1H, Ar*H*), 7.39 (dd, *J* = 8.7, 1.8 Hz, 1H, Ar*H*), 7.29 (d, *J* = 8.7 Hz , 1H, Ar*H*), 7.13 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.53 (dd, *J* = 3.2, 0.9 Hz, 1H, Ar*H*), 0.91 (s, 9H, SiC(CH_3)$_3$), 0.59 (s, 6H, 2 x SiCH_3).
Data match the literature report.[7]

Methyl 1-(*tert*-butyldimethylsilyl)-1H-indole-6-carboxylate (**6g**)

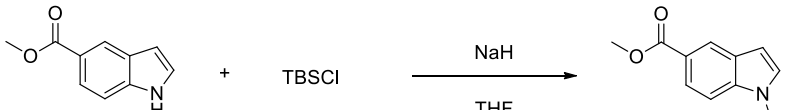


27 **6g**

Following a modified procedure,[4] a solution of methyl 1H-indole-6-carboxylate (**27**) (0.53 g, 3.0 mmol, 1.0 equiv) in THF (3 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.36 g, 9.0 mmol, 3.0 equiv) in THF (4 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.72 g, 4.8 mmol, 1.6 equiv) was added as a solution in THF (2 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 12:1) afforded methyl 1-(tert-butyldimethylsilyl)-1H-indole-6-carboxylate (**6g**) (0.77 g, 2.7 mmol, 89% yield) as pale yellow oil.

R_f: (SiO_2, pentane:ethyl acetate 20:1) 0.58;
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 (s, 1H, Ar*H*), 7.80 (dd, *J* = 8.3, 1.4 Hz, 1H, Ar*H*), 7.63 (d, *J* = 8.2 Hz, 1H, Ar*H*), 7.34 (d, *J* = 3.1 Hz, 1H, Ar*H*), 6.65 (dd, *J* = 3.1, 0.9 Hz, 1H, Ar*H*), 3.93 (s, 3H, CO_2CH_3), 0.93 (s, 9H, SiC(CH_3)$_3$), 0.65 (s, 6H, 2 x SiCH_3).
Data match the literature report.[8]

Methyl 1-(*tert*-butyldimethylsilyl)-1H-indole-5-carboxylate (**6h**)



28 **6h**

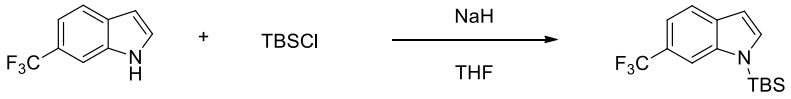
Following a modified procedure,[4] a solution of methyl 1H-indole-5-carboxylate (**28**) (0.35 g, 2.0 mmol, 1.0 equiv) in THF (3 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil,

[7] Song, Y.-L.; Morin, C., *Synlett*, **2001**, *2*, 266–268.
[8] Islam, S., Larrosa, I., *Chem. Eur. J.* **2013**, *19*, 15093-15096.

0.24 g, 6.0 mmol, 3.0 equiv) in THF (4 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.45 g, 3.0 mmol, 1.5 equiv) was added as a solution in THF (2 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 40:1) afforded methyl 1-(tert-butyldimethylsilyl)-1H-indole-5-carboxylate (**6h**) (0.50 g, 1.7 mmol, 86% yield) as white solid.

R_f: (SiO_2, pentane:ethyl acetate 40:1) 0.20;
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (d, *J* = 1.2 Hz, 1H, Ar*H*), 7.85 (dd, *J* = 8.7, 1.8 Hz, 1H, Ar*H*), 7.50 (d, *J* = 8.7 Hz, 1H, Ar*H*), 7.23 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.70 (dd, *J* = 3.3, 0.9 Hz, 1H, Ar*H*), 3.92 (s, 3H, CO_2CH_3), 0.92 (s, 9H, $SiC(CH_3)_3$), 0.62 (s, 6H, 2 x $SiCH_3$).
Data match the literature report.[9]

1-(*Tert*-butyldimethylsilyl)-6-(trifluoromethyl)-1H-indole (**6i**)

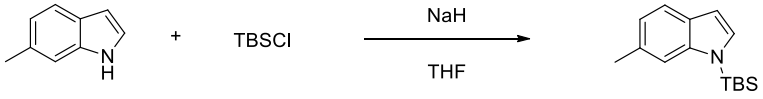


29 **6i**

Following a modified procedure,[4] a solution of the 6-(trifluoromethyl)-1H-indole (**29**) (0.37 g, 2.0 mmol, 1.0 equiv) in THF (2 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.24 g, 6.0 mmol, 3.0 equiv) in THF (3 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.45 g, 3.0 mmol, 1.5 equiv) was added as a solution in THF (1.5 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 20:1) afforded 1-(Tert-butyldimethylsilyl)-6-(trifluoromethyl)-1H-indole (**6i**) (0.54 g, 1.8 mmol, 90% yield) as colorless oil.

R_f: (SiO_2, pentane) 0.56;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (s, 1H, Ar*H*), 7.70 (d, *J* = 8.3 Hz, 1H, Ar*H*), 7.34 (dd, *J* = 7.9, 0.9 Hz, 1H, Ar*H*), 7.32 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.67 (dd, *J* = 3.1, 0.9 Hz, 1H, Ar*H*), 0.93 (s, 9H, $SiC(CH_3)_3$), 0.63 (s, 6H, 2 x $SiCH_3$).
Data match the literature report.[10]

1-(*tert*-butyldimethylsilyl)-6-methyl-1H-indole (**6j**)



30 **6j**

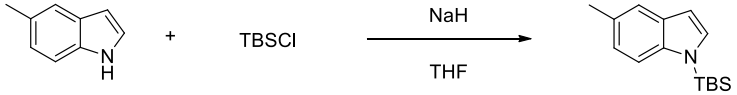
Following a modified procedure,[4] a solution of 6-methyl-1H-indole (**30**) (0.26 g, 2.0 mmol, 1.0 equiv) in THF (2 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.24 g, 6.0

[9] Wales, S. M.; Walker, M. M.; Johnson, J. S., *Org. Lett.* **2013**, *15*, 2558 – 2561.
[10] Belley, M., Scheigetz, J., Dubé, P., Dolman, S., *Synlett* **2001**, *2*, 222 - 225.

mmol, 3.0 equiv) in THF (3 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.45 g, 3.0 mmol, 1.5 equiv) was added as a solution in THF (1.5 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 40:1) afforded 1-(tert-butyldimethylsilyl)-6-methyl-1H-indole (**6j**) (0.45 g, 1.8 mmol, 92% yield) as yellow oil.

R_f: (SiO_2, pentane) 0.37;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 8.0 Hz, 1H, Ar*H*), 7.29 (s, 1H, Ar*H*), 7.10 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.94 (dd, *J* = 7.7, 1.2 Hz, 1H, Ar*H*), 6.55 (dd, *J* = 3.2, 0.9 Hz, 1H, Ar*H*), 2.46 (s, 3H, C*H*$_3$), 0.93 (s, 9H, SiC(C*H*$_3$)$_3$), 0.59 (s, 6H, 2 x SiC*H*$_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 141.5, 130.9, 130.4, 129.1, 121.5, 120.1, 113.9, 104.5, 26.4, 22.1, 19.5, -3.9;
IR (film) $\tilde{\nu}$ 2956 (m), 2931 (m), 2888 (w), 2857 (m), 1514 (w), 1465 (m), 1286 (m), 1256 (m), 1175 (w), 1144 (s), 1009 (w), 837 (s), 800 (s), 720 (m);
HRMS (ESI) calcd. for $C_{15}H_{24}NSi^+$ $[M+H]^+$ 246.1673; found 246.1674.

1-(*Tert*-butyldimethylsilyl)-5-methyl-1H-indole (**6k**)



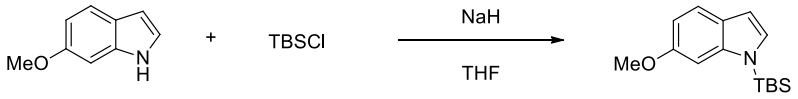
31 **6k**

Following a modified procedure,[4] a solution of the 5-methyl-1H-indole (**31**) (0.20 g, 1.5 mmol, 1.0 equiv) in THF (2 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.18 g, 4.5 mmol, 3.0 equiv) in THF (3 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.339 g, 2.25 mmol, 1.5 equiv) was added as a solution in THF (1.5 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate = 40:1) afforded 1-(Tert-butyldimethylsilyl)-5-methyl-1H-indole (**6k**) (0.33 g, 1.3 mmol, 90% yield) as colorless oil.

R_f: (SiO_2, pentane) 0.30;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.36 (m, 2H, Ar*H*), 7.14 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.98 (dd, *J* = 8.5, 1.8 Hz, 1H, Ar*H*), 6.53 (dd, *J* = 3.2, 0.9 Hz, 1H, Ar*H*), 2.44 (s, 3H, C*H*$_3$), 0.92 (s, 9H, SiC(C*H*$_3$)$_3$), 0.59 (s, 6H, 2 x SiC*H*$_3$).
Data match the literature report.[11]

1-(*tert*-butyldimethylsilyl)-6-methoxy-1H-indole (**6l**)

[11] Terada, M.; Yokoyama, S.; Sorimachi, K.; Uraguchi, D., *Adv. Synth. Catal.* **2007**, *349*, 1863–1867.

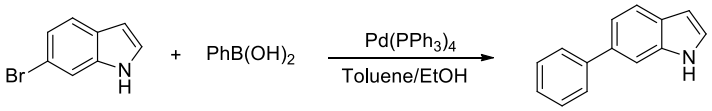


32 **6l**

Following a modified procedure,[4] a solution of 6-methoxy-1H-indole (**32**) (0.44 g, 3.0 mmol, 1.0 equiv) in THF (3 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.36 g, 9.0 mmol, 3.0 equiv) in THF (4 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.68 g, 4.5 mmol, 1.5 equiv) was added as a solution in THF (2 mL). The mixture was allowed to warm to room temperature and stirred for 6 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 10:1) afforded 1-(tert-butyldimethylsilyl)-6-methoxy-1H-indole (**6l**) (0.62 g, 2.4 mmol, 79% yield) as yellow oil.

R_f: (SiO_2, pentane:ethyl acetate 20:1) 0.56;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.6 Hz, 1H, Ar*H*), 7.07 (d, *J* = 3.2 Hz, 1H, Ar*H*), 7.03 (d, J = 2.2 Hz, 1H, Ar*H*), 6.80 (dd, *J* = 8.6, 2.2 Hz, 1H, Ar*H*), 6.53 (d, *J* = 3.1 Hz, 1H, Ar*H*), 3.84 (s, 3H, OC*H*$_3$), 0.94 (s, 9H, SiC(C*H*$_3$)$_3$), 0.59 (s, 6H, 2 x SiC*H*$_3$).
Data match the literature report.[12]

6-Phenyl-1H-indole (33)



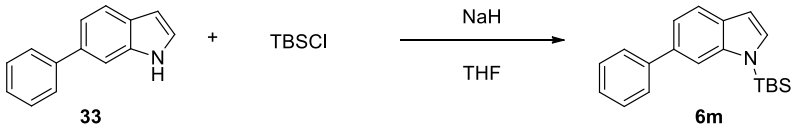
24 **33**

Following a reported procedure,[13] a solution of 6-bromoindole (**24**) (0.47 g, 2.1 mmol, 1 equiv) in anhydrous toluene (5 mL) under an N_2 atmosphere was treated with $Pd(PPh_3)_4$ (0.1 equiv). After stirring the mixture for 30 minutes, phenylboronic acid (0.38 g, 3.1 mmol, 1.5 equiv) in anhydrous ethanol (2.5 mL) were added, followed by saturated $NaHCO_3$ (1.2 mL). The bi-phasic mixture was heated to reflux for 24 hours. After cooling to room temperature, the mixture was added to brine and extracted with ethyl acetate 2 times. The organic layer was dried over $MgSO_4$, filtered and concentrated in vacuo. The residue was purified by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 7:1) to give 6-Phenyl-1H-indole (**33**) (0.11 g, 0.57 mmol, 27% yield) as yellow solid.

R_f: (SiO_2, pentane:ethyl acetate 6:1) 0.48;
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 (s, 1H, N*H*), 7.74 – 7.59 (m, 4H, Ar*H*), 7.48 – 7.37 (m, 3H, Ar*H*), 7.36 – 7.23 (m, 2H, Ar*H*), 6.59 (s, 1H, Ar*H*).
Data match the literature report.[14]

1-(*Tert*-butyldimethylsilyl)-6-phenyl-1H-indole (**6m**)

[12] Seffar, F.; Llor, N.; Bosch, J.; Amat, M., *Synthesis* **2001**, *2*, 267-275.
[13] Van Zandt, M. C.; Jones, M. L.; Gunn, D. E.; Geraci, L. S.; Jones, J. H.;Sawicki, D. R.; Sredy, J.; Jacot, J.; Dicioccio, A. T.; Petrova, T.; Mitschler, A.; Podjarny, A. D., *J. Med. Chem.* **2005**, *48*, 3141 – 3152
[14] Pascanu, V.; Hansen, P. R.; Gomez, A. B.; Ayats, C.; Platero-Prats, A. E.; Johansson, M. J.; Pericas, M. A.; Martin-Matute, B., *ChemSusChem* **2015**, *8*, 123-130.

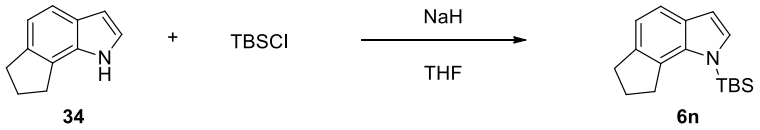


33 6m

Following a modified procedure,[4] a solution of 6-phenyl-1H-indole (**33**) (0.100 g, 0.520 mmol, 1.0 equiv) in THF (2 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 62.0 mg, 1.55 mmol, 3.0 equiv) in THF (3 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (118 mg, 0.780 mmol, 1.5 equiv) was added as a solution in THF (1.5 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 40:1) afforded 1-(Tert-butyldimethylsilyl)-6-phenyl-1H-indole (**6m**) (118 mg, 0.380 mmol, 74% yield) as yellow solid.

R_f: (SiO_2, pentane:ethyl acetate 40:1) 0.21;
Mp: 82.8-83.4 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (s, 1H, Ar*H*), 7.69 (d, *J* = 8.2 Hz, 1H, Ar*H*), 7.63 (dd, *J* = 8.3, 1.3 Hz, 2H, Ar*H*), 7.46 (dd, *J* = 8.4, 6.9 Hz, 2H, Ar*H*), 7.38 (dd, *J* = 8.2, 1.5 Hz, 1H, Ar*H*), 7.36 – 7.31 (m, 1H, Ar*H*), 7.22 (d, *J* = 3.2 Hz, 1H, Ar*H*), 6.64 (dd, *J* = 3.2, 0.9 Hz, 1H, Ar*H*), 0.98 (s, 9H, SiC(C*H*$_3$)$_3$), 0.65 (s, 6H, 2 x SiC*H*$_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 142.8, 141.6, 134.9, 131.7, 130.7, 128.7, 127.4, 126.4, 120.7, 119.7, 112.5, 104.6, 26.3, 19.5, -3.9;
IR (film) $\tilde{\nu}$ 3063 (w), 3026 (w), 2952 (m), 2934 (m), 2891 (w), 2860 (m), 1602 (w), 1503 (w), 1466 (m), 1429 (m), 1312 (m), 1263 (m), 1146 (s), 1078 (w), 986 (w), 819 (s), 788 (m), 757 (m);
HRMS (ESI) calcd. for $C_{20}H_{26}NSi^+$ $[M+H]^+$ 308.1829; found 308.1831.

1-(*Tert*-butyldimethylsilyl)-1,6,7,8-tetrahydrocyclopenta[g]indole (**6n**)



34 6n

Following a modified procedure,[4] a solution of 1,6,7,8-tetrahydrocyclopenta[g]indole (**34**) (0.47 g, 3.0 mmol, 1.0 equiv) in THF (3 mL) was added dropwise to a suspension of NaH (60% suspension in mineral oil, 0.36 g, 9.0 mmol, 3.0 equiv) in THF (4 mL) under N_2 atmosphere at 0 °C. The mixture was allowed to warm to room temperature with stirring over 45 minutes to give a near homogenous solution. After re-cooling to 0 °C, tert-butylchlorodimethylsilane (0.68 g, 4.5 mmol, 1.5 equiv) was added as a solution in THF (2 mL). The mixture was allowed to warm to room temperature and stirred for 12 hours. The mixture was diluted with Et_2O (25 mL) and water (10 mL). The organic layer was washed with brine (10 mL), dried over $MgSO_4$, concentrated under reduced pressure. Purification by flash column chromatography (SiO_2, eluent pentane:ethyl acetate 20:1) afforded (**6n**) (0.74 g, 2.7 mmol, 91% yield) as white solid.

R_f: (SiO_2, pentane) 0.40;
Mp: 53.8-54.8 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.8 Hz, 1H, Ar*H*), 7.22 (d, *J* = 3.2 Hz, 1H, Ar*H*), 7.08 (d, *J* = 7.8 Hz, 1H, Ar*H*), 6.61 (d, *J* = 3.2 Hz, 1H, Ar*H*), 3.18 (t, *J* = 7.2 Hz, 2H, $CH_2CH_2CH_2$), 3.01 (t, *J* =

7.4 Hz, 2H, C*H*$_2$CH$_2$CH$_2$), 2.12 (p, *J* = 7.3 Hz, 2H, CH$_2$C*H*$_2$ CH$_2$), 0.91 (s, 9H, SiC(C*H*$_3$)$_3$), 0.62 (s, 6H, 2 x SiC*H*$_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 139.1, 138.6, 131.8, 131.2, 126.8, 118.7, 117.3, 105.2, 34.5, 33.3, 26.6, 26.0, 19.6, -1.0;
IR (film) $\tilde{\nu}$ 2952 (m), 2934 (m), 2891 (w), 2860 (m), 1528 (w), 1466 (m), 1411 (m), 1294 (w), 1263 (m), 1214 (w), 1133 (m), 1084 (m), 1022 (w), 838 (m), 807 (s), 720 (m);
HRMS (ESI) calcd. for $C_{17}H_{26}NSi^+$ $[M+H]^+$ 272.1829; found 272.1828.

3. Synthesis of the ligands

(2S,2'S)-Dimethyl 2,2'-((2,2-dimethylmalonyl)bis(azanediyl))bis(3-hydroxypropanoate) (35)

35

Following a modified procedure,[15] a flame dried flask was put under N_2 atmosphere. Serine methylester hydrochloride (8.00 g, 51.4 mmol, 2 equiv) was added in the flask, together with 80 mL of dry dichloromethane, and the flask was cooled to 0 °C. Triethylamine (14.3 mL, 103 mmol, 4 equiv) was added dropwise over 30 minutes. Then, a solution of 2,2-dimethylmalonyl dichloride (3.40 mL, 25.7 mmol, 1 equiv) in 16 mL of dry dichloromethane was added dropwise over 1 hour. The reaction was warmed to room temperature and stirred for 16 hours. The solvent was evaporated, and the residue was purified by column chromatography (SiO_2, eluent pentane:ethyl acetate:tetrahydrofuran 90:10:0 to 0:0:100) to afford (2S,2'S)-dimethyl 2,2'-((2,2-dimethylmalonyl)bis(azanediyl))bis(3-hydroxypropanoate) (**35**) (8.60 g, 25.7 mmol, quantitative yield) as a colorless oil.

R_f: (SiO_2, ethyl acetate) 0.17;
$[\alpha]_D^{20.0}$ = -164.5 (c = 0.03. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 (d, *J* = 6.8 Hz, 2H, N*H*), 4.58 (dt, *J* = 7.3, 3.6 Hz, 2H, NC*H*), 3.92 (d, *J* = 3.8 Hz, 4H, OCH_2), 3.77 (s, 6H, CO_2CH_3), 1.49 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 173.7, 170.9, 62.1, 55.2, 52.8, 50.1, 23.2;
IR (film) $\tilde{\nu}$ 3383 (m), 2955 (w), 1741 (s), 1662 (s), 1519 (s), 1464 (w), 1439 (w), 1347 (w), 1284 (w), 1224 (m), 1180 (m), 1127 (w), 1077 (w);
HRMS (ESI) calcd for $C_{13}H_{22}N_2NaO_8^+$ $[M+Na]^+$ 357.1268; found 357.1265.

(4S,4'S)-Dimethyl 2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4-carboxylate) (9)

35 **9**

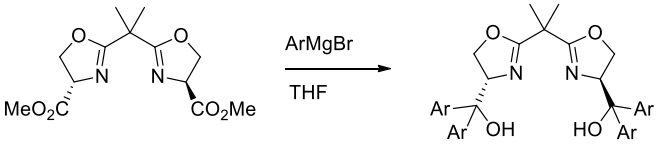
Following a modified procedure,[15] a flame dried flask was put under N_2 atmosphere. (2S,2'S)-dimethyl 2,2'-((2,2-dimethylmalonyl)bis(azanediyl))bis(3-hydroxypropanoate) (**35**) (3.19 g, 9.54 mmol, 1 equiv) was added to the flask, followed by 95 mL of dry tetrahydrofuran. The flask was cooled to 0 °C, and Burgess' reagent (5.00 g, 21.0 mmol, 2.2 equiv) was added portionwise. The mixture was then warmed to room temperature, and heated at reflux for 2.5 hours. The mixture was then concentrated, the residue dissolved in 60 mL of dichloromethane, washed with 20 mL of 5% aqueous solution of $NaHCO_3$, and 20 mL of brine. The organic layer was dried over $MgSO_4$, filtered and concentrated. The crude was purified by column chromatography (SiO_2, eluent pentane:ethyl acetate:tetrahydrofuran 20:20:1 to 0:100:0) to afford (4S,4'S)-dimethyl 2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4-carboxylate) (**9**) (1.77 g, 5.94 mmol, 62% yield) as a pale yellow solid.

R_f: (SiO_2, ethyl acetate) 0.23;
Mp: 50.6-52.6 °C;

[15] Matsumoto, T.; Matsumoto, K., Tanaka, A., EP 2 781 522 A1, *optically active bisoxazoline compound, asymmetric catalyst, and method for producing optically active cyclopropane compound using said catalyst.*

$[\alpha]_D^{20.0}$ = -33.2 (c = 0.15. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 4.74 (dd, *J* = 10.6, 7.8 Hz, 2H, NC*H*), 4.50 (dd, *J* = 8.7, 7.8 Hz, 2H, OCH_2), 4.41 (dd, *J* = 10.6, 8.7 Hz, 2H, OCH_2), 3.76 (s, 6H, CO_2CH_3), 1.53 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 171.6, 171.3, 70.0, 67.9, 52.6, 38.8, 24.2;
IR (film) $\tilde{\nu}$ 2993 (w), 1736 (s), 1644 (s), 1447 (w), 1366 (w), 1286 (w), 1219 (s), 1151 (s), 1120 (m), 1046 (w), 966 (m), 917 (m), 806 (w), 744 (m) cm^{-1};
HRMS (ESI) calcd for $C_{13}H_{18}N_2NaO_6^+$ $[M+Na]^+$ 321.1057; found 321.1058.

Grignard addition



9 **10**

General procedure A:

Grignard preparation: under N_2 atmosphere, in a flame dried microwave vial, magnesium turnings (49 mg, 2.0 mmol, 2 equiv) were added, followed by I_2 (cat.) and 1.8 mL of dry tetrahydrofuran. The corresponding aryl bromide (1.00 mmol, 1 equiv) was dissolved in 0.3 mL of dry tetrahydrofuran, and added dropwise. The mixture was then heated at reflux for 30 seconds, and then allowed to reach room temperature.

Ligand synthesis: Following a modified procedure,[15] under N_2 atmosphere in a flame dried flask, a solution of (4S,4'S)-dimethyl 2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4-carboxylate) (**9**) (50 mg, 0.17 mmol, 1 equiv) in 2.5 mL of dry tetrahydrofuran was added. The flask was cooled to -78 °C with a dry ice/acetone bath, and the freshly prepared Grignard (1.00 mmol, 6 equiv) was added dropwise over 5 minutes. The reaction was stirred at -78 °C for 24 hours allowing it to slowly reach room temperature. The reaction was then quenched at 0 °C by adding 2 mL of a saturated aqueous NH_4Cl solution. The organic layer was separated and the aqueous layer was extracted with 2 mL of dichloromethane. The combined organic layers were dried over Na_2SO_4, filtered and concentrated. An aliquot of the crude was purified by preparative TLC (SiO_2) for analysis, and the scratched silica was washed with 10 mL of ethyl acetate.

General procedure B:

Ligand synthesis: Following a modified procedure,[15] under N_2 atmosphere in a flame dried flask, a solution of (4S,4'S)-dimethyl 2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4-carboxylate) (**9**) (2.00 g, 6.70 mmol, 1 equiv) in 100 mL of dry tetrahydrofuran was added. The flask was cooled to -78 °C with a dry ice/acetone bath, and a 1 M solution of arylmagnesium bromide in tetrahydrofuran (13.4 mL, 40.2 mmol, 6 equiv) was added dropwise over 5 minutes. The reaction was stirred at -78 °C for 24 hours allowing it to slowly reach room temperature. The reaction was then quenched at 0 °C by adding 50 mL of saturated aqueous NH_4Cl solution. The organic layer was separated and the aqueous layer was extracted with 100 mL of dichloromethane. The combined organic layers were dried over Na_2SO_4, filtered and concentrated.

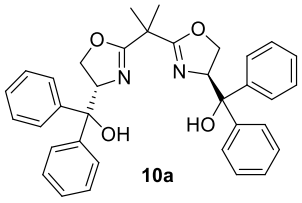
General procedure C:

Grignard preparation: under N_2 atmosphere, in a flame dried flask equipped with a reflux condenser, magnesium turnings (293 mg, 12.1 mmol, 2 equiv) were added, followed by I_2 (cat.) and 10 mL of dry

tetrahydrofuran. The aryl bromide was then added dropwise. The mixture was then heated at reflux for 30 seconds, and then allowed to reach room temperature.

Ligand synthesis: Following a modified procedure,[15] under N_2 atmosphere in a flame dried flask, a solution of (4S,4'S)-dimethyl 2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4-carboxylate) (**9**) (300 mg, 1.00 mmol, 1 equiv) in 15 mL of dry tetrahydrofuran was added. The flask was cooled to -78 °C with a dry ice/acetone bath, and the freshly prepared Grignard (6.03 mmol, 6 equiv) was added dropwise over 5 minutes. The reaction was stirred at -78 °C for 24 hours allowing it to slowly reach room temperature. The reaction was then quenched at 0 °C by adding 12 mL of saturated aqueous NH_4Cl solution. The organic layer was separated and the aqueous layer was extracted with 30 mL of dichloromethane. The combined organic layers were dried over Na_2SO_4, filtered and concentrated. The crude was purified by column chromatography.

((4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(diphenylmethanol) (10a)

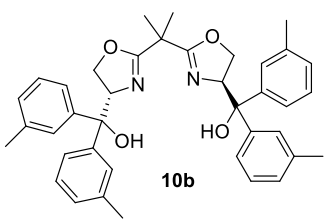


10a

Following general procedure **B**, using a phenylmagnesium bromide solution. The crude was purified by column chromatography, (SiO_2, eluent pentane:ethyl acetate 10:1 to 6:1 to 4:1) to afford ((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(diphenylmethanol) (**10a**) (1.40 g, 2.57 mmol, 38% yield) as a white solid.

R_f: (SiO_2, pentane: ethyl acetate 8:2) 0.28;
Mp: 115.0-116.5 °C;
$[\alpha]_D^{20.0}$ = -28.8 (c = 0.3. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (d, *J* = 7.0 Hz, 4H, Ar*H*), 7.29 (t, *J* = 7.7 Hz, 4H, Ar*H*), 7.25 (d, *J* = 6.2 Hz, 4H, Ar*H*), 7.23 – 7.12 (m, 8H, Ar*H*), 5.36 (dd, *J* = 9.8, 6.8 Hz, 2H, OCH_2CHNR), 4.25 (dd, *J* = 8.7, 6.8 Hz, 2H, OCH_2CHNR), 4.11 (t, *J* = 9.2 Hz, 2H, OCH_2CHNR), 3.65 (s, 2H, O*H*), 1.38 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 145.4, 144.4, 128.3, 128.0, 126.7, 126.6, 125.8, 78.8, 72.0, 69.7, 39.5, 23.6 *(one aromatic carbon signal not resolved)*;
IR (film) $\tilde{\nu}$ 3368 (w), 3005 (w), 1650 (m), 1496 (w), 1447 (m), 1360 (w), 1249 (w), 1212 (w), 1163 (w), 1120 (m), 1071 (w), 991 (w), 898 (w), 750(s);
HRMS (ESI) calcd for $C_{35}H_{35}N_2O_4^+$ $[M+H]^+$ 547.2591; found 547.2598.

((4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di-*m*-tolylmethanol) (10b)



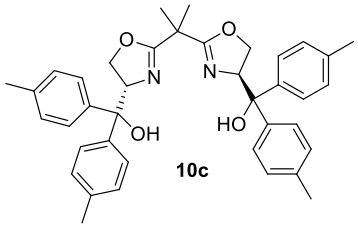
10b

Following general procedure **A**, using 1-bromo-3-methylbenzene (0.172 g, 1.00 mmol, 6 equiv). The weight of the crude was 125 mg. 40 mg of crude were purified for analysis by preparative TLC (SiO_2,

eluent toluene:ethyl acetate 9:1) to afford (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di-m-tolylmethanol) (**10b**) (16.6 mg, 28.0 µmol, 41% calculated yield) as a colorless oil.

R_f: (SiO_2, toluene: ethyl acetate 9:1) 0.4;
Mp: 119-123 °C;
$[\alpha]_D^{20.0}$ = -36.27 (c = 0.25. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (s, 2H, Ar*H*), 7.17 (d, *J* = 4.6 Hz, 6H, Ar*H*), 7.09 – 6.98 (m, 6H, Ar*H*), 6.95 (d, *J* = 7.4 Hz, 2H, Ar*H*), 5.33 (dd, *J* = 9.8, 6.8 Hz, 2H, OCH_2CHNR), 4.26 (dd, *J* = 8.7, 6.8 Hz, 2H, OCH_2CHNR), 4.12 (dd, *J* = 9.8, 8.7 Hz, 2H, OCH_2CHNR), 3.66 (s, 2H, O*H*), 2.34 (s, 6H, CH_3), 2.23 (s, 6H, CH_3), 1.36 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.4, 145.4, 144.6, 137.8, 137.3, 128.1, 127.9, 127.5, 127.3, 126.6, 123.7, 123.0, 78.8, 72.2, 69.8, 39.5, 23.6, 21.7, 21.6 (*one aromatic carbon signal not resolved*);
IR (film) $\tilde{\nu}$ 3560 (w), 3381 (w), 2966 (w), 2917 (m), 2861 (w), 2242 (w), 1661 (m), 1605 (w), 1481 (m), 1364 (w), 1302 (w), 1240 (m), 1147 (m), 1122 (m), 986 (m), 912 (S), 850 (w), 776 (m), 733 (S). IR 3557 (w), 3386 (w), 2921 (w), 2247 (w), 1738 (w), 1660 (m), 1606 (w), 1484 (w), 1363 (w), 1297 (w), 1244 (w), 1150 (m), 1120 (m), 986 (w), 911 (s), 848 (w), 780 (w), 736 (s);
HRMS (ESI) calcd for $C_{39}H_{43}N_2O_4^+$ $[M+H]^+$ 603.3217; found 603.3222.

((4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di-*p*-tolylmethanol) (10c)

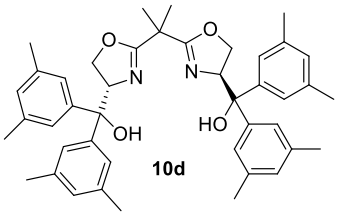


10c

Following general procedure **A**, using 1-bromo-4-methylbenzene (0.172 g, 1.00 mmol, 6 equiv). The weight of the crude was 107 mg. 40 mg of crude were purified by preparative TLC (SiO_2, eluent toluene:ethyl acetate 9:1) to afford (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di-p-tolylmethanol) (**10c**) (12.9 mg, 21.0 µmol, 34% calculated yield) as a white solid.

R_f: (SiO_2, toluene: ethyl acetate 9:1) 0.3;
Mp: 88.4-92.1 °C;
$[\alpha]_D^{20.0}$ = 79.96 (c = 0.24. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 (d, *J* = 8.3 Hz, 4H, Ar*H*), 7.15 (d, *J* = 8.2 Hz, 4H, Ar*H*), 7.07 (d, *J* = 8.0 Hz, 4H, Ar*H*), 7.03 (d, *J* = 8.0 Hz, 4H, Ar*H*), 5.33 (dd, *J* = 9.8, 7.0 Hz, 2H, OCH_2CHNR), 4.22 (dd, *J* = 8.6, 7.0 Hz, 2H, OCH_2CHNR), 4.09 (dd, *J* = 9.9, 8.6 Hz, 2H, OCH_2CHNR), 3.72 (s, 2H, O*H*), 2.28 (s, 6H, CH_3), 2.26 (s, 6H, CH_3), 1.41 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 143.1, 141.8, 136.1, 136.0, 128.9, 128.8, 126.3, 125.5, 78.4, 72.1, 69.8, 39.5, 23.7, 21.0, 20.9;
IR (film) $\tilde{\nu}$ 3377 (w), 2993 (w), 2924 (w), 2246 (w), 1660 (m), 1513 (m), 1470 (w), 1411 (w), 1362 (w), 1247 (w), 1171 (w), 1120 (m), 1022 (w), 986 (m), 912 (s), 818 (m), 785 (w), 736 (s);
HRMS (ESI) calcd for $C_{39}H_{43}N_2O_4^+$ $[M+H]^+$ 603.3217; found 603.3223.

((4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-dimethylphenyl)methanol) (10d)

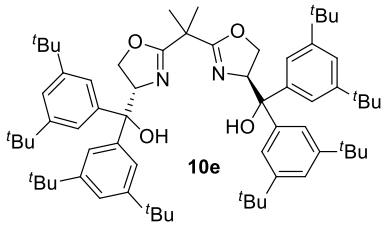


10d

Following general procedure **C**, using 1-bromo-3,5-dimethylbenzene (0.820 mL, 6.03 mmol, 6 equiv). The crude was purified by column chromatography (deactivated SiO_2, eluent pentane:ethyl acetate 9:1 + 1% of triethylamine) to afford (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-dimethylphenyl)methanol) (**10d**) (316 mg, 0.480 mmol, 48% yield) as a white solid.

R_f: (SiO_2, pentane: ethyl acetate 8:2) 0.5;
Mp: 108.1-112.6 °C;
$[\alpha]_D^{20.0}$ = -4.46 (c = 0.5. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.10 (s, 4H, *ortho*-Ar*H*), 6.93 (s, 4H, *ortho*-Ar*H*), 6.83 (s, 2H, *para*-Ar*H*), 6.75 (s, 2H, *para*-Ar*H*), 5.27 (dd, *J* = 9.8, 6.5 Hz, 2H, OCH_2CHNR), 4.29 (app t, *J* = 7.7 Hz, 2H, OCH_2CHNR), 4.13 (app t, *J* = 9.2 Hz, 2H, OCH_2CHNR), 3.49 (br s, 2H, O*H*), 2.29 (s, 12H, CH_3), 2.12 (s, 12H, CH_3), 1.29 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.0, 145.0, 144.8, 137.5, 137.0, 128.5, 128.4, 124.6, 124.0, 79.0, 72.3, 69.9, 39.4, 23.4, 21.5, 21.4;
IR (film) $\tilde{\nu}$ 3401 (w), 2917 (w), 2246 (w), 1660 (w), 1603 (w), 1471 (w), 1366 (w), 1244 (w), 1150 (w), 1119 (m), 985 (w), 910 (m), 854 (w), 732 (s);
HRMS (ESI) calcd for $C_{43}H_{51}N_2O_4^+$ $[M+H]^+$ 659.3843; found 659.3846.

((4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-di-*tert*-butylphenyl)methanol) (10e)



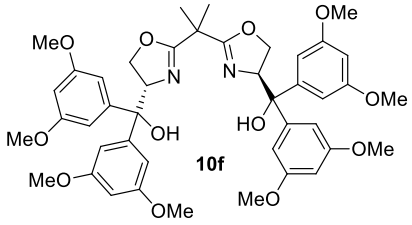
10e

Following general procedure **A**, using 1-bromo-3,5-di-tert-butylbenzene (0.271 g, 1.00 mmol, 6 equiv). The weight of the crude was 246 mg. 40 mg of crude were purified by preparative TLC (SiO_2, eluent toluene:ethyl acetate 9:1) to afford (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-di-tert-butylphenyl)methanol) (**10e**) (14.3 mg, 14.0 µmol, 53% calculated yield) as a colorless oil.

R_f: (SiO_2, toluene: ethyl acetate 9:1) 0.54;
$[\alpha]_D^{20.0}$ = 8.96 (c = 0.4. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (d, *J* = 1.8 Hz, 4H, Ar*H*), 7.23 (m, 8H, Ar*H*), 5.24 (t, *J* = 9.2 Hz, 2H, OCH_2CHNR), 4.15 (dd, *J* = 9.2, 1.8 Hz, 4H, OCH_2CHNR), 2.89 (s, 2H, O*H*), 1.45 (s, 6H, CH_3), 1.27 (s, 36H, $C(CH_3)_3$), 1.26 (s, 36H, $C(CH_3)_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 171.7, 150.0, 149.6, 145.3, 143.2, 121.3, 120.5, 120.4, 120.3, 79.3, 73.7, 70.4, 39.2, 34.9, 34.8, 31.5, 24.3 (*one aliphatic carbon signal is not resolved*);

IR (film) $\tilde{\nu}$ 3528 (w), 3071 (w), 2962 (s), 2906 (m), 2868 (m), 2246 (w), 1661 (m), 1599 (m), 1475 (m), 1393 (w), 1363 (m), 1250 (m), 1202 (w), 1178 (w), 1152 (w), 1121 (m), 1071 (w), 983 (w), 911 (m), 878 (w), 847 (w), 824 (w), 737 (s);
HRMS (ESI) calcd for $C_{67}H_{99}N_2O_4^+$ $[M+H]^+$ 995.7599; found 995.7595.

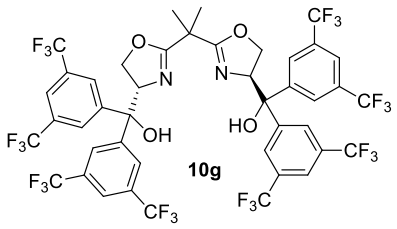
((4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-dimethoxyphenyl)methanol) (10f)



Following general procedure **A**, using 1-bromo-3,5-dimethoxybenzene (0.218 g, 1.00 mmol, 6 equiv). The weight of the crude was 154 mg. 35 mg of crude were purified by preparative TLC (SiO_2, eluent heptane:ethyl acetate 6:4). The obtained product was resubjected to preparative TLC (SiO_2, eluent heptane:ethyl acetate 6:4) to afford (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-dimethoxyphenyl)methanol) (**10f**) (11.0 mg, 14.0 µmol, 41% calculated yield) as a colorless oil.

R_f: (SiO_2, pentane:ethyl acetate 6:4) 0.13;
$[\alpha]_D^{20.0}$ = -30.24 (c = 0.47. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 6.58 (dd, *J* = 6.0, 2.3 Hz, 8H, Ar*H*), 6.27 (dt, *J* = 9.9, 2.2 Hz, 4H, Ar*H*), 5.21 (dd, *J* = 9.8, 7.2 Hz, 2H, OCH_2CHNR), 4.24 (dd, *J* = 8.7, 7.1 Hz, 2H, OCH_2CHNR), 4.16 (dd, *J* = 9.8, 8.7 Hz, 2H, OCH_2CHNR), 3.75 (s, 12H, OCH_3), 3.70 (s, 12H, OCH_3), 1.40 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.4, 160.5, 160.3, 147.7, 146.6, 105.2, 104.4, 98.5, 98.4, 78.9, 72.3, 69.9, 55.3, 55.1, 39.4, 23.6;
IR (film) $\tilde{\nu}$ 3442 (w), 3000 (w), 2942 (w), 2838 (w), 2254 (w), 1661 (w), 1600 (s), 1462 (m), 1426 (m), 1345 (w), 1294 (m), 1249 (w), 1206 (s), 1156 (s), 1121 (w), 1063 (m), 983 (w), 919 (m), 838 (w), 737 (s);
HRMS (ESI) calcd for $C_{43}H_{51}N_2O_{12}^+$ $[M+H]^+$ 787.3437; found 787.3433.

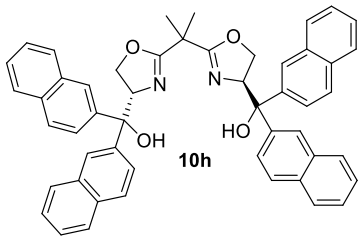
((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-bis(trifluoromethyl)phenyl)methanol) (10g)



Following general procedure **A**, using 1-bromo-3,5-bis(trifluoromethyl)benzene (0.295 g, 1.00 mmol, 6 equiv). The weight of the crude was 239 mg. 40 mg of crude were purified by preparative TLC (SiO_2, eluent toluene:ethyl acetate 9:1) to afford (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-bis(trifluoromethyl)phenyl)methanol) (**10g**) (25.3 mg, 23.0 µmol, 83% calculated yield) as an off-white solid.

R_f: (silica, toluene: ethyl acetate 9:1) 0.59;
Mp: 53.8-58.2 °C.
$[\alpha]_D^{20.0}$ = -99.03 (c = 0.33. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 1.6 Hz, 4H, Ar*H*), 7.82 (s, 6H, Ar*H*), 7.77 (s, 2H), 5.36 (dd, *J* = 9.8, 7.7 Hz, 2H, OCH_2CHNR), 4.19 (app t, *J* = 9.4 Hz, 2H, OCH_2CHNR), 4.10 (dd, *J* = 9.0, 7.7 Hz, 2H, OCH_2CHNR), 3.51 (br s, 2H, O*H*), 1.43 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 174.1, 146.3, 145.0, 132.3 (q, *J* = 33.3 Hz), 131.8 (q, *J* = 34.3 Hz), 127.0 (m), 126.0 (m), 123.0 (q, *J* = 273.7 Hz), 123.0 (q, *J* = 273.7 Hz), 122.1 (m), 122.1 (m), 77.9, 71.7, 69.3, 39.7, 23.3;
^{19}F NMR (376 MHz, $CDCl_3$) δ -62.9, -63.0;
IR (film) $\tilde{\nu}$ 3381 (w), 1662 (w), 1632 (w), 1472 (w), 1375 (m), 1279 (s), 1171 (s), 1129 (s), 975 (w), 902 (m), 847 (w), 812 (w), 739 (m), 711 (m);
HRMS (ESI) calcd for $C_{43}H_{27}F_{24}N_2O_4^+$ $[M+H]^+$ 1091.1582; found 1091.1595.

((4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di(naphthalen-2-yl)methanol) (10h)

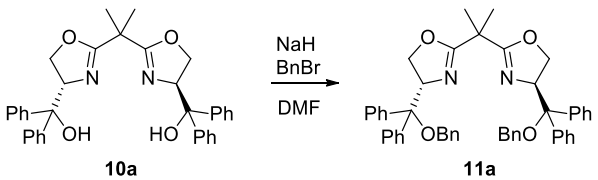


10h

Following general procedure **A**, using 2-bromonaphthalene (0.208 g, 1.00 mmol, 6 equiv). The weight of the crude was 194 mg. 40 mg of crude were purified by preparative TLC (SiO_2, eluent toluene:ethyl acetate 9:1) to afford (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di(naphthalen-2-yl)methanol) (**10h**) (12.1 mg, 16.0 µmol, 47% calculated yield) as an off-white solid.

R_f: (SiO_2, toluene: ethyl acetate 9:1) 0.38;
Mp: 139-147 °C;
$[\alpha]_D^{20.0}$ = -246.12 (c = 0.19. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (s, 2H, Ar*H*), 8.00 (s, 2H, Ar*H*), 7.95 (d, *J* = 8.1 Hz, 2H, Ar*H*), 7.84 – 7.72 (m, 4H, Ar*H*), 7.67 (dd, *J* = 8.4, 5.4 Hz, 4H, Ar*H*), 7.55 – 7.23 (m, 12H, Ar*H*), 6.98 – 6.91 (m, 2H, Ar*H*), 5.63 (dd, *J* = 9.8, 6.7 Hz, 2H, OCH_2CHNR), 4.40 (dd, *J* = 8.7, 6.7 Hz, 2H, OCH_2CHNR), 4.16 (t, *J* = 9.3 Hz, 2H, OCH_2CHNR), 4.11 (s, 2H, O*H*), 1.41 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 142.2, 141.4, 133.0, 132.8, 132.3, 132.2, 128.6, 128.4, 128.0, 127.6, 127.4, 127.3, 126.1, 126.0, 125.8, 125.7, 125.7, 125.1, 124.5, 124.4, 79.0, 71.6, 69.8, 39.6, 23.6;
IR (film) $\tilde{\nu}$ 3635 (w), 3557 (w), 3363 (w), 3057 (w), 2939 (w), 2248 (w), 1923 (w), 1654 (m), 1600 (w), 1507 (w), 1472 (w), 1363 (w), 1245 (w), 1154 (w), 1120 (m), 1020 (w), 987 (w), 908 (s), 858 (w), 821 (m), 795 (m), 733 (s);
HRMS (ESI) calcd for $C_{51}H_{43}N_2O_4^+$ $[M+H]^+$ 747.3217; found 747.3219.

(4S,4'S)-2,2'-(Propane-2,2-diyl)bis(4-((benzyloxy)diphenylmethyl)-4,5-dihydrooxazole) (11a)



10a **11a**

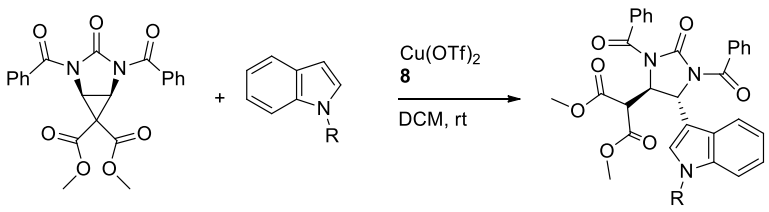
Following a modified procedure,[16] under N_2 atmosphere, in a flame dried flask, (2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(diphenylmethanol) (**10a**) (100 mg, 0.183 mmol, 1 equiv) was added, followed by dry dimethylformamide (0.4 mL). The flask was cooled at 0 °C, and sodium hydride (60% dispersion in mineral oil, 18.0 mg, 0.439 mmol, 2.4 equiv) was added. The reaction mixture was stirred for 1 hour at 0 °C. Then, benzyl bromide (52.0 µL, 0.439 mmol, 2.4 equiv) was added dropwise. The reaction was warmed to room temperature and stirred for 16 hours. The reaction was then quenched by the addition of 5 mL of saturated aqueous NH_4Cl solution, and extracted with diethyl ether (3x5 mL). The combined organic phases were dried over Na_2SO_4, filtered and evaporated. The residue was purified by column chromatography (SiO_2, eluent pentane:ethyl acetate 49:1) to afford 2,2'-(propane-2,2-diyl)bis(4-((benzyloxy)diphenylmethyl)-4,5-dihydrooxazole) (**11a**) (73.0 mg, 0.100 mmol, 55% yield) as a white solid.

R_f: (SiO_2, toluene: ethyl acetate 9:1) 0.23;
Mp: 84.2-92.4 °C;
$[\alpha]_D^{20.0}$ = 82.34 (c = 0.15. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 – 7.61 (m, 4H, Ar*H*), 7.44 – 7.38 (m, 4H), 7.36 – 7.26 (m, 15H, Ar*H*), 7.26 – 7.16 (m, 7H, Ar*H*), 5.26 (dd, *J* = 10.1, 7.4 Hz, 2H, OCH_2CHNR), 4.41 – 4.32 (m, 4H, OCH_2CHNR + OCH_2Ph), 4.20 (d, *J* = 11.8 Hz, 2H, OCH_2Ph), 4.06 (dd, *J* = 10.1, 8.8 Hz, 2H, OCH_2CHNR), 0.98 (s, 6H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 143.5, 141.3, 139.1, 129.0, 128.6, 128.2, 127.9, 127.3, 127.2, 127.01, 126.95, 126.91, 83.9, 70.2, 69.1, 65.6, 38.5, 23.1;
IR (film) $\tilde{\nu}$ 4051 (w), 3062 (w), 3030 (w), 2905 (w), 2249 (w), 1953 (w), 1741 (w), 1655 (s), 1604 (w), 1544 (w), 1495 (m), 1449 (m), 1386 (w), 1313 (w), 1261 (m), 1220 (w), 1152 (m), 1121 (m), 1063 (s), 1032 (m), 985 (m), 910 (s), 843 (w), 735 (s);
HRMS (ESI) calcd for $C_{49}H_{47}N_2O_4^+$ $[M+H]^+$ 727.3530; found 727.3534.

[16] Wang, S.-H.; Chein, R.-J., *Tetrahedron* **2016**, *72*, 2607-2615.

4. Optimization of the enantioselective desymmetrization

General procedure D:

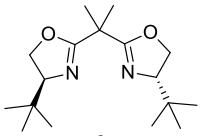


20 | **21** (R = H), **36** (R = Me), **6a** (R = TBS) | **37a** (R = H), **37b** (R = Me), **37c** (R = TBS)

In a glovebox, an oven dried microwave vial was charged with copper(II) triflate (3.6 mg, 10 µmol, 0.2 equiv), and ligand (3.5 mg, 12 µmol, 0.24 equiv). The vial was taken out of the glovebox and put under N_2 atmosphere. 0.5 mL of dry dichloromethane was added and the suspension was stirred vigorously for 2 hours. Then, a solution of dimethyl 2,4-dibenzoyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (**20**) (21.1 mg, 50.0 µmol, 1 equiv) and the indole (60.0 µmol, 1.2 equiv) in 0.5 mL of dry dichloromethane was added. The reaction was stirred at room temperature for 16 hours, diluted with 0.5 mL of ethyl acetate and then filtered on a pad of SiO_2, eluting with 5 mL of ethyl acetate. The solution was concentrated and subjected to preparative TLC (SiO_2) with the specified eluent. The scratched SiO_2 was washed with 10 mL of ethyl acetate. The solvent was evaporated to afford the product.

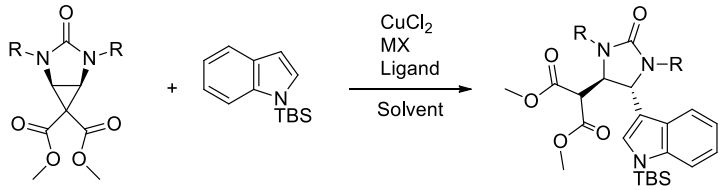
Table S1. Screening of N-substituents of the indole.

entry	R	Yield (%)	er
1	H	50	46:54
2	Me	65	46:54
3	TBS	60	42:58



8

General procedure E:



2 (R = Piv), **19** (R = Ac), **20** (R = Bz) | **6a** | **7a** (R = Piv), **38** (R = Ac), **37c** (R = Bz)

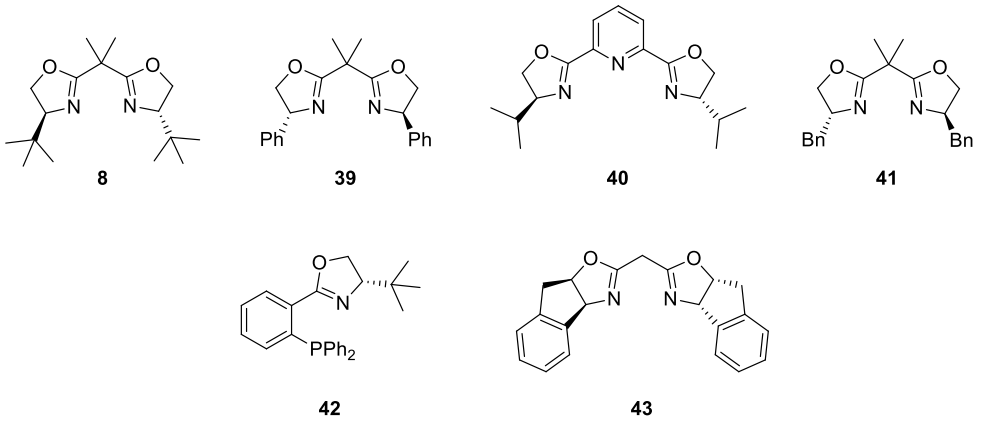
In a glovebox, an oven dried microwave vial was charged with copper(II) chloride (1.3 mg, 10 µmol, 0.2 equiv), MX (4.0 µmol, 0.4 equiv), and ligand (24 µmol, 0.24 equiv). The vial was protected from light with aluminum foil, taken out of the glovebox and put under N_2 atmosphere. 0.5 mL of dry solvent

was added and the suspension was stirred vigorously for 2 hours. Then, a solution of cyclopropane (50.0 µmol, 1 equiv) and 1-(tert-butyldimethylsilyl)-1H-indole (**6a**) (13.9 mg, 60.0 µmol, 1.2 equiv) in 0.5 mL of dry solvent were added. The reaction was stirred at room temperature for 16 hours, diluted with 0.5 mL of ethyl acetate and then filtered on a pad of SiO_2, eluting with 5 mL of ethyl acetate. The solution was concentrated and subjected to preparative TLC (SiO_2) with heptane:ethyl acetate 65:35 as eluent. The scratched SiO_2 was washed with 10 mL of ethyl acetate. The solvent was evaporated to afford the product.

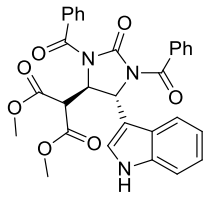
Table S2. Screening of protecting groups on cyclopropane, ligands, counterions and solvents.

entry	R	Ligand	MX	Solvent	Yield (%)	er
1	PhCO	**8**	$AgSbF_6$	DCM	80	39.5:60.5
2	PhCO	**8**	$AgSbF_6$	$CDCl_3$	74	29:71
3	PhCO	**8**	$AgSbF_6$	Toluene[a]	52	19.4:80.6
4	MeCO[2]	**8**	$AgSbF_6$	Toluene	39	39.5:60.5
5	^{t}BuCO	**8**	$AgSbF_6$	Toluene	70	25:75
6	^{t}BuCO	**39**	$AgSbF_6$	Toluene	77	46:54
7	^{t}BuCO	**40**	$AgSbF_6$	Toluene	71	61:39
8	^{t}BuCO	**41**	$AgSbF_6$	Toluene	68	57:43
9	^{t}BuCO	**42**	$AgSbF_6$	Toluene	91	42:58
10	^{t}BuCO	**43**	$AgSbF_6$	p-xylene	72	42:58
11	^{t}BuCO	**8**	AgOTf	p-xylene	42	29:71
12	^{t}BuCO	**8**	$AgBF_4$	Toluene	44	28:72
13	^{t}BuCO	**8**	$AgClO_4$	Toluene	45	27.5:72.5
14	^{t}BuCO	**8**	$AgPF_6$	Toluene	44	28:72
15	^{t}BuCO	**8**	$AgNTF_2$	Toluene	25	37.5:62.5
16	^{t}BuCO	**8**	NaBARF	Toluene	No conversion	-
17	^{t}BuCO	**8**	$AgSbF_6$	CCl_4	45	20:80
18	^{t}BuCO	**8**	$AgSbF_6$	DCM	74	37.5:62.5
19	^{t}BuCO	**8**	$AgSbF_6$	Trifluorotoluene	83	34:66
20	^{t}BuCO	**8**	$AgSbF_6$	o-xylene	79	26.5:73.5
21	^{t}BuCO	**8**	$AgSbF_6$	m-xylene	87	25:75
22	^{t}BuCO	**8**	$AgSbF_6$	p-xylene	86	24:76
23	^{t}BuCO	**8**	$AgSbF_6$	Benzene	73	21.5:78.5
24	^{t}BuCO	**8**	$AgSbF_6$	Chlorobenzene	75	30:70

[a]Using 5 mL of solvent. [b]The cyclopropane was added as a solid.



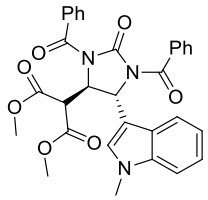
Dimethyl 2-(1,3-dibenzoyl-5-(1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**37a**)



Following general procedure **D**, using 1H-indole (**21**) (7.0 mg, 60 µmol, 1.2 equiv). Preparative TLC using eluent 1:1 heptane:ethyl acetate afforded dimethyl 2-(1,3-dibenzoyl-5-(1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**37a**) (18.7 mg, 35.0 µmol, 69% yield) as a grey solid. Chiral HPLC conditions: er = 54:46; Chiralpak IB 80:20 Hexane/iPrOH, 1.0 mL/min, 60 min. t_r (major) = 23.0 min. and t_r (minor) = 31.7 min. $\lambda = 250$ cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 6:4) 0.28;
Mp: 99.4-102.9 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (s, 1H, N*H*), 7.80 – 7.75 (m, 1H, Ar*H*), 7.67 – 7.63 (m, 2H, Ar*H*), 7.56 – 7.52 (m, 2H, Ar*H*), 7.51 – 7.46 (m, 1H, Ar*H*), 7.41 – 7.34 (m, 4H, Ar*H*), 7.32 – 7.26 (m, 3H, Ar*H*), 7.25 – 7.18 (m, 2H, Ar*H*), 6.14 (d, *J* = 3.6 Hz, 1H, indole-C*H*), 5.28 (dd, *J* = 4.2, 3.6 Hz, 1H, indole-CH-C*H*), 4.46 (d, *J* = 4.2 Hz, 1H, C*H*(CO_2CH_3)$_2$), 3.80 (s, 3H, CO_2CH_3), 3.64 (s, 3H, CO_2CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 169.2, 167.2, 166.9, 150.4, 136.7, 133.9, 133.7, 132.2, 131.9, 128.9, 127.9, 127.8, 124.5, 124.0, 122.6, 120.5, 118.7, 113.5, 111.8, 57.2, 53.1, 52.8, 52.5, 51.3 (*one aromatic carbon signal is not resolved)*;
IR (film) $\tilde{\nu}$ 3399 (w), 1758 (s), 1679 (s), 1444 (w), 1339 (m), 1277 (s), 1188 (m), 1031 (w), 910 (w);
HRMS (ESI) calcd for $C_{30}H_{25}N_3O_7$ [M+] 539.1687; found 539.1684.

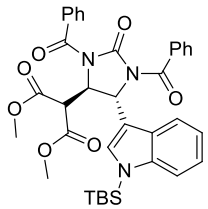
Dimethyl 2-(1,3-dibenzoyl-5-(1-methyl-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**37b**)



Following general procedure **D**, using 1-methyl-1H-indole (**36**) (7.9 mg, 60 µmol, 1.2 equiv). Preparative TLC using eluent 1:1 heptane:ethyl acetate afforded dimethyl 2-(1,3-dibenzoyl-5-(1-methyl-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**37b**) (17.0 mg, 31.0 µmol, 61% yield) as a yellow solid. Chiral HPLC conditions: er = 54:46; Chiralpak IB 80:20 Hexane/iPrOH, 1.0 mL/min, 60 min. t_r (major) = 20.1 min. and t_r (minor) = 26.4 min. λ = 260 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 6:4) 0.40;
Mp: 103.8-107.5 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, *J* = 8.0 Hz, 1H, Ar*H*), 7.68 – 7.64 (m, 2H, Ar*H*), 7.55 – 7.52 (m, 2H, Ar*H*), 7.51 – 7.46 (m, 1H, Ar*H*), 7.42 – 7.37 (m, 3H, Ar*H*), 7.35 – 7.26 (m, 4H, Ar*H*), 7.23 – 7.17 (m, 2H, Ar*H*), 6.11 (d, *J* = 3.4 Hz, 1H, indole-C*H*), 5.28 (dd, *J* = 4.2, 3.4 Hz, 1H, indole-CH-C*H*), 4.44 (d, *J* = 4.2 Hz, 1H, C*H*(CO_2CH_3)$_2$), 3.79 (s, 3H, CO_2CH_3), 3.77 (s, 3H, CO_2CH_3), 3.67 (s, 3H, NCH_3);
^{13}C NMR (101 MHz, CDCl3) δ 170.1, 169.1, 167.2, 166.9, 150.4, 137.5, 133.9, 133.7, 132.1, 131.9, 128.9, 128.5, 127.9, 127.7, 125.0, 122.1, 120.1, 118.8, 111.8, 109.9, 57.3, 53.1, 52.8, 52.5, 51.3, 32.9 (*one aromatic carbon signal is not resolved*);
IR (film) $\tilde{\nu}$ 2949 (w), 1758 (s), 1679 (s), 1444 (w), 1318 (m), 1266 (s), 1198 (m), 1036 (w), 916 (w);
HRMS (ESI) calcd for $C_{31}H_{27}N_3O_7$ [M+] 553.1844; found 553.1844.

Dimethyl 2-(1,3-dibenzoyl-5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**37c**)

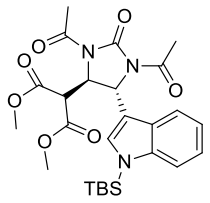


37c

Following general procedure **E**, using dimethyl 2,4-dibenzoyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (**20**) (21.1 mg, 50.0 µmol, 1 equiv). Preparative TLC using eluent 55:45 heptane:ethyl acetate afforded dimethyl 2-(1,3-dibenzoyl-5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**37c**) (16.9 mg, 26.0 µmol, 52% yield) as a white solid. Chiral HPLC conditions: er = 80.6:19.4; Chiralpak IB 95:5 Hexane/iPrOH, 0.5 mL/min, 31 min. t_r (major) = 15.7 min. and t_r (minor) = 19.1 min. λ = 260 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate1:1) 0.62;
$[\alpha]_D^{20.0}$ = 21.1 (c = 0.31. $CHCl_3$);
Mp: 87.6-88.7 °C;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 – 7.75 (m, 1H, Ar*H*), 7.66 – 7.62 (m, 2H, Ar*H*), 7.55 – 7.46 (m, 4H, Ar*H*), 7.42 – 7.36 (m, 3H, Ar*H*), 7.32 – 7.27 (m, 3H, Ar*H*), 7.23 – 7.17 (m, 2H, Ar*H*), 6.13 (d, *J* = 3.4 Hz, 1H, indole-C*H*), 5.26 – 5.21 (m, 1H, indole-CH-C*H*), 4.45 (d, *J* = 4.1 Hz, 1H, C*H*(CO_2CH_3)$_2$), 3.79 (s, 3H, CO_2CH_3), 3.67 (s, 3H, CO_2CH_3), 0.92 (s, 9H, SiC(CH_3)$_3$), 0.61 (s, 6H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 170.2, 169.0, 167.2, 166.9, 150.5, 142.0, 134.1, 133.8, 132.2, 131.8, 130.6, 128.9, 128.8, 128.0, 127.9, 127.8, 122.1, 120.5, 118.8, 115.4, 114.5, 57.2, 53.1, 52.8, 52.6, 51.4, 26.3, 19.4, -3.9 (*one $SiCH_3$ carbon signal is not resolved*);
IR (film) $\tilde{\nu}$ 2952 (w), 2928 (w), 1787 (m), 1733 (s), 1691 (s), 1446 (w), 1327 (s), 1279 (s), 1225 (s), 1166 (s), 1082 (w), 909 (w), 825 (w);
HRMS (ESI) calcd. for $C_{36}H_{39}N_3NaO_7Si^+$ $[M+Na]^+$ 676.2449; found 676.2452.

Dimethyl 2-(1,3-diacetyl-5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**38**)



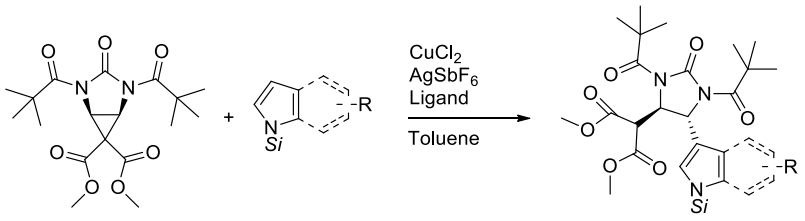
38

Following general procedure **E**, using dimethyl 2,4-diacetyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (**19**) (14.9 mg, 50.0 µmol, 1 equiv). Preparative TLC using eluent 65:35 heptane:ethyl acetate afforded dimethyl 2-(1,3-diacetyl-5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (**38**) (10.4 mg, 20.0 µmol, 39% yield) as a colorless oil. Chiral HPLC conditions: er = 60.5:39.5; Chiralpak IB 95:5 Hexane/iPrOH, 0.5 mL/min, 31 min. t_r (major) = 8.0 min. and t_r (minor) = 10.4 min. λ = 260 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 6:4) 0.67;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 8.2 Hz, 1H, Ar*H*), 7.42 – 7.36 (m, 1H, Ar*H*), 7.19 (s, 1H, Ar*H*), 7.18 – 7.13 (m, 1H, Ar*H*), 7.13 – 7.08 (m, 1H, Ar*H*), 5.80 (d, *J* = 1.8 Hz, 1H, indole-C*H*), 4.84 (dd, *J* = 4.1, 1.9 Hz, 1H, indole-CH-C*H*), 4.24 (d, *J* = 4.1 Hz, 1H, C*H*(CO_2CH_3)$_2$), 3.75 (s, 3H, CO_2CH_3), 3.72 (s, 3H, CO_2CH_3), 2.66 (s, 3H, $COCH_3$), 2.48 (s, 3H, $COCH_3$), 0.90 (s, 9H, SiC(CH_3)$_3$), 0.59 (s, 3H, $SiCH_3$), 0.59 (s, 3H, $SiCH_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 170.8, 169.6, 167.1, 166.9, 152.1, 141.9, 130.7, 127.6, 121.8, 120.4, 118.4, 115.7, 114.5, 56.6, 52.9, 52.8, 51.8, 51.4, 26.2, 24.6, 24.4, 19.5, -3.9 (*one $SiCH_3$ carbon signal is not resolved*);
IR (film) $\tilde{\nu}$ 2958 (w), 2934 (w), 2862 (w), 1757 (s), 1703 (m), 1452 (w), 1369 (m), 1255 (s), 1166 (m), 1028 (w), 975 (w), 915 (w), 843 (w), 813 (w);
HRMS (ESI) calcd. for $C_{26}H_{36}N_3O_7Si^+$ $[M+H]^+$ 530.2317; found 530.2327.

5. Scope of the enantioselective desymmetrization

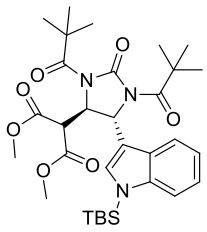
General procedure F:



2 **6** **7**

In a glovebox, an oven dried microwave vial was charged with copper(II) chloride (2.7 mg, 20 µmol, 0.2 equiv) and silver hexafluoroantimonate(V) (13.1 mg, 38.0 µmol, 0.38 equiv). The vial was protected from light with aluminum foil, taken out of the glovebox and put under N_2. A solution of ligand **10d** (15.8 mg, 24.0 µmol, 0.24 equiv) in 2 mL of dry toluene was added in the vial, and the suspension was stirred vigorously for 2 hours. Then the vial was cooled at the indicated temperature in a cryostat. After 10 minutes, a solution of the indole/pyrrole **6** (0.100 mmol, 1 equiv) and cyclopropane **2** (57.4 mg, 0.150 mmol, 1.5 equiv) in 2 mL of dry toluene was added dropwise. The reaction was stirred at the same temperature for the indicated time, diluted with 2 mL of a mixture of pentane:ethyl acetate 1:1 and then filtered on a pad of SiO_2, eluting with the same mixture (15 mL). The solution was concentrated and subjected to preparative TLC (SiO_2) with the specified eluent. The scratched SiO_2 was washed with 10 mL of ethyl acetate to afford the product.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7a**)



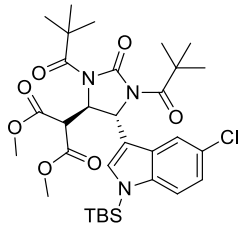
7a

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-1H-indole (**6a**) (23.1 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 18 hours and 30 minutes. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7a**) (49.0 mg, 80.0 µmol, 80% yield) as a white solid. Chiral HPLC conditions: er = 94.2:5.8; Chiralpak IB 97:3 Hexane/iPrOH, 1.0 mL/min, 30 min. t_r (minor) = 14.7 min. and t_r (major) = 16.1 min. λ = 280 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 8:2) 0.6;
Mp: 72.3-73.2 °C;
$[\alpha]_D^{20.0}$ = -22.7 (c = 0.24. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 – 7.74 (m, 1H, Ar*H*), 7.48 – 7.43 (m, 1H, Ar*H*), 7.18 – 7.09 (m, 2H, Ar*H*), 7.00 (s, 1H, Ar*H*), 5.90 (s, 1H, indole-C*H*), 4.79 (dd, *J* = 4.6, 1.2 Hz, 1H, indole-CH-C*H*), 4.14 (d, *J* = 4.6 Hz, 1H, C*H*(CO_2CH_3)$_2$), 3.75 (s, 6H, 2 x CO_2CH_3), 1.42 (s, 9H, C(CH_3)$_3$), 1.35 (s, 9H, C(CH_3)$_3$), 0.87 (s, 9H, SiC(CH_3)$_3$), 0.56 (s, 3H, SiCH_3), 0.54 (s, 3H, SiCH_3);

^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 167.2, 149.6, 141.8, 128.3, 128.2, 121.9, 120.1, 119.3, 117.1, 114.1, 58.7, 53.0, 52.8, 52.8, 51.7, 41.8, 41.8, 26.3, 26.2, 19.5, -4.0, -4.0;
IR (film) $\tilde{\nu}$ 2955 (w), 2934 (w), 2860 (w), 1758 (m), 1684 (w), 1454 (w), 1318 (w), 1261 (m), 1209 (w), 1156 (s), 1010 (w), 968 (w), 916 (w), 843 (w), 817 (w);
HRMS (ESI) calcd. for $C_{32}H_{47}N_3NaO_7Si^+$ $[M+Na]^+$ 636.3075; found 636.3077.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-chloro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7b**)

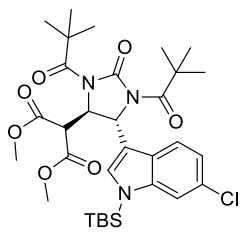


7b

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-5-chloro-1H-indole (**6b**) (26.6 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 42 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-chloro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7b**) (52.5 mg, 81.0 µmol, 81% yield) as a white solid. Chiral HPLC conditions: er = 95:5; Chiralpak IA 98:2 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 5.9 min. and t_r (major) = 7.2 min. λ = 260 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.51;
Mp: 131.2-132.0 °C;
$[\alpha]_D^{20.0}$ = -29.9 (c = 0.30. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 2.0 Hz, 1H, Ar*H*), 7.35 (d, *J* = 8.8 Hz, 1H, Ar*H*), 7.10 (dd, *J* = 8.8, 2.1 Hz, 1H, Ar*H*), 7.04 (s, 1H, Ar*H*), 5.84 (s, 1H, indole-C*H*), 4.74 (d, *J* = 4.5 Hz, 1H, indole-CH-C*H*), 4.16 (d, *J* = 4.5 Hz, 1H, C*H*($CO_2Me)_2$), 3.78 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3),1.44 (s, 9H, $C(CH_3)_3$), 1.34 (s, 9H, $C(CH_3)_3$), 0.85 (s, 9H, $SiC(CH_3)_3$), 0.55 (s, 3H, $SiCH_3$), 0.54 (s, 3H, $SiCH_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 149.4, 140.1, 129.8, 129.2, 126.0, 122.2, 118.8, 116.9, 115.0, 58.6, 52.9, 52.7, 51.6, 41.9, 41.8, 26.3, 26.3, 26.1, 19.4, -4.1 ppm (*one carbonyl and one $SiCH_3$ carbon signals are not resolved*);
IR (film) $\tilde{\nu}$ 2960 (w), 2933 (w), 2859 (w), 1763 (m), 1684 (m), 1440 (w), 1366 (w), 1319 (w), 1260 (m), 1202 (m), 1155 (s), 1006 (w), 969 (w), 842 (w);
HRMS (ESI) calcd. For $C_{32}H_{46}ClN_3NaO_7Si^+$ $[M+Na]^+$ 670.2686; found 670.2698.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-chloro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7c**)

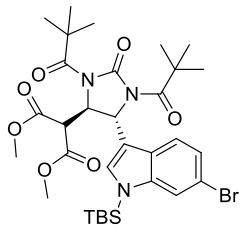


7c

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-6-chloro-1H-indole (**6c**) (26.6 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 44 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-chloro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7c**) (49.6 mg, 77.0 µmol, 77% yield) as a white solid. Chiral HPLC conditions: er = 95.7:4.3; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 7.4 min. and t_r (major) = 9.7 min. λ = 260 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.5;
Mp: 126.3-128.8 °C;
$[\alpha]_D^{20.0}$ = -21.0 (c = 0.30. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.6 Hz, 1H, Ar*H*), 7.41 (d, *J* = 1.7 Hz, 1H, Ar*H*), 7.12 (dd, *J* = 8.5, 1.8 Hz, 1H, Ar*H*), 6.97 (s, 1H, Ar*H*), 5.87 (s, 1H, indole-C*H*), 4.74 (dd, *J* = 4.6, 1.1 Hz, 1H, indole-CH-C*H*), 4.13 (d, *J* = 4.6 Hz, 1H, C*H*(CO_2Me)$_2$), 3.75 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3), 1.42 (s, 9H, C(CH_3)$_3$), 1.35 (s, 9H, C(CH_3)$_3$), 0.87 (s, 9H, SiC(CH_3)$_3$), 0.55 (s, 3H, SiCH_3), 0.54 (s, 3H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 167.2, 149.5, 142.1, 128.6, 128.0, 126.8, 120.8, 120.1, 117.4, 113.9, 58.6, 52.9, 52.8, 52.7, 51.5, 41.8, 41.8, 26.3, 26.1, 19.3, -4.1 (*one aliphatic and one $SiCH_3$ carbon signals are not resolved*);
IR (film) $\tilde{\nu}$ 2952 (w), 2866 (w), 1762 (m), 1688 (w), 1436 (w), 1331 (w), 1263 (m), 1207 (w), 1158 (s), 973 (w), 850 (w), 757 (w);
HRMS (ESI) calcd. For $C_{32}H_{46}ClN_3NaO_7Si^+$ $[M+Na]^+$ 670.2686; found 670.2684.

Dimethyl 2-(5-(6-bromo-1-(*tert*-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7d**)



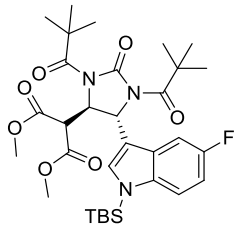
7d

Following general procedure **F**, 6-bromo-1-(tert-butyldimethylsilyl)-1H-indole (**6d**) (31.0 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 42 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(6-bromo-1-(tert-butyldimethylsilyl)-1H-indol-2-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7d)** (58.0 mg, 84.0 µmol, 84% yield) as a white solid. Chiral HPLC conditions: er = 95.2:4.8; Chiralpak IA 98:2 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 6.0 min. and t_r (major) = 7.3 min. λ = 260 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.51;
Mp: 71.2-71.9 °C;
$[\alpha]_D^{20.0}$ = -13.1 (c = 0.3. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.4 Hz, 1H, Ar*H*), 7.60 (s, 1H, Ar*H*), 7.29 (s, 1H, Ar*H*), 6.99 (s, 1H, Ar*H*), 5.89 (s, 1H, indole-C*H*), 4.76 (d, *J* = 4.4 Hz, 1H, indole-CH-C*H*), 4.16 (d, *J* = 4.3 Hz, 1H, C*H*(CO_2Me)$_2$), 3.77 (s, 6H, 2 x CO_2CH_3), 1.44 (s, 9H, C(CH_3)$_3$), 1.37 (s, 9H, C(CH_3)$_3$), 0.90 (s, 9H, SiC(CH_3)$_3$), 0.58 (s, 3H, SiCH_3), 0.57 (s, 3H, SiCH_3);

^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 167.2, 149.5, 142.6, 128.6, 127.1, 123.4, 120.5, 117.5, 116.9, 115.7, 58.6, 52.9, 52.8, 52.7, 51.5, 41.9, 41.8, 26.3, 26.1, 19.3, -4.0 (*one aliphatic and one $SiCH_3$ carbon signals are not resolved*);
IR (film) $\tilde{\nu}$ 2958 (w), 2866 (w), 1760 (m), 1686 (w), 1459 (w), 1435 (w), 1367 (w), 1330 (w), 1263 (m), 1213 (w), 1152 (s), 1005 (w), 974 (w), 845 (w), 759 (w);
HRMS (ESI) calcd. For $C_{32}H_{46}{}^{79}BrN_3NaO_7Si^+$ $[M+Na]^+$ 714.2181; found 714.2179.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-fluoro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7e**)

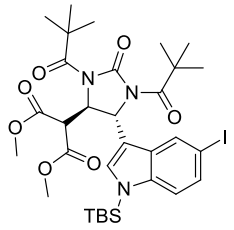


7e

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-5-methyl-1H-indole (**6e**) (24.9 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 42 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-fluoro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7e**) (45.8 mg, 72.0 µmol, 72% yield) as a colorless oil. Chiral HPLC conditions: er = 96:4; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 8.1 min. and t_r (major) = 9.2 min. λ = 280 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.58;
$[\alpha]_D^{20.0}$ = -20.3 (c = 0.30. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (dd, *J* = 9.8, 2.6 Hz, 1H, Ar*H*), 7.35 (dd, *J* = 9.0, 4.3 Hz, 1H, Ar*H*), 7.02 (s, 1H, Ar*H*), 6.90 (td, *J* = 9.0, 2.6 Hz, 1H, Ar*H*), 5.84 (s, 1H, indole-C*H*), 4.74 (dd, *J* = 4.7, 1.1 Hz, 1H, indole-CH-C*H*), 4.13 (d, *J* = 4.6 Hz, 1H, C*H*($CO_2Me)_2$), 3.77 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3), 1.42 (s, 9H, C($CH_3)_3$), 1.35 (s, 9H, C($CH_3)_3$), 0.85 (s, 9H, SiC($CH_3)_3$), 0.54 (s, 3H, SiCH_3), 0.53 (s, 3H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.4, 167.2, 167.2, 157.9 (d, *J* = 235.9 Hz), 149.4, 138.2, 129.7, 128.6 (d, *J* = 9.9 Hz), 117.3 (d, *J* = 4.8 Hz), 114.5 (d, *J* = 9.7 Hz), 110.2 (d, *J* = 26.0 Hz), 104.4 (d, *J* = 24.2 Hz), 58.6, 52.8, 52.7, 51.5, 41.8, 41.7, 26.3, 26.1, 19.4, -4.1 (*one aliphatic and one $SiCH_3$ carbon signals are not resolved*);
^{19}F NMR (376 MHz, $CDCl_3$) δ -123.7;
IR (film) $\tilde{\nu}$ 2953 (w), 2867 (w), 1763 (m), 1689 (w), 1479 (w), 1442 (w), 1368 (w), 1318 (w), 1263 (m), 1214 (m), 1158 (s), 1010 (w), 911 (w), 844 (w), 757 (w);
HRMS (ESI) calcd. For $C_{32}H_{46}FN_3NaO_7Si^+$ $[M+Na]^+$ 654.2981; found 654.2986.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-iodo-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7f**)

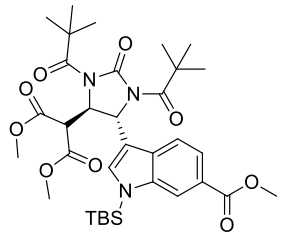


7f

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-5-iodo-1H-indole (**6f**) (35.7 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 42 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-iodo-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7f**) (57.4 mg, 78.0 µmol, 78% yield) as a white solid. Chiral HPLC conditions: er = 96.7:3.3; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 7.1 min. and t_r (major) = 10.1 min. λ = 260 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.58;
Mp: 71.0-71.5 °C;
$[\alpha]_D^{20.0}$ = -31.2 (c = 0.30. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 1.7 Hz, 1H, Ar*H*), 7.39 (dd, *J* = 8.7, 1.7 Hz, 1H, Ar*H*), 7.22 (d, *J* = 8.8 Hz, 1H, Ar*H*), 7.00 (s, 1H, Ar*H*), 5.83 (d, *J* = 1.1 Hz, 1H, indole-C*H*), 4.73 (dd, *J* = 4.5, 1.2 Hz, 1H, indole-CH-C*H*), 4.17 (d, *J* = 4.4 Hz, 1H, C*H*($CO_2Me)_2$), 3.78 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3), 1.45 (s, 9H, C($CH_3)_3$), 1.34 (s, 9H, C($CH_3)_3$), 0.85 (s, 9H, SiC($CH_3)_3$), 0.55 (s, 3H, SiCH_3), 0.54 (s, 3H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.1, 149.4, 140.8, 130.5, 130.2, 129.4, 128.0, 116.5, 116.0, 83.9, 58.6, 52.9, 52.8, 52.6, 51.6, 41.9, 41.8, 26.4, 26.3, 26.1, 19.4, -4.1 (*one $SiCH_3$ signal is not resolved*);
IR (film) $\tilde{\nu}$ 2955 (w), 2936 (w), 2862 (w), 1765 (m), 1684 (w), 1444 (w), 1364 (w), 1327 (w), 1259 (m), 1210 (m), 1154 (s), 846 (w), 809 (w), 759 (m);
HRMS (ESI) calcd. For $C_{32}H_{46}IN_3NaO_7Si^+$ $[M+Na]^+$ 762.2042; found 762.2048.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-(methoxycarbonyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7g**)



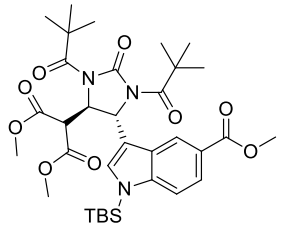
7g

Following general procedure **F**, methyl 1-(tert-butyldimethylsilyl)-1H-indole-6-carboxylate (**6g**) (28.9 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -30 °C for 42 hours. Preparative TLC using eluent 65:35 heptane:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-(methoxycarbonyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7g**) (49.2 mg, 73.0 µmol, 73% yield) as a white solid. Chiral HPLC conditions: er = 95.1:4.9; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 12.3 min. and t_r (major) = 14.8 min. λ = 260 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 8:2) 0.5;

Mp: 61.7-63.9 °C;
$[\alpha]_D^{20.0}$ = -9.1 (c = 0.35. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 1H, Ar*H*), 7.82 (dd, *J* = 8.4, 1.3 Hz, 1H, Ar*H*), 7.76 (d, *J* = 8.5 Hz, 1H, Ar*H*), 7.18 (s, 1H, Ar*H*), 5.90 (s, 1H, indole-C*H*), 4.76 (dd, *J* = 4.5, 1.2 Hz, 1H, indole-CH-C*H*), 4.15 (d, *J* = 4.5 Hz, 1H, C*H*(CO_2Me)$_2$), 3.92 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3), 1.43 (s, 9H, C(CH_3)$_3$), 1.34 (s, 9H, C(CH_3)$_3$), 0.88 (s, 9H, SiC(CH_3)$_3$), 0.60 (s, 3H, SiCH_3), 0.59 (s, 3H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.6, 168.0, 167.2, 167.2, 149.5, 141.1, 131.7, 131.7, 123.6, 121.2, 118.8, 117.6, 116.3, 58.6, 52.9, 52.8, 52.7, 52.0, 51.5, 41.9, 41.8, 26.3, 26.3, 26.1, 19.3, -4.0 (*one $SiCH_3$ carbon signal not resolved*);
IR (film) $\tilde{\nu}$ 2955 (w), 2930 (w), 2861 (w), 1760 (m), 1685 (w), 1442 (w), 1355 (w), 1293 (w), 1262 (m), 1162 (s), 1001 (w), 839 (w), 758 (w);
HRMS (ESI) calcd. For $C_{34}H_{49}N_3NaO_9Si^+$ $[M+Na]^+$ 694.3130; found 694.3141.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-(methoxycarbonyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7h**)

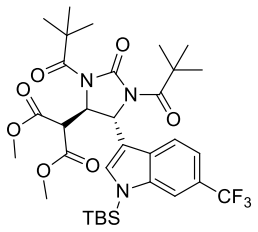


7h

Following general procedure **F**, methyl 1-(tert-butyldimethylsilyl)-1H-indole-5-carboxylate (**6g**) (35.7 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -40 °C for 47 hours. Preparative TLC using eluent 65:35 heptane:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-(methoxycarbonyl)-1H-indol-2-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7g**) (43.0 mg, 64.0 µmol, 64% yield) as a colorless oil. Chiral HPLC conditions: er = 92.8:7.2; Chiralpak IA 98:2 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 10.4 min. and t_r (major) = 14.9 min. λ = 280 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 8:2) 0.5;
$[\alpha]_D^{20.0}$ = -25.9 (c = 0.25. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (d, *J* = 1.8 Hz, 1H, Ar*H*), 7.86 (dd, *J* = 8.8, 1.7 Hz, 1H, Ar*H*), 7.46 (d, *J* = 8.8 Hz, 1H, Ar*H*), 7.11 (s, 1H, Ar*H*), 5.92 (s, 1H, indole-C*H*), 4.78 (dd, *J* = 4.4, 1.3 Hz, 1H, indole-CH-C*H*), 4.18 (d, *J* = 4.5 Hz, 1H, C*H*(CO_2Me)$_2$), 3.90 (s, 3H, CO_2CH_3), 3.79 (s, 3H, CO_2CH_3), 3.76 (s, 3H, CO_2CH_3), 1.44 (s, 9H, C(CH_3)$_3$), 1.34 (s, 9H, C(CH_3)$_3$), 0.87 (s, 9H, SiC(CH_3)$_3$), 0.58 (s, 3H, SiCH_3), 0.57 (s, 3H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.8, 167.2, 167.1, 149.4, 144.4, 129.9, 127.7, 123.3, 122.1, 121.8, 118.3, 113.7, 58.6, 52.8, 52.7, 51.7, 51.7, 41.8, 41.8, 26.3, 26.1, 19.4, -4.1 (*one aliphatic and one $SiCH_3$ carbon signals are not resolved*);
IR (film) $\tilde{\nu}$ 2959 (w), 2861 (w), 1757 (m), 1689 (m), 1436 (w), 1332 (m), 1264 (s), 1208 (m), 1159 (s), 968 (w), 844 (w), 814 (w), 758 (m);
HRMS (ESI) calcd. For $C_{34}H_{49}N_3NaO_9Si^+$ $[M+Na]^+$ 694.3130; found 694.3140.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-(trifluoromethyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7i**)

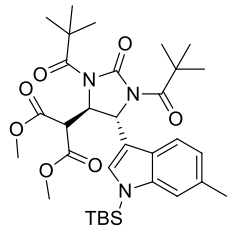


7i

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-6-(trifluoromethyl)-1H-indole (**6i**) (29.9 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -30 °C for 42 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-(trifluoromethyl)-1H-indol-2-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7i**) (56.0 mg, 82.0 µmol, 82% yield) as a white solid. Chiral HPLC conditions: er = 95:5; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 7.2 min. and t_r (major) = 8.8 min. λ = 260 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 8:2) 0.6;
Mp: 151.5-152.4 °C;
$[\alpha]_D^{20.0}$ = -36.7 (c = 0.10. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.4 Hz, 1H, Ar*H*), 7.71 (s, 1H, Ar*H*), 7.39 (dd, *J* = 8.5, 1.4 Hz, 1H, Ar*H*), 7.15 (s, 1H, Ar*H*), 5.92 (s, 1H, indole-C*H*), 4.75 (dd, *J* = 4.5, 1.1 Hz, 1H, indole-CH-C*H*), 4.15 (d, *J* = 4.5 Hz, 1H, C*H*($CO_2Me)_2$), 3.76 (s, 3H, CO_2CH_3), 3.76 (s, 3H, CO_2CH_3), 1.43 (s, 9H, $C(CH_3)_3$), 1.35 (s, 9H, $C(CH_3)_3$), 0.88 (s, 9H, $SiC(CH_3)_3$), 0.59 (s, 3H, $SiCH_3$), 0.58 (s, 3H, $SiCH_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 167.2, 149.4, 140.6, 130.7, 130.5, 125.1 (q, *J* = 271.6 Hz), 124.0 (q, *J* = 31.7 Hz), 119.7, 117.7, 116.9 (q, *J* = 3.6 Hz), 111.3 (q, *J* = 4.2 Hz), 58.6, 52.9, 52.8, 52.6, 51.4, 41.8, 41.7, 26.3, 26.2, 26.0, 19.3, -4.1 (*one $SiCH_3$ carbon is not resolved*);
^{19}F NMR (376 MHz, $CDCl_3$) δ -60.8;
IR (film) $\tilde{\nu}$ 2953 (w), 2935 (w), 2867 (w), 1763 (m), 1689 (w), 1442 (w), 1337 (m), 1263 (m), 1208 (w), 1158 (s), 1121 (w), 980 (w), 838 (w), 758 (w);
HRMS (ESI) calcd. For $C_{33}H_{46}F_3N_3NaO_7Si^+$ $[M+Na]^+$ 704.2949; found 704.2966.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-methyl-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7j**)



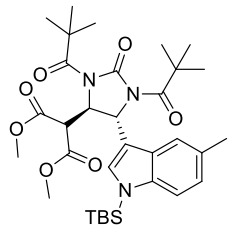
7j

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-6-methyl-1H-indole (**6j**) (24.5 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 44 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-methyl-1H-indol-2-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7j**) (51.2 mg, 82.0 µmol, 82% yield) as a white solid. Chiral HPLC conditions: er = 90.7:9.3; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 6.7 min. and t_r (major) = 9.1 min. λ = 260 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.5;

Mp: 65.2-67.0 °C;
$[\alpha]_D^{20.0}$ = -12.4 (c = 0.29. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 8.1 Hz, 1H, Ar*H*), 7.23 (s, 1H, Ar*H*), 6.97 (d, *J* = 8.2 Hz, 1H, Ar*H*), 6.94 (s, 1H, Ar*H*), 5.86 (s, 1H, indole-C*H*), 4.78 (dd, *J* = 4.6, 1.2 Hz, 1H, indole-CH-C*H*), 4.14 (d, *J* = 4.6 Hz, 1H, C*H*(CO_2Me)$_2$), 3.74 (s, 6H, 2 x CO_2CH_3), 2.43 (s, 3H, C*H*$_3$), 1.42 (s, 9H, C(C*H*$_3$)$_3$), 1.34 (s, 9H, C(C*H*$_3$)$_3$), 0.87 (s, 9H, SiC(C*H*$_3$)$_3$), 0.55 (s, 3H, SiC*H*$_3$), 0.53 (s, 3H, SiC*H*$_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 167.2, 149.6, 142.2, 131.5, 127.7, 126.0, 121.8, 118.8, 116.9, 114.1, 58.7, 53.0, 52.8, 52.8, 51.7, 41.8, 41.8, 26.3, 26.2, 22.0, 19.4, -3.9, -4.0;
IR (film) $\tilde{\nu}$ 2959 (w), 2928 (w), 2860 (w), 1762 (m), 1738 (m), 1682 (m), 1442 (w), 1362 (w), 1331 (m), 1257(m), 1207 (m), 1152 (s), 1010 (w), 844 (w), 807 (m), 757 (m);
HRMS (ESI) calcd. For $C_{33}H_{49}N_3NaO_7Si^+$ $[M+Na]^+$ 650.3232; found 650.3234.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-methyl-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7k**)

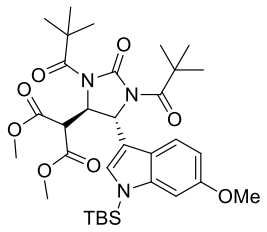


7k

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-5-methyl-1H-indole (**6k**) (24.5 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 42 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-methyl-1H-indol-2-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7k**) (48.2 mg, 77.0 μmol, 77% yield) as a white solid. Chiral HPLC conditions: er = 95:5; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 7.2 min. and t_r (major) = 8.8 min. λ = 260 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.58;
Mp: 68.5-69.7 °C;
$[\alpha]_D^{20.0}$ = -18.1 (c = 0.21. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (s, 1H, Ar*H*), 7.34 (d, *J* = 8.4 Hz, 1H, Ar*H*), 7.01 (s, 1H, Ar*H*), 6.97 (d, *J* = 8.5 Hz, 1H, Ar*H*), 5.86 (s, 1H, indole-C*H*), 4.79 (d, *J* = 4.5 Hz, 1H, indole-CH-C*H*), 4.16 (d, *J* = 3.9 Hz, 1H, C*H*(CO_2Me)$_2$), 3.75 (s, 6H, 2 x CO_2CH_3), 2.42 (s, 3H, C*H*$_3$), 1.44 (s, 9H, C(C*H*$_3$)$_3$), 1.34 (s, 9H, C(C*H*$_3$)$_3$), 0.87 (s, 9H, C(C*H*$_3$)$_3$), 0.55 (s, 3H, SiC*H*$_3$), 0.54 (s, 3H, SiC*H*$_3$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 178.9, 177.5, 167.2, 167.1, 149.6, 140.0, 129.2, 128.8, 128.3, 123.3, 118.8, 116.5, 113.7, 58.7, 53.0, 52.8, 52.7, 51.7, 41.8, 41.8, 26.3, 26.3, 26.2, 21.4, 19.4, -4.1 (*one SiCH*$_3$ *carbon signal is not resolved*);
IR (film) $\tilde{\nu}$ 2954 (w), 2861 (w), 1764 (m), 1689 (w), 1466 (w), 1367 (w), 1262 (w), 1156 (s), 1001 (w), 840 (w), 791 (w), 760 (w);
HRMS (ESI) calcd. For $C_{33}H_{49}N_3NaO_7Si^+$ $[M+Na]^+$ 650.3232; found 650.3232.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-methoxy-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7l**)

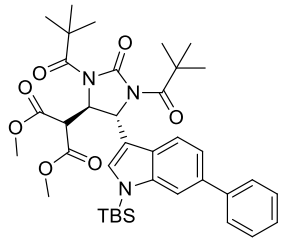


7l

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-6-methoxy-1H-indole **6l** (26.1 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 48 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate, followed by a second preparative TLC using eluent 92:8 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-methoxy-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate **7l** (41.2 mg, 64.0 µmol, 64% yield) as a white solid. Chiral HPLC conditions: er = 93.4:6.6; Chiralpak IA 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 9.1 min. and t_r (major) = 13.0 min. λ = 260 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.54;
Mp: 71.4-71.7 °C;
$[\alpha]_D^{20.0}$ = -22.3 (c = 0.24. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.8 Hz, 1H, Ar*H*), 6.95 (d, *J* = 2.2 Hz, 1H, Ar*H*), 6.87 (s, 1H, Ar*H*), 6.82 (dd, *J* = 8.7, 2.2 Hz, 1H, Ar*H*), 5.85 (t, *J* = 0.8 Hz, 1H, indole-C*H*), 4.77 (dd, *J* = 4.7, 1.1 Hz, 1H, indole-CH-C*H*), 4.12 (d, *J* = 4.7 Hz, 1H, C*H*($CO_2Me)_2$), 3.82 (s, 3H, OCH_3), 3.75 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3), 1.41 (s, 9H, C(C$H_3)_3$), 1.35 (s, 9H, C(C$H_3)_3$), 0.88 (s, 9H, SiC(C$H_3)_3$), 0.54 (s, 3H, SiCH_3), 0.53 (s, 3H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 167.2, 156.1, 149.6, 142.6, 126.8, 122.7, 119.7, 117.1, 109.1, 98.6, 58.7, 55.7, 53.0, 52.8, 52.8, 51.6, 41.8, 41.8, 26.3, 26.2, 19.5, -4.1, -4.1 (*one aliphatic carbon signal is not resolved*);
IR (film) $\tilde{\nu}$ 2959 (w), 2860 (w), 1756 (m), 1737 (w), 1682 (w), 1621 (w), 1559 (w), 1442 (w), 1325 (w), 1257 (m), 1207(m), 1152 (m), 1035 (w), 985 (w), 844 (w), 801 (w), 757 (m);
HRMS (ESI) calcd. For $C_{33}H_{49}N_3NaO_8Si^+$ $[M+Na]^+$ 666.3181; found 666.3182.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-phenyl-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7m**)

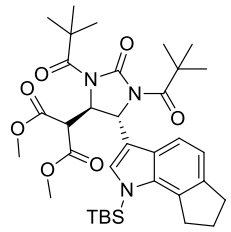


7m

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-6-phenyl-1H-indole (**6m**) (30.8 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 48 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-phenyl-1H-indol-2-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7m**) (51.7 mg, 75.0 µmol, 75% yield) as a white solid. Chiral HPLC conditions: er = 92.3:7.7; Chiralpak IB 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 8.1 min. and t_r (major) = 9.3 min. λ = 280 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.57;
Mp: 155.0-156.2 °C;
$[\alpha]_D^{20.0}$ = -9.3 (c = 0.30. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 8.3 Hz, 1H, Ar*H*), 7.65 (s, 1H, Ar*H*), 7.59 (d, *J* = 7.2 Hz, 2H, Ar*H*), 7.44 (t, *J* = 7.7 Hz, 2H, Ar*H*), 7.40 (dd, *J* = 8.3, 1.5 Hz, 1H, Ar*H*), 7.32 (t, *J* = 7.4 Hz, 1H, Ar*H*), 7.04 (s, 1H, Ar*H*), 5.92 (s, 1H, indole-C*H*), 4.81 (dd, *J* = 4.6, 1.2 Hz, 1H, indole-CH-C*H*), 4.16 (d, *J* = 4.6 Hz, 1H, C*H*(CO_2Me)$_2$), 3.77 (s, 3H, CO_2CH_3), 3.76 (s, 3H, CO_2CH_3), 1.44 (s, 9H, C(CH_3)$_3$), 1.36 (s, 9H, C(CH_3)$_3$), 0.91 (s, 9H, SiC(CH_3)$_3$), 0.59 (s, 3H, CH_3), 0.58 (s, 3H, CH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.0, 177.5, 167.2, 149.6, 142.5, 142.3, 135.4, 128.8, 128.7, 127.5, 127.3, 126.6, 120.0, 119.4, 117.2, 112.7, 58.7, 52.9, 52.8, 52.8, 51.6, 41.8, 41.8, 26.3, 26.2, 19.4, -4.0 (*one carbonyl, one aliphatic and one $SiCH_3$ carbon signals are not resolved*);
IR (film) $\tilde{\nu}$ 2954 (w), 2861 (w), 1758 (m), 1690 (m), 1468 (w), 1431 (w), 1333 (w), 1258 (m), 1203 (m), 1154 (s), 975 (w), 839 (w), 759 (w);
HRMS (ESI) calcd. For $C_{38}H_{51}N_3NaO_7Si^+$ $[M+Na]^+$ 712.3388; found 712.3390.

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-1,6,7,8-tetrahydrocyclopenta[g]indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7n**)

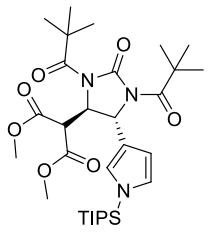


7n

Following general procedure **F**, 1-(tert-butyldimethylsilyl)-1,6,7,8-tetrahydrocyclopenta[g]indole (**6n**) (28.9 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -50 °C for 42 hours. Preparative TLC using eluent 9:1 toluene:ethyl acetate afforded dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-1,6,7,8-tetrahydrocyclopenta[g]indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7n**) (39.4 mg, 60.0 µmol, 60% yield) as a white solid. Chiral HPLC conditions: er = 90.5:9.5; Chiralpak IA 98:2 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 5.7 min. and t_r (major) = 7.3 min. λ = 280 cm^{-1}.

R_f: (SiO_2, toluene:ethyl acetate 9:1) 0.51;
Mp: 70.7-71.1 °C;
$[\alpha]_D^{20.0}$ = -11.7 (c = 0.20. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 8.0 Hz, 1H, Ar*H*), 7.12 (d, *J* = 8.0 Hz, 1H, Ar*H*), 7.05 (s, 1H, Ar*H*), 5.87 (s, 1H, indole-C*H*), 4.78 (dd, *J* = 4.5, 1.2 Hz, 1H, indole-CH-C*H*), 4.13 (d, *J* = 4.5 Hz, 1H, C*H*(CO_2Me)$_2$), 3.75 (s, 3H, CO_2CH_3), 3.75 (s, 3H, CO_2CH_3), 3.13 (t, *J* = 7.2 Hz, 2H, C$H_2CH_2CH_2$), 2.99 (t, *J* = 7.3 Hz, 2H, $CH_2CH_2CH_2$), 2.10 (p, *J* = 7.3 Hz, 2H, $CH_2CH_2CH_2$), 1.43 (s, 9H, C(CH_3)$_3$), 1.35 (s, 9H, C(CH_3)$_3$), 0.84 (s, 9H, SiC(CH_3)$_3$), 0.58 (s, 3H, SiCH_3), 0.56 (s, 3H, SiCH_3);
^{13}C NMR (101 MHz, $CDCl_3$) δ 178.9, 177.3, 167.2, 167.1, 149.6, 139.7, 139.4, 129.1, 128.0, 127.1, 117.6, 117.3, 117.2, 58.6, 52.9, 52.8, 52.7, 51.8, 41.8, 41.7, 34.5, 33.2, 26.5, 26.3, 25.9, 19.6, -1.1, -1.1;
IR (film) $\tilde{\nu}$ 2958 (w), 2860 (w), 1761 (w), 1687 (w), 1472 (w), 1435 (w), 1319 (w), 1257 (m), 1208 (m), 1153 (s), 1036 (w), 846 (w), 809 (w), 754 (w);
HRMS (ESI) calcd. For $C_{35}H_{51}N_3NaO_7Si^+$ $[M+Na]^+$ 676.3388; found 676.3400.

Dimethyl 2-(2-oxo-1,3-dipivaloyl-5-(1-(triisopropylsilyl)-1H-pyrrol-3-yl)imidazolidin-4-yl)malonate (**7o**)



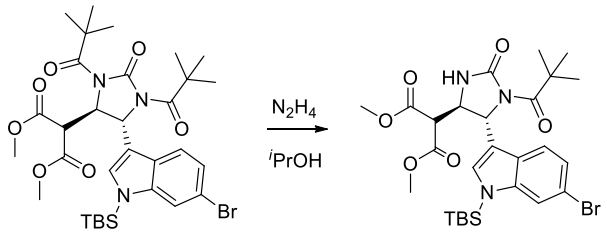
7o

Following general procedure **F**, 1-(triisopropylsilyl)-1H-pyrrole (**6o**) (22.3 mg, 0.100 mmol, 1 equiv) and cyclopropane **2** were stirred at -30 °C for 42 hours. Preparative TLC using eluent 65:35 heptane:ethyl acetate afforded dimethyl 2-(2-oxo-1,3-dipivaloyl-5-(1-(triisopropylsilyl)-1H-pyrrol-3-yl)imidazolidin-4-yl)malonate (**7o**) (42.1 mg, 69.0 µmol, 69% yield) as a colorless oil. Chiral HPLC conditions: er = 88.8:11.2; Chiralpak IF 99:1 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (minor) = 14.2 min. and t_r (major) = 15.3 min. λ = 260 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 8:2) 0.44;
$[\alpha]_D^{20.0}$ = -5.3 (c = 0.21. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 6.66 (t, *J* = 2.5 Hz, 1H, Ar*H*), 6.61 (s, 1H, Ar*H*), 6.21 (dd, *J* = 2.8, 1.5 Hz, 1H, Ar*H*), 5.55 (s, 1H, pyrrol-C*H*), 4.76 (dd, *J* = 4.8, 1.1 Hz, 1H, pyrrol-CH-C*H*), 4.08 (d, *J* = 4.8 Hz, 1H, C*H*($CO_2Me)_2$), 3.74 (s, 3H, CO_2CH_3), 3.70 (s, 3H, CO_2CH_3), 1.40-1.32 (m, 21H, 2 x C($CH_3)_3$ + 3 x SiC*H*), 1.07-1.01 (m, 18H, CH($CH_3)_2$);
^{13}C NMR (101 MHz, $CDCl_3$) δ 179.4, 177.5, 167.3, 167.2, 149.4, 125.0, 124.9, 121.0, 108.1, 59.6, 53.5, 52.7, 52.7, 51.7, 41.8, 41.7, 26.4, 26.3, 17.8, 11.6;
IR (film) $\tilde{\nu}$ 2952 (w), 2869 (w), 1755 (m), 1736 (m), 1682 (m), 1464 (w), 1436 (w), 1354 (w), 1315 (w), 1260 (m), 1206 (m), 1152 (s), 1099 (m), 1011 (w), 856 (w), 749 (w), 691 (w);
HRMS (ESI) calcd. For $C_{31}H_{51}N_3NaO_7Si^+$ $[M+Na]^+$ 628.3388; found 628.3396.

6. Derivatizations of the products

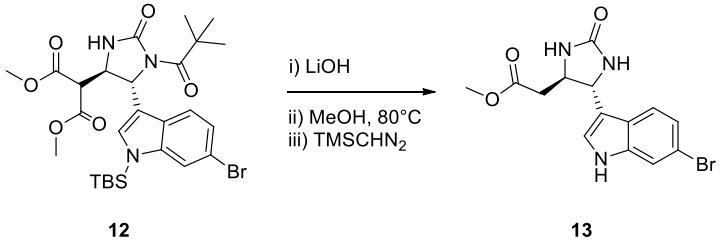
Dimethyl 2-(5-(6-bromo-1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1-pivaloylimidazolidin-4-yl)malonate (12)



In a microwave vial, a solution of dimethyl 2-(5-(6-bromo-1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (**7d**) (111 mg, 0.160 mmol, 1 equiv) in 2.8 mL of isopropanol was added, followed by hydrazine (80% wt in water, 14.6 µL, 0.240 mmol, 1.5 equiv) and stirred for 20 minutes. Then, 1 mL of a 1 M HCl aqueous solution was added, followed by 2 mL of water. The aqueous phase was extracted with 3x5 mL of dichloromethane, dried over Na_2SO_4, filtered and evaporated, to afford dimethyl 2-(5-(6-bromo-1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1-pivaloylimidazolidin-4-yl)malonate (**12**) (92.0 mg, 0.151 mmol, 94% yield) as a white solid. Chiral HPLC conditions: er = 95.8:4.2; Chiralpak IA 90:10 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (major) = 12.3 min. and t_r (minor) = 15.3 min. λ = 260 cm^{-1}.

R_f: (SiO_2, pentane:ethyl acetate 2:1) 0.52;
Mp: 68.8 °C (degradation);
$[\alpha]_D^{20.0}$ = 25.7 (c =0.15. $CHCl_3$);
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 1.8 Hz, 1H, Ar*H*), 7.51 (d, *J* = 8.5 Hz, 1H, Ar*H*), 7.23 (dd, *J* = 8.5, 1.7 Hz, 1H, Ar*H*), 7.06 (s, 1H, Ar*H*), 5.69 (s, 1H, N*H*), 5.63 (d, *J* = 3.0 Hz, 1H, indole-C*H*), 4.16 (ddd, *J* = 7.5, 3.1, 1.4 Hz, 1H, indole-CH-C*H*), 3.78 (s, 3H, CO_2CH_3), 3.71 (s, 3H, CO_2CH_3), 3.67 (d, *J* = 7.4 Hz, 1H, $CH(CO_2CH_3)_2$), 1.28 (s, 9H, $C(CH_3)_3$), 0.88 (s, 9H, $SiC(CH_3)_3$), 0.58 (s, 3H, $SiCH_3$), 0.57 (s, 3H, $SiCH_3$).
^{13}C NMR (101 MHz, $CDCl_3$) δ 178.3, 167.2, 167.0, 154.1, 142.5, 129.7, 126.9, 123.4, 119.9, 117.1, 116.9, 115.5, 56.1, 55.7, 55.0, 53.2, 53.0, 41.5, 26.4, 26.1, 19.3, -4.0, -4.0.
IR (film) $\tilde{\nu}$ 3291 (w), 2955 (w), 2931 (w), 2860 (w), 1734 (s), 1675 (w), 1460 (w), 1434 (w), 1286 (w), 1194 (m), 1152 (m), 973 (w), 838 (w), 805 (w), 756 (w);
HRMS (ESI) calcd. For $C_{27}H_{39}{}^{79}BrN_3O_6Si^+$ $[M+H]^+$ 608.1786; found 608.1789.

Methyl 2-(5-(6-bromo-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)acetate (13)



i) dimethyl 2-(5-(6-bromo-1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1-pivaloylimidazolidin-4-yl)malonate (**12**) (64.0 mg, 0.105 mmol, 1 equiv) was dissolved in 0.7 mL of tetrahydrofuran in a microwave vial, and a 0.5 M aqueous solution of LiOH (1.7 mL, 0.84 mmol, 8 equiv) was added, and the mixture stirred for 13 hours at room temperature. The reaction was acidified to pH 1 using a 1 M

aqueous HCl solution. The aqueous layer was extracted with 3x3 mL of ethyl acetate. The combined organic layers were washed with 7 mL of 1 M aqueous NaOH solution. The aqueous layer was extracted with 5 mL of ethyl acetate, and then acidified to pH 1 using 1 M aqueous HCl solution, and finally extracted with 3x10 mL of ethyl acetate. The combined organic layers were dried over Na_2SO_4, filtered and concentrated to afford crude product.

ii) The crude product was dissolved in 2.1 mL of methanol, and heated to 80 °C for 16 hours, then cooled to rt.

iii) The solution was cooled to 0 °C, and a 2 M solution of TMSdiazomethane in diethyl ether (0.53 mL, 1.1 mmol, 10 equiv) was added until gas evolution ceased. The solution was then evaporated and subjected to column chromatography (SiO_2, eluent dichloromethane:methanol 100:0 to 98:2 to 95:5) to afford methyl 2-(5-(6-bromo-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)acetate (**13**) (20.9 mg, 59.0 µmol, 56% yield over three steps) as a pale brown solid. Chiral HPLC conditions: er = 96.3:3.7; Chiralpak IC 50:50 Hexane/iPrOH, 1.0 mL/min, 31 min. t_r (major) = 9.7 min. and t_r (minor) = 13.4 min. λ = 210 cm^{-1}.

R_f: (SiO_2, dichloromethane:methanol 9:1) 0.28;
Mp: 87.0 - 88.9 °C;
$[\alpha]_D^{20.0}$ = 97.4 (c = 0.24. MeOH);
^{1}H NMR (400 MHz, CD_3OD) δ 7.60 (d, *J* = 8.5 Hz, 1H, Ar*H*), 7.54 (d, *J* = 1.7 Hz, 1H, Ar*H*), 7.27 (s, 1H, Ar*H*), 7.15 (dd, *J* = 8.5, 1.8 Hz, 1H, Ar*H*), 4.76 (d, *J* = 6.5 Hz, 1H, Indole-C*H*), 4.15 – 4.06 (m, 1H, indole-CH-C*H*), 3.63 (s, 3H, CH_3) 2.73 – 2.63 (m, 2H).
^{13}C NMR (101 MHz, CD_3OD) δ 172.9, 165.2, 139.6, 125.6, 125.1, 123.3, 121.5, 116.3, 116.1, 115.5, 58.3, 56.9, 52.2, 40.4.
IR (film) $\tilde{\nu}$ 3249 (w), 2952 (w), 2924 (w), 2854 (w), 1691 (s), 1614 (w), 1546 (w), 1440 (w), 1360 (w), 1332 (w), 1213 (w), 1176 (w), 1106 (w), 1050 (w), 896 (w), 804 (w), 759 (w);
HRMS (ESI) calcd. For $C_{14}H_{15}{}^{79}BrN_3O_3^+$ $[M+H]^+$ 352.0291; found 352.0292.

7.Crystal structure of 7d

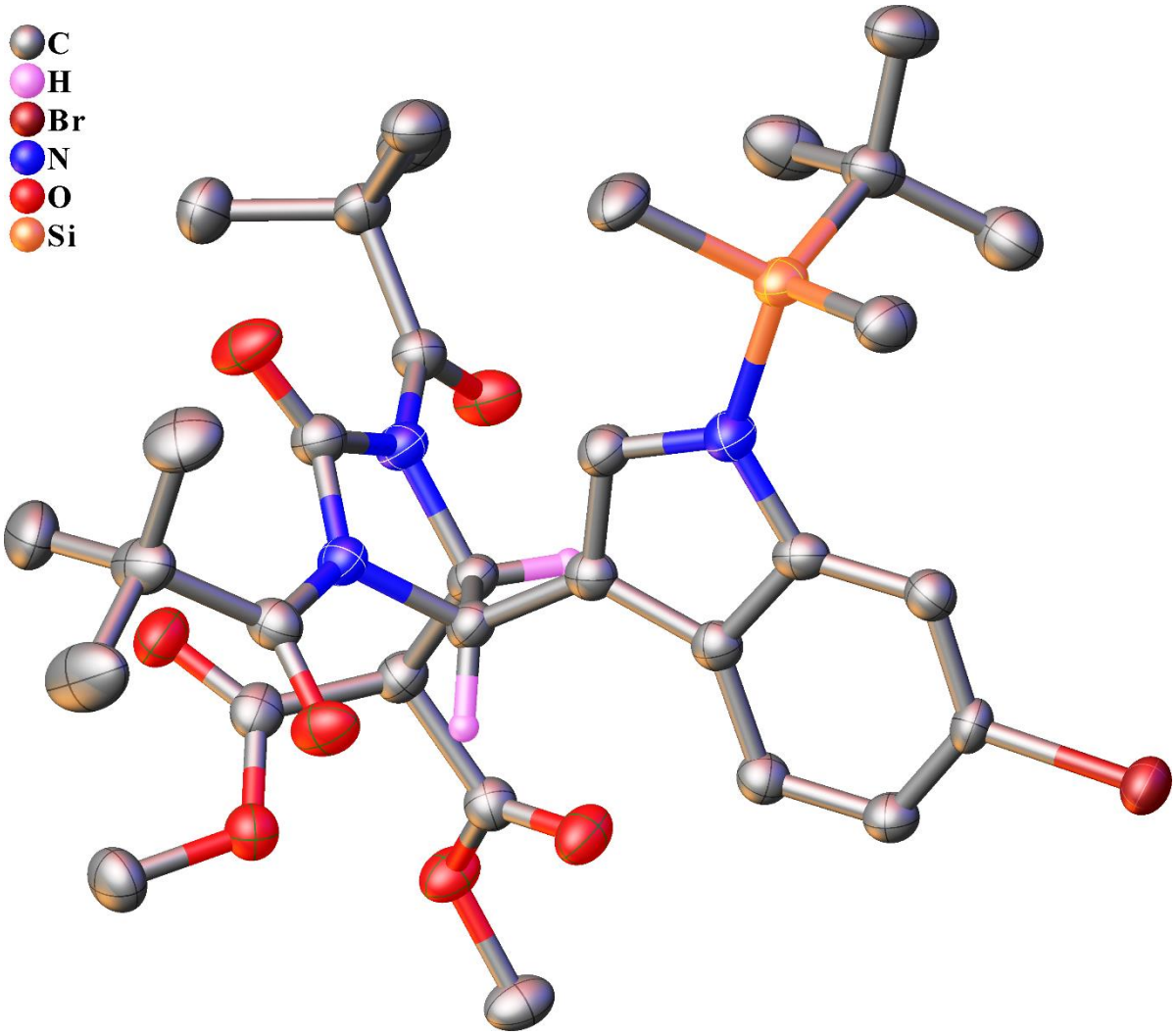


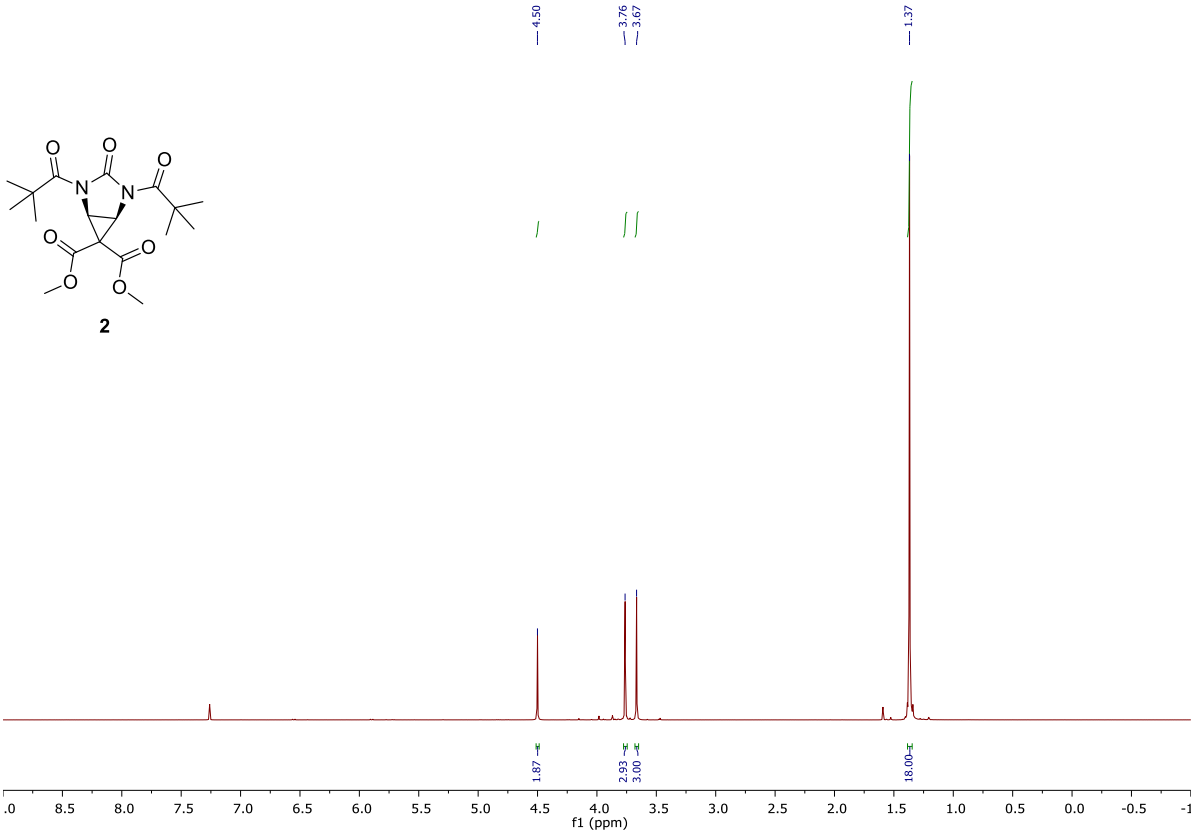
Figure S1. Crystal structure of **7d**.

A single crystal was grown by slow evaporation of the solution of **7d** in Methanol. Supplementary crystallographic data for this compound have been deposited at Cambridge Crystallographic Data Centre (1815214) and can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.

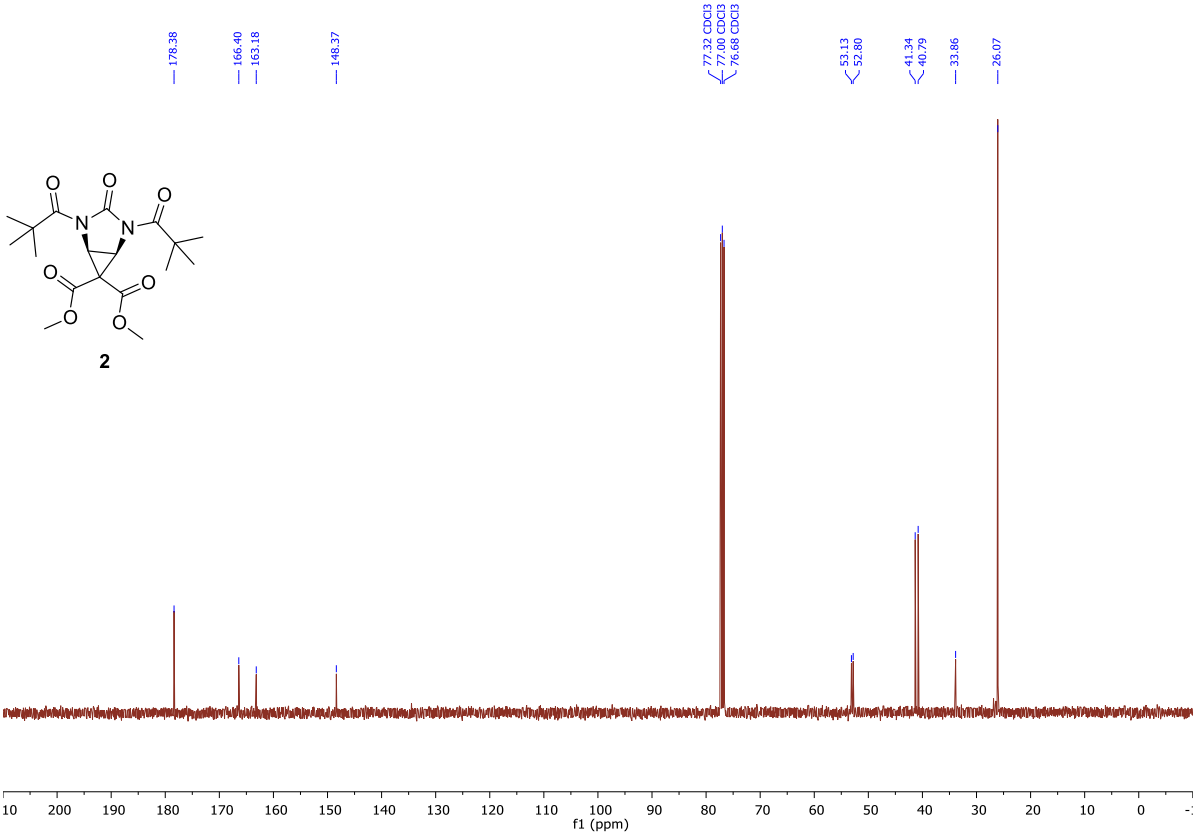
8. Spectra of new compounds

Dimethyl 3-oxo-2,4-dipivaloyl-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (2)

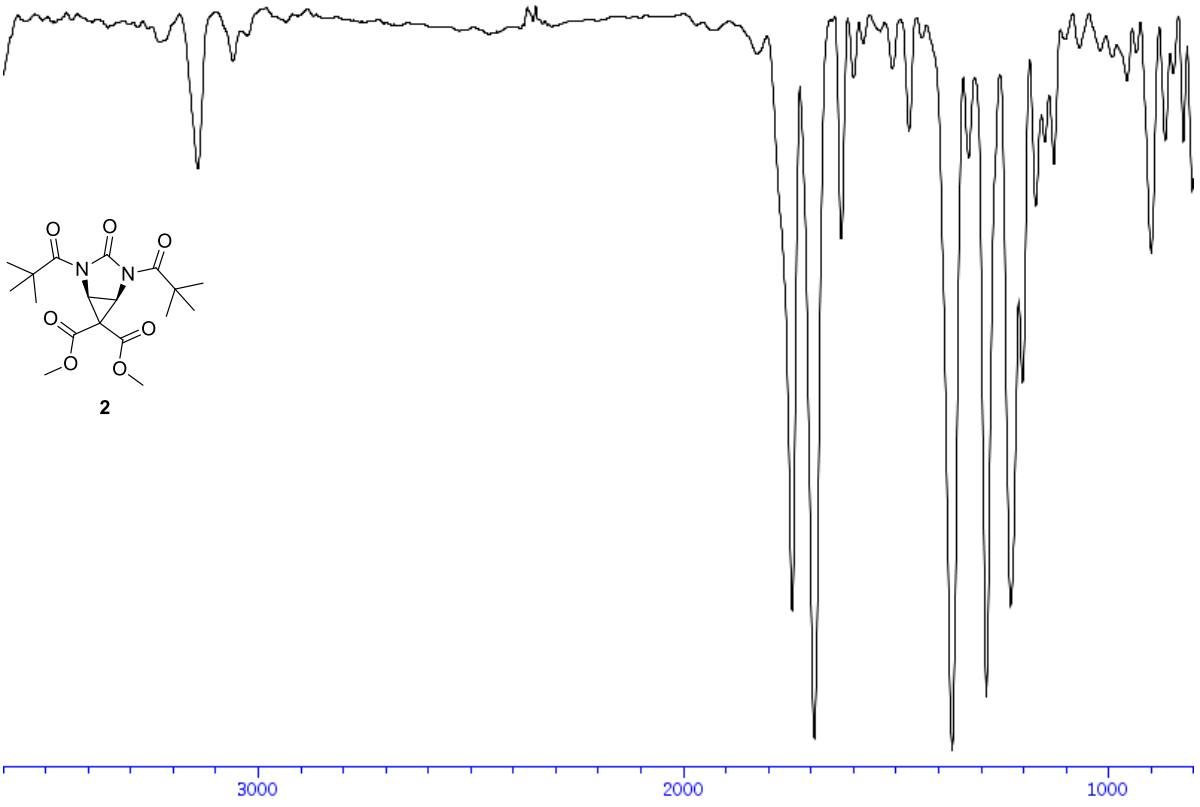
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



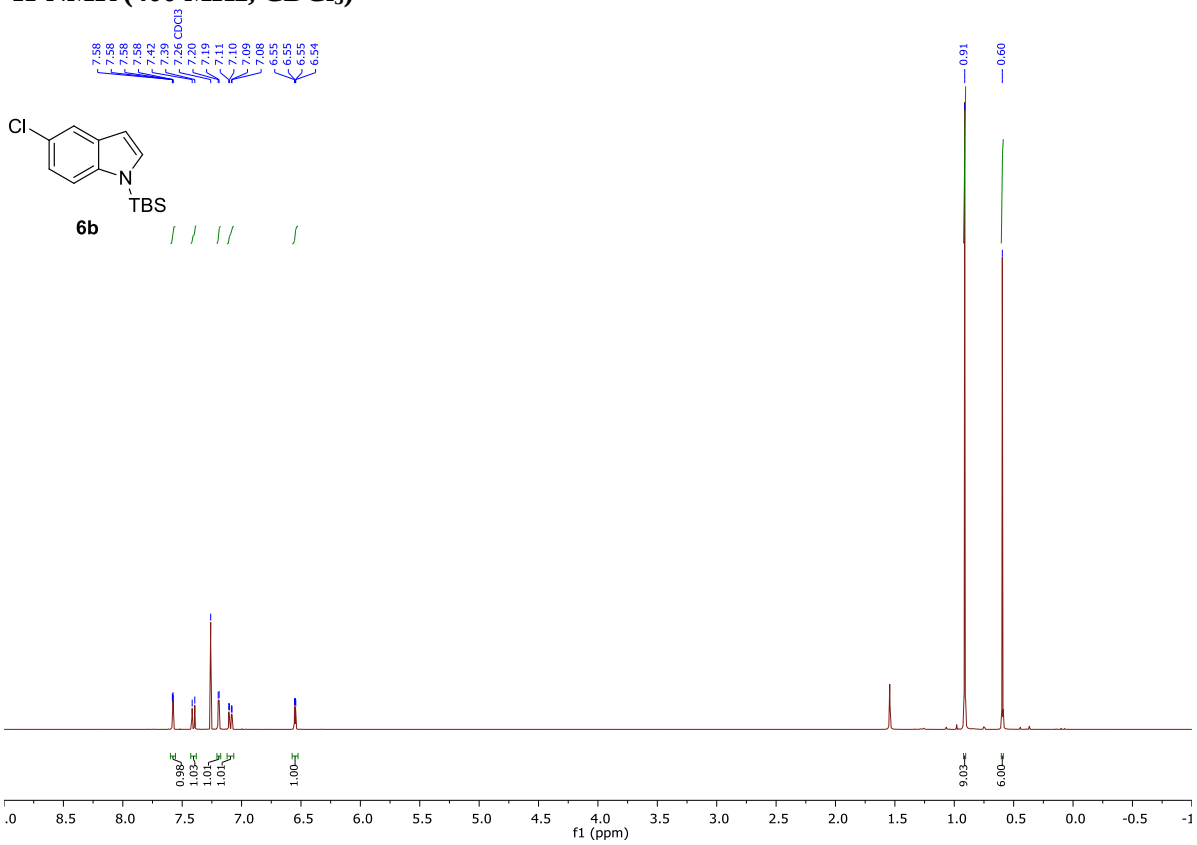
IR



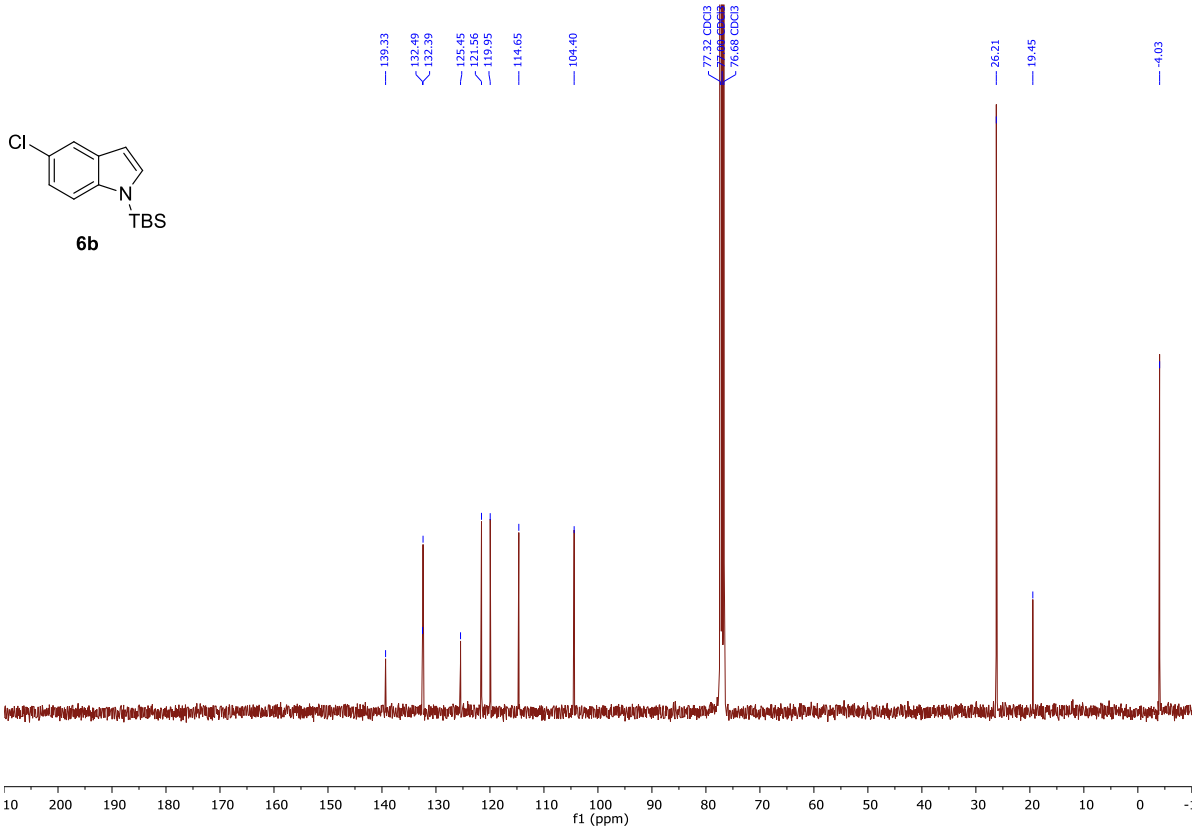
2

1-(*Tert*-butyldimethylsilyl)-5-chloro-1H-indole (6b)

^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



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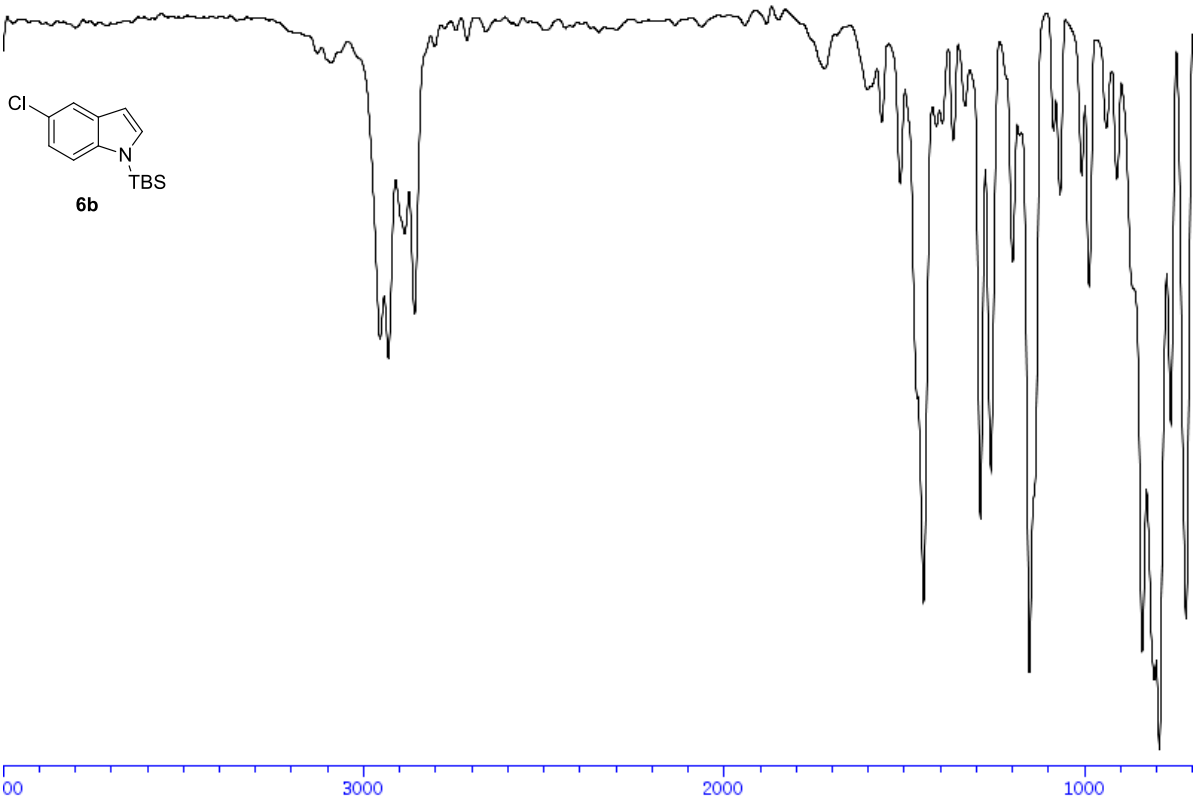
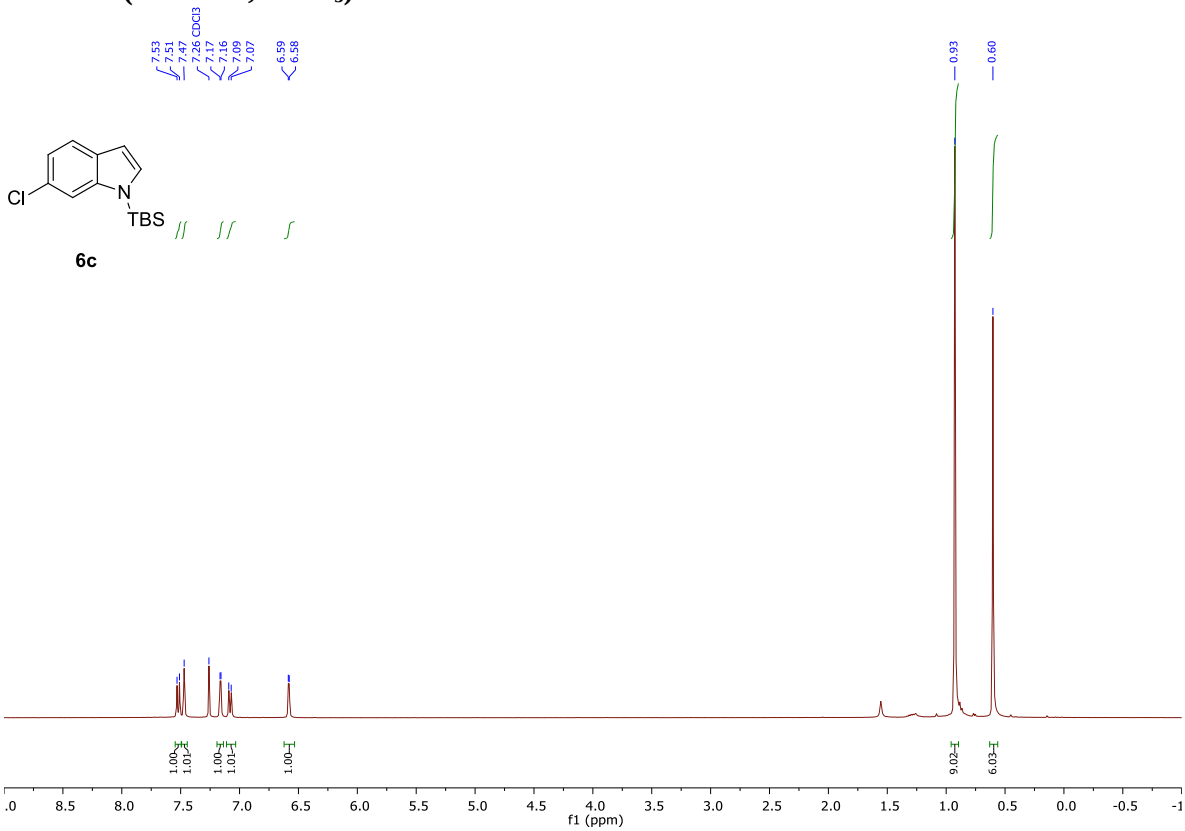
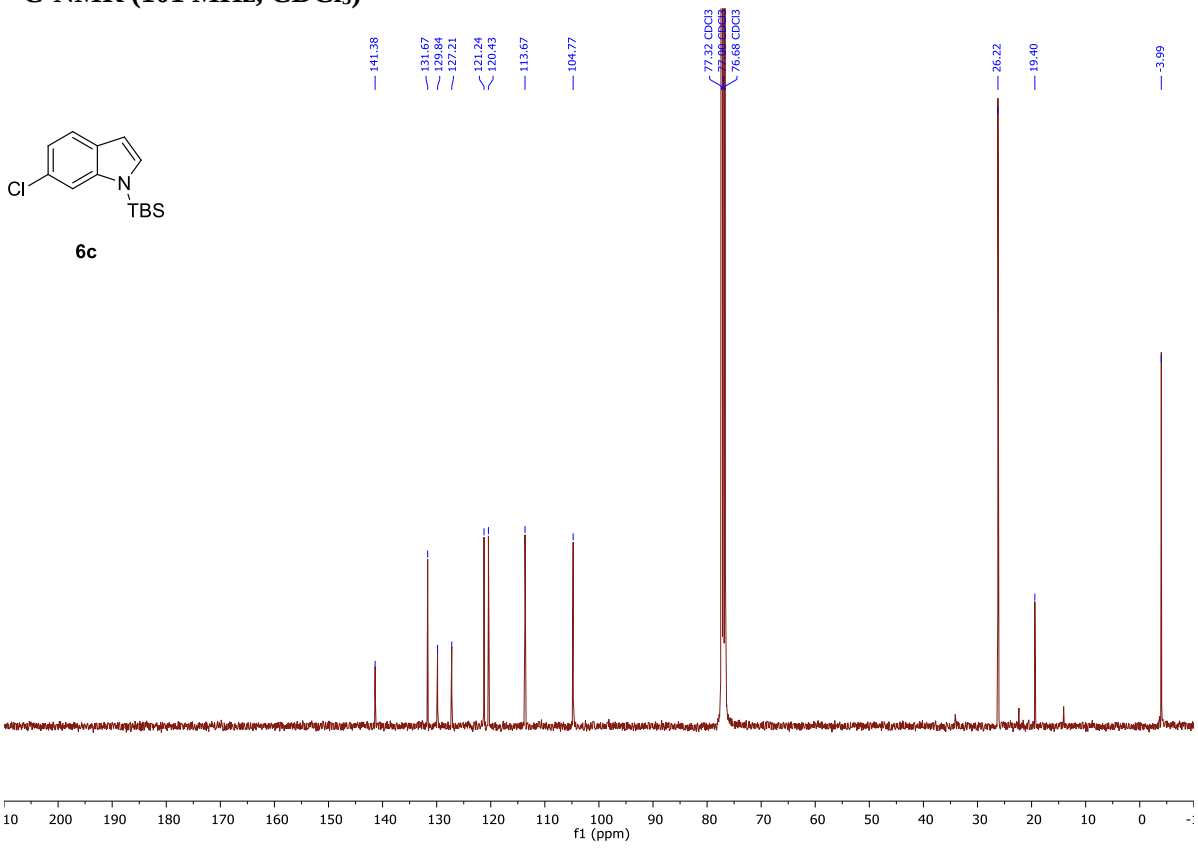


1-(*Tert*-butyldimethylsilyl)-6-chloro-1H-indole (6c)

^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



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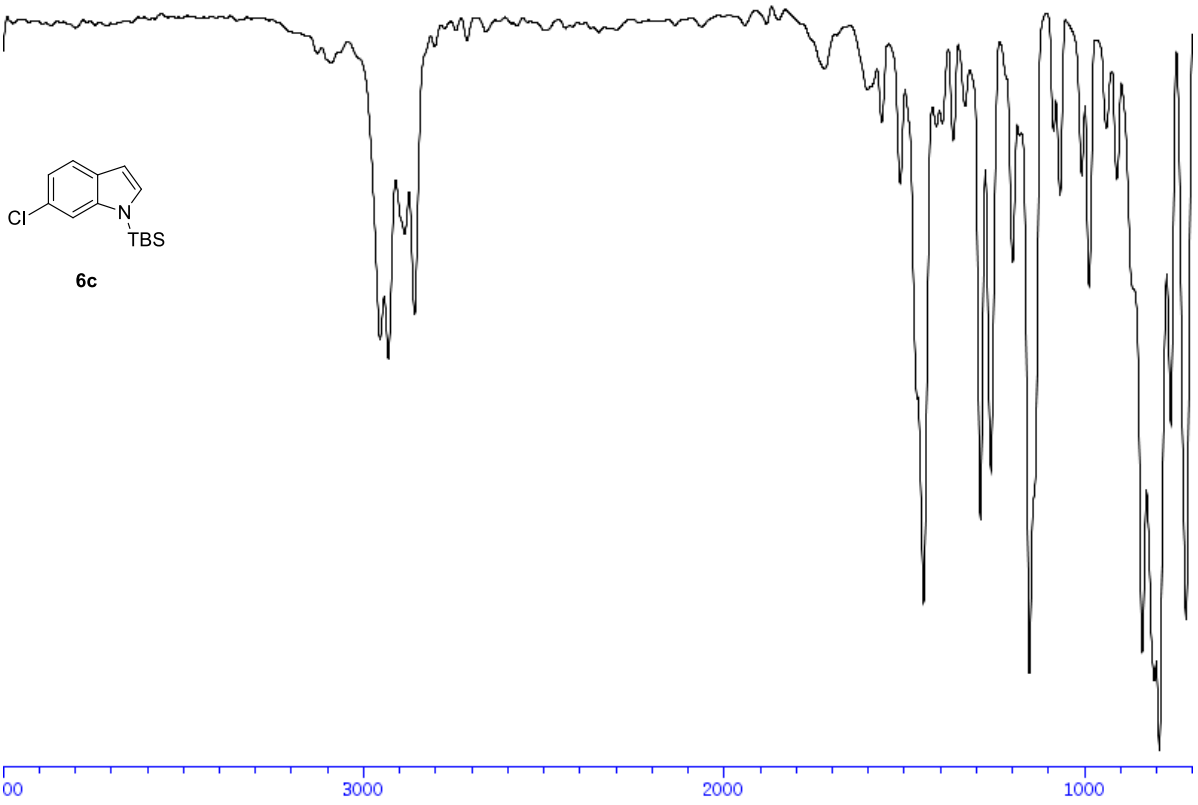
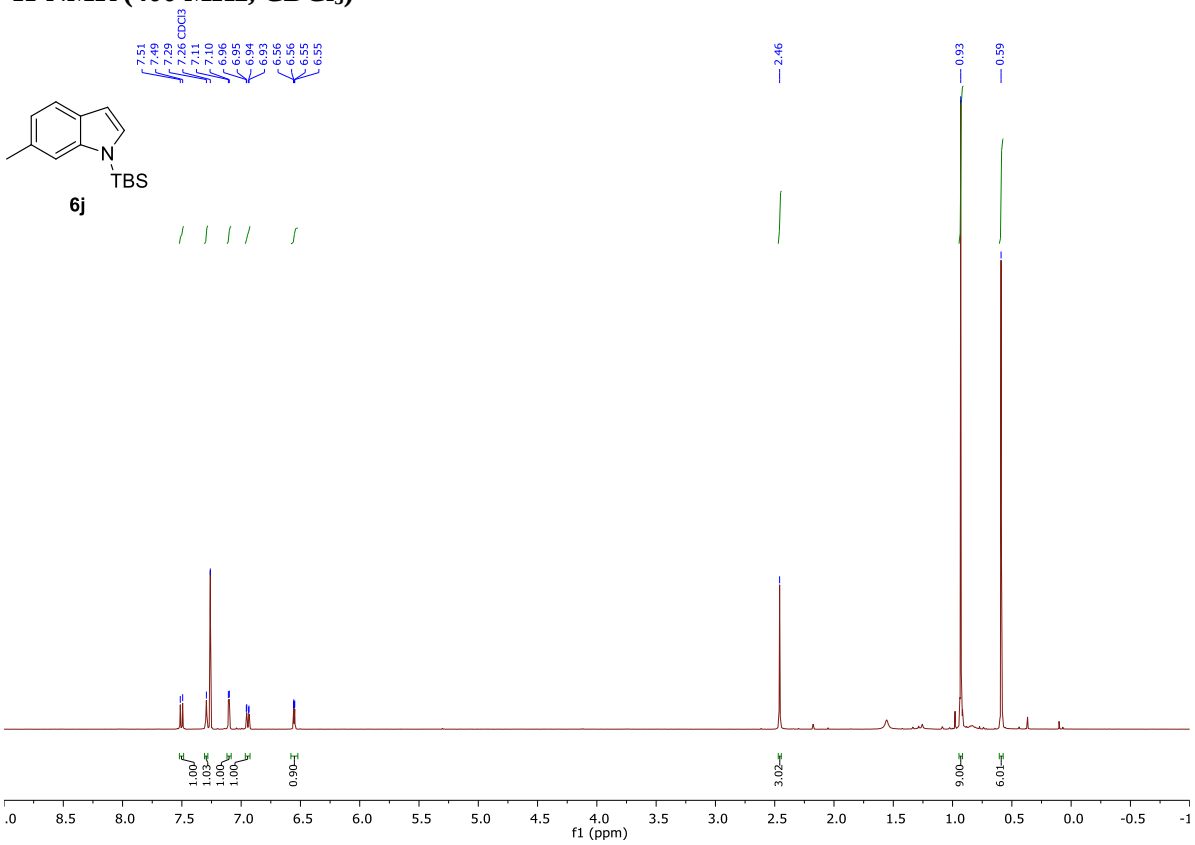
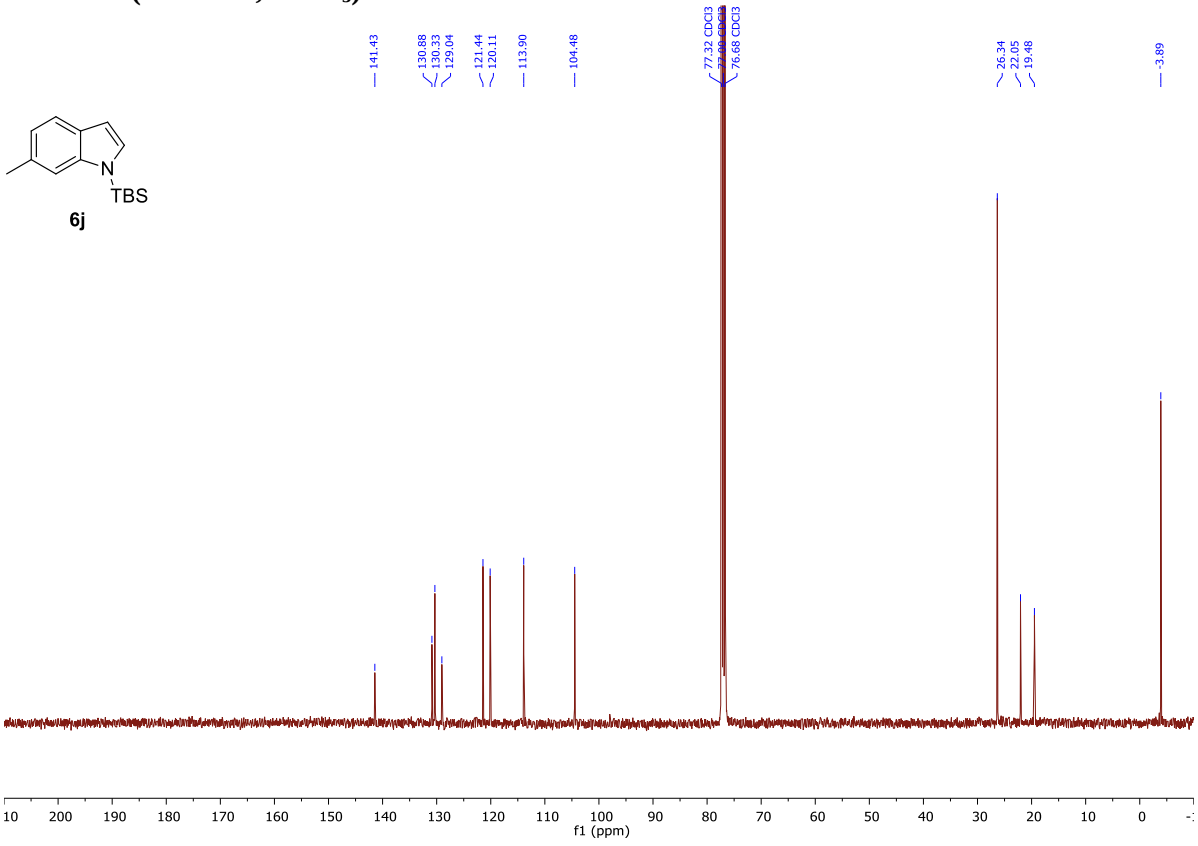


1-(*tert*-butyldimethylsilyl)-6-methyl-1H-indole (6j)

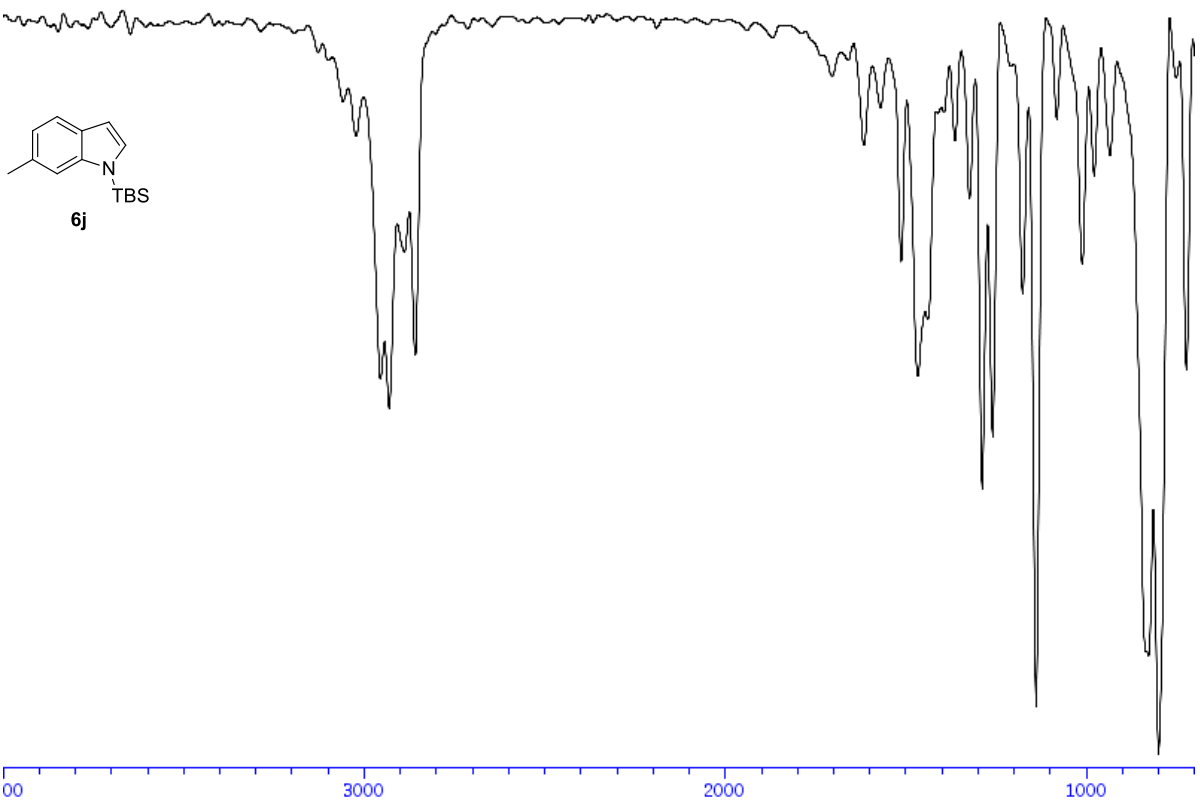
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)

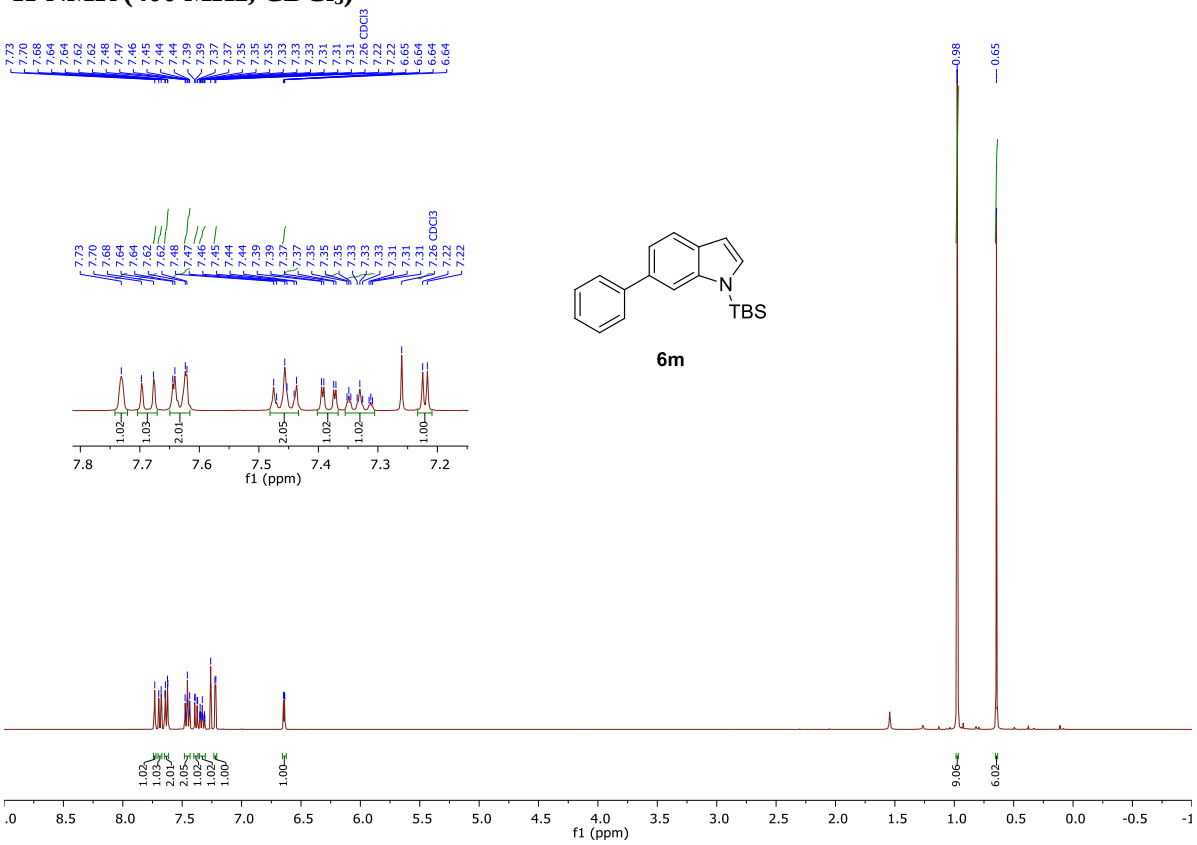


IR



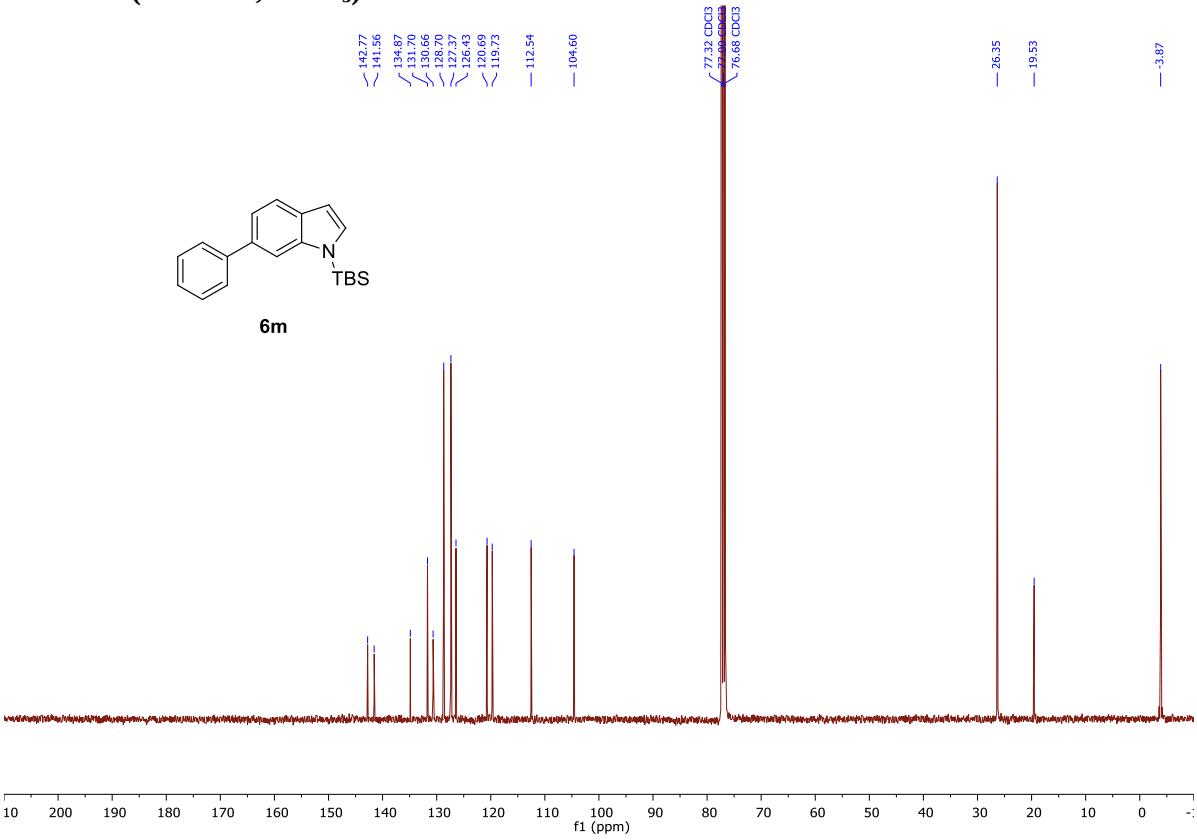
1-(*tert*-butyldimethylsilyl)-6-phenyl-1H-indole (6m)

^{1}H-NMR (400 MHz, $CDCl_3$)



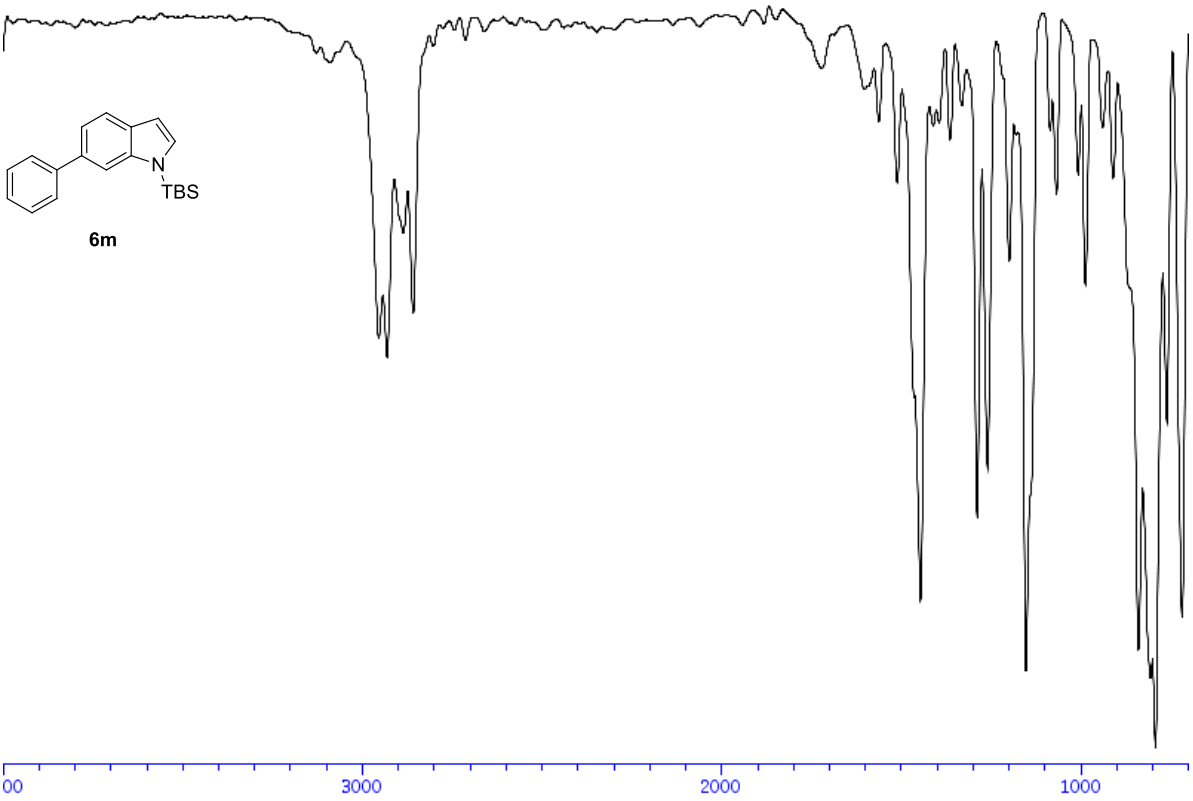
6m

^{13}C-NMR (101 MHz, $CDCl_3$)



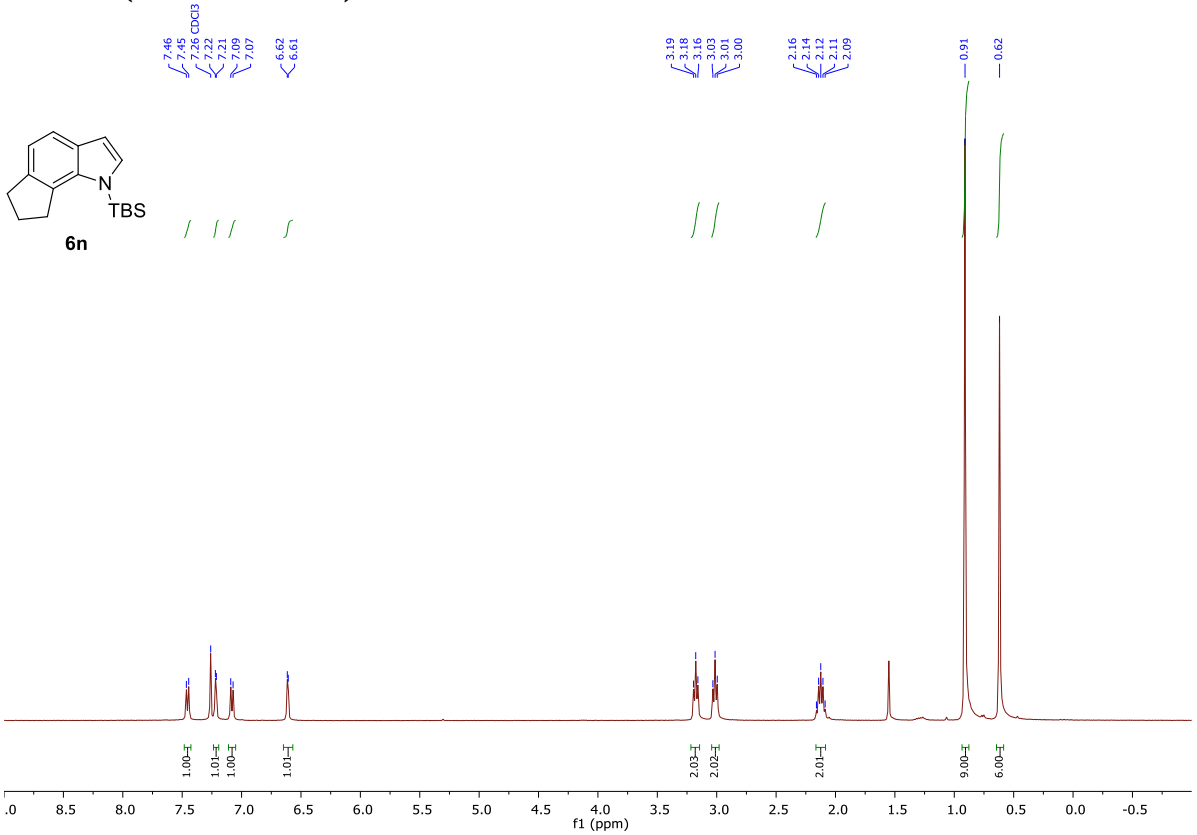
6m

IR

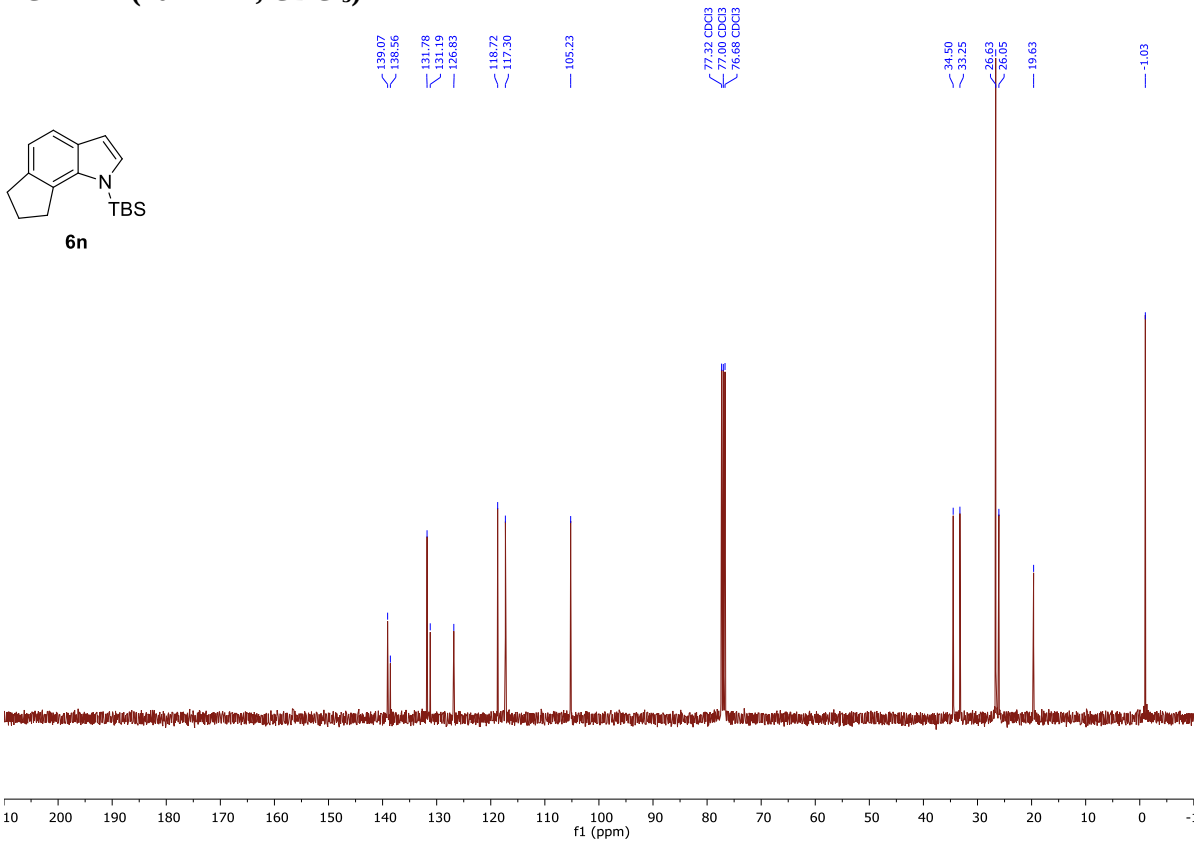


1-(*tert*-butyldimethylsilyl)-1,6,7,8-tetrahydrocyclopenta[g]indole (6n)

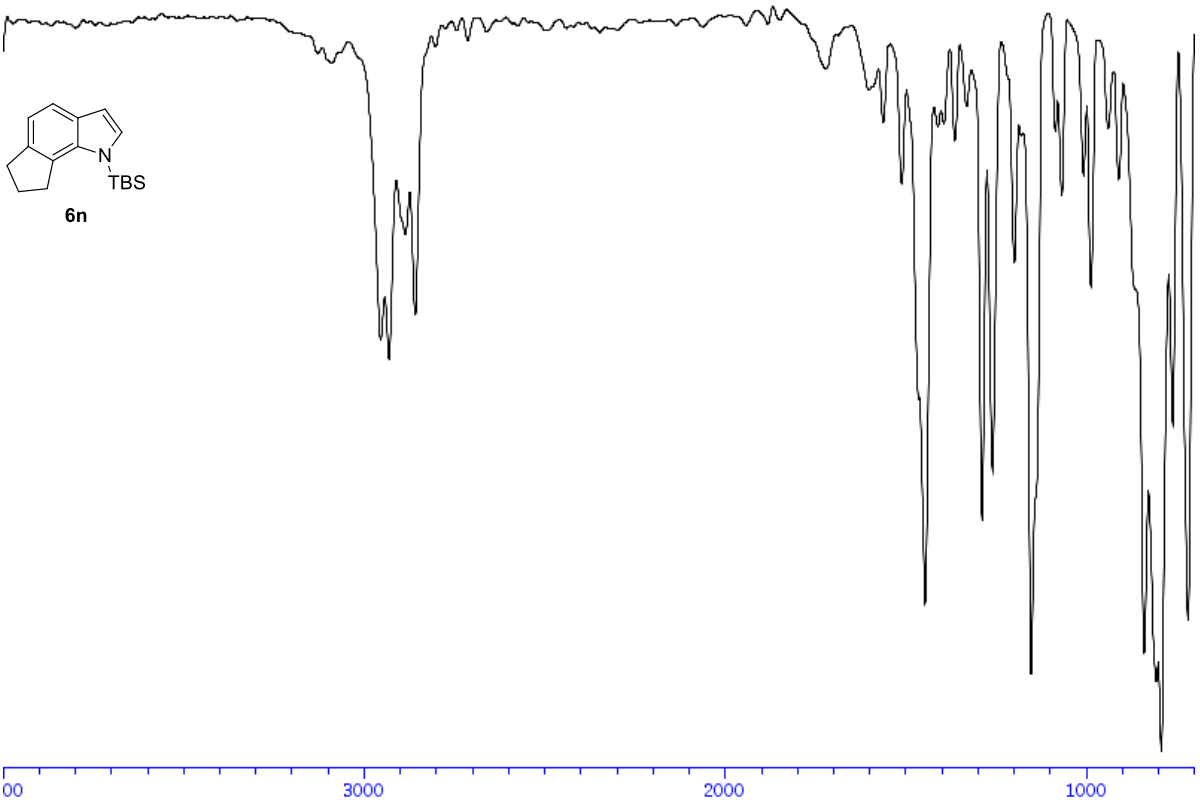
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)

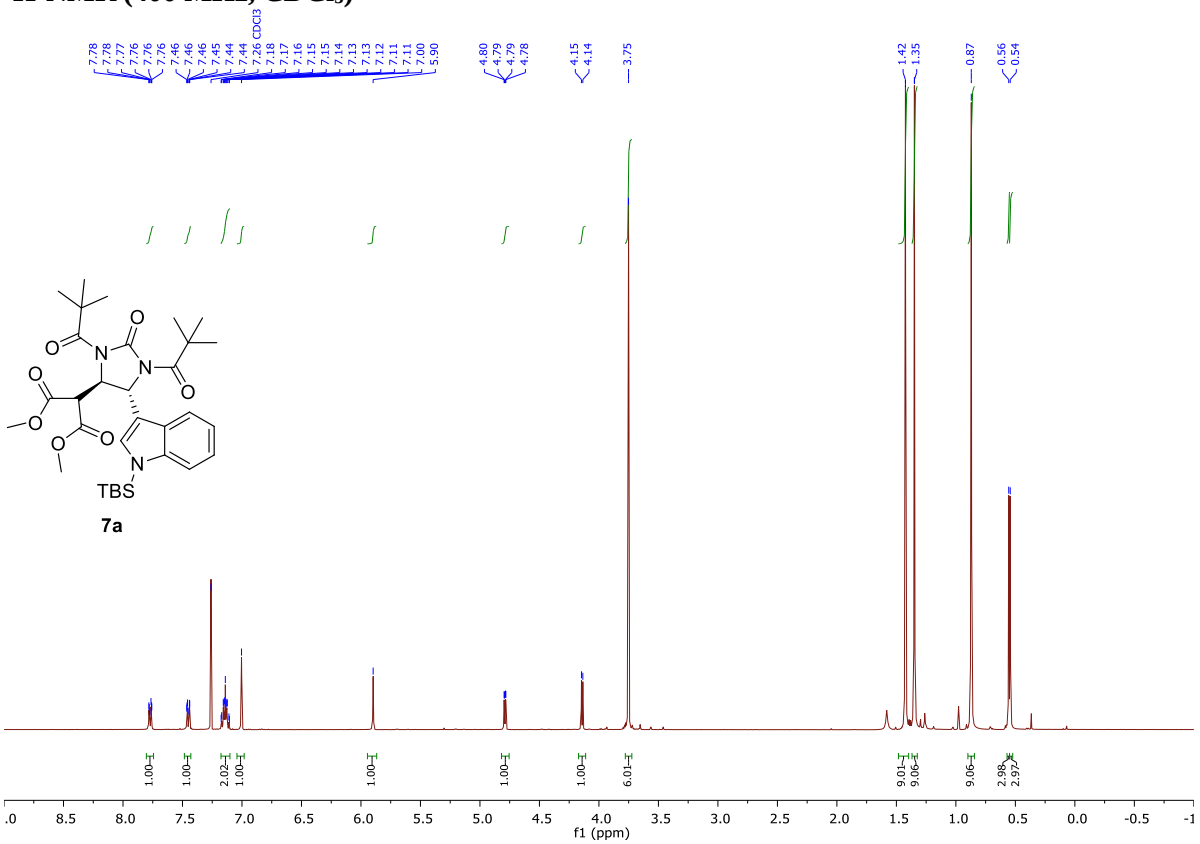


IR

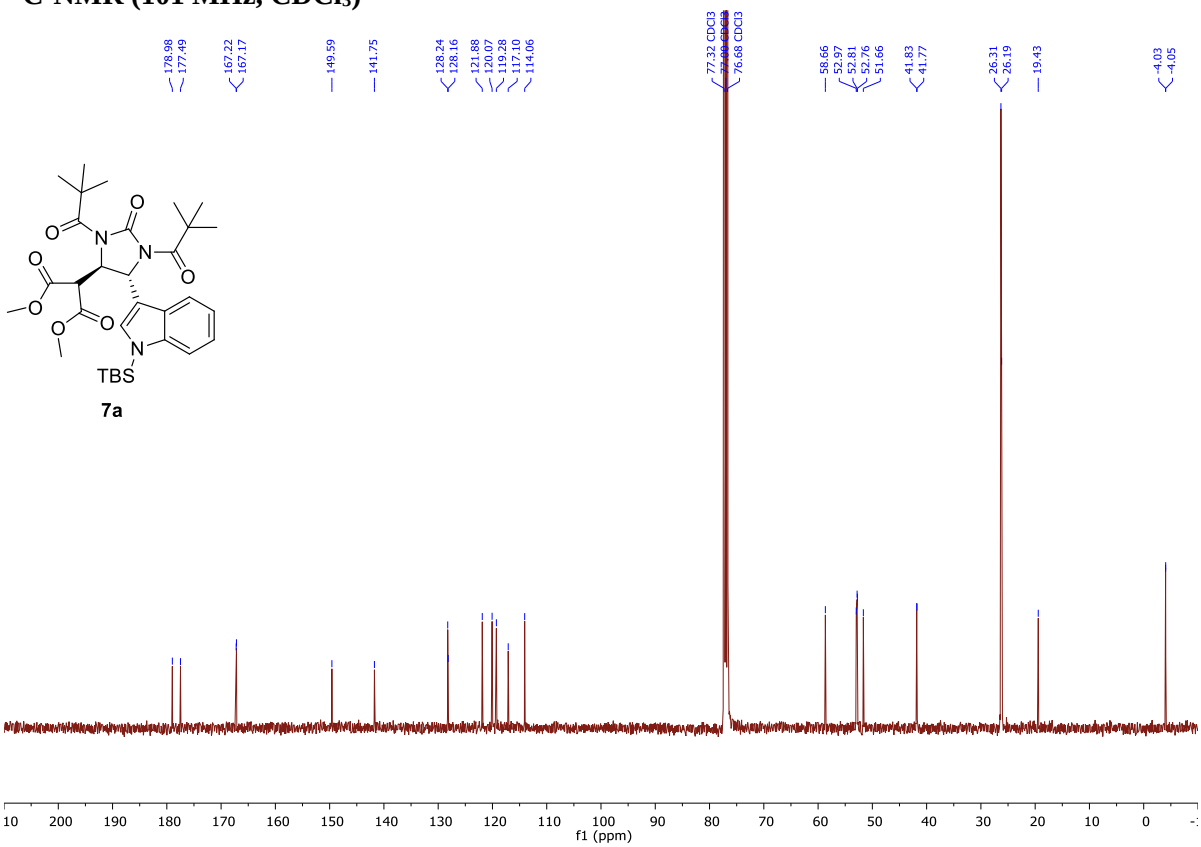


Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7a)

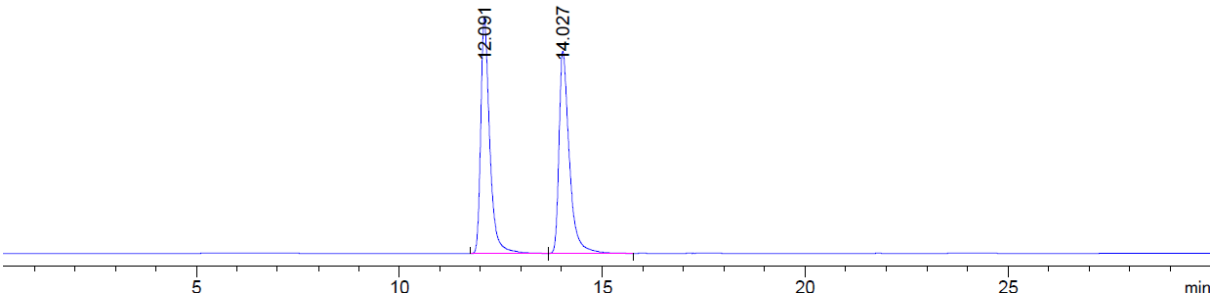
^{1}H-NMR (400 MHz, $CDCl_3$)



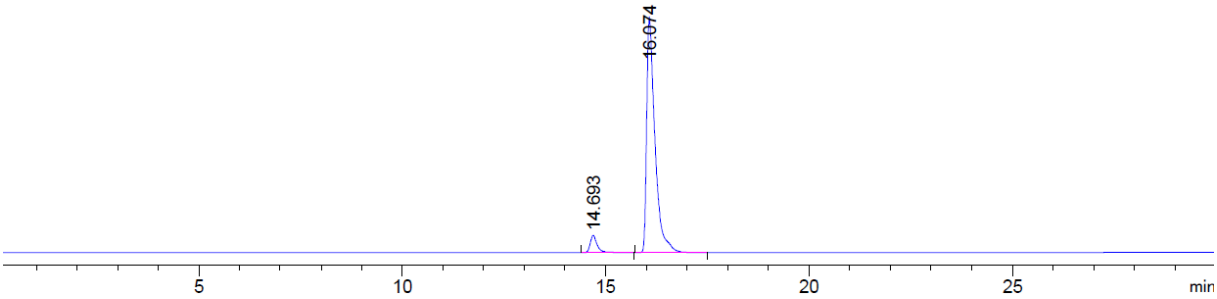
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

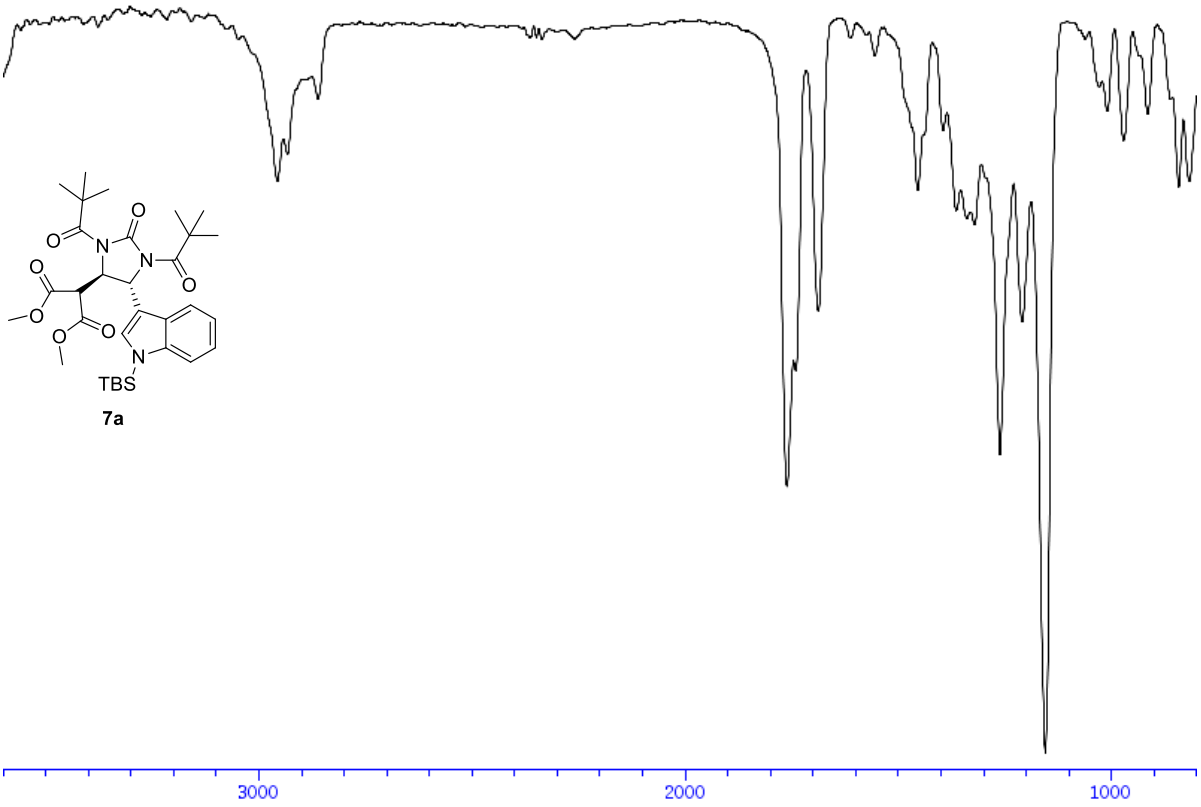


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.091	BB	0.2323	1748.08521	113.11364	50.5393
2	14.027	BB	0.2662	1710.77966	96.79921	49.4607



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.693	BB	0.1807	901.92865	74.77305	5.7814
2	16.074	BB	0.2107	1.46986e4	1028.92822	94.2186

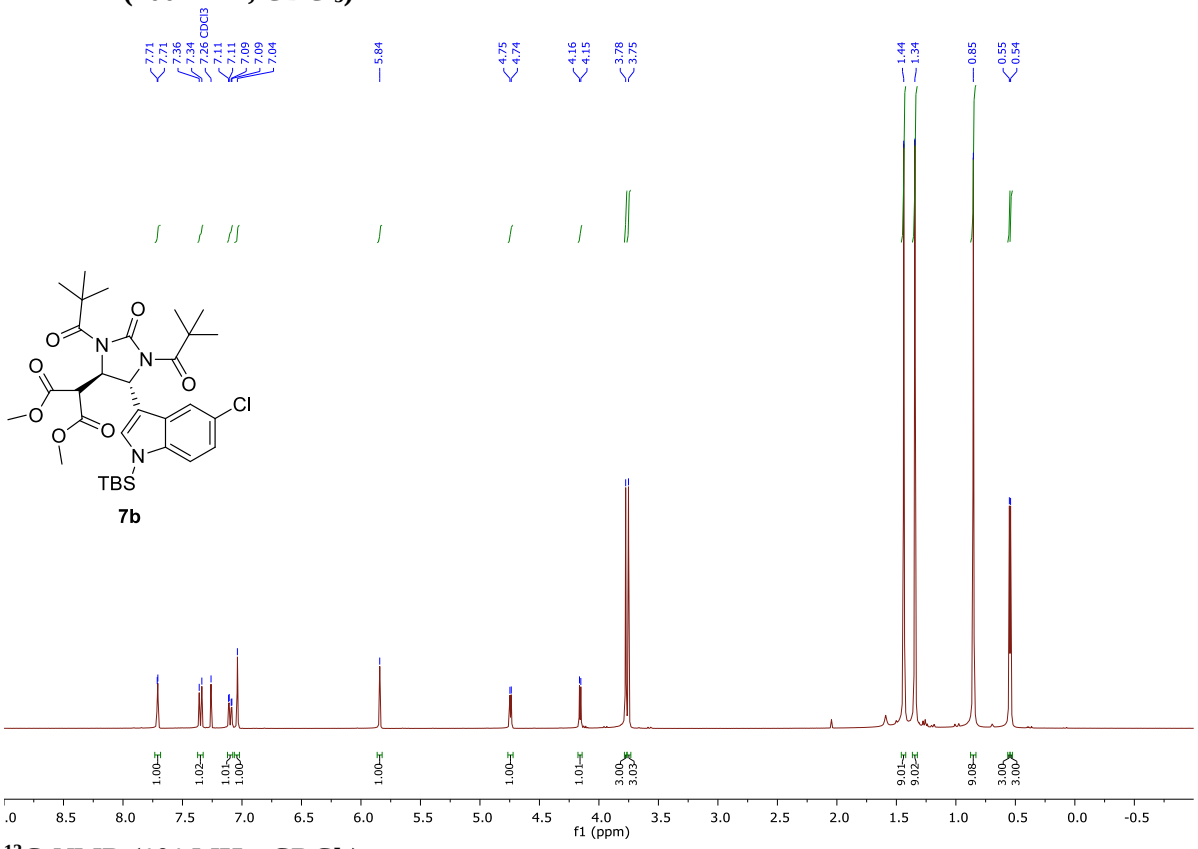
IR



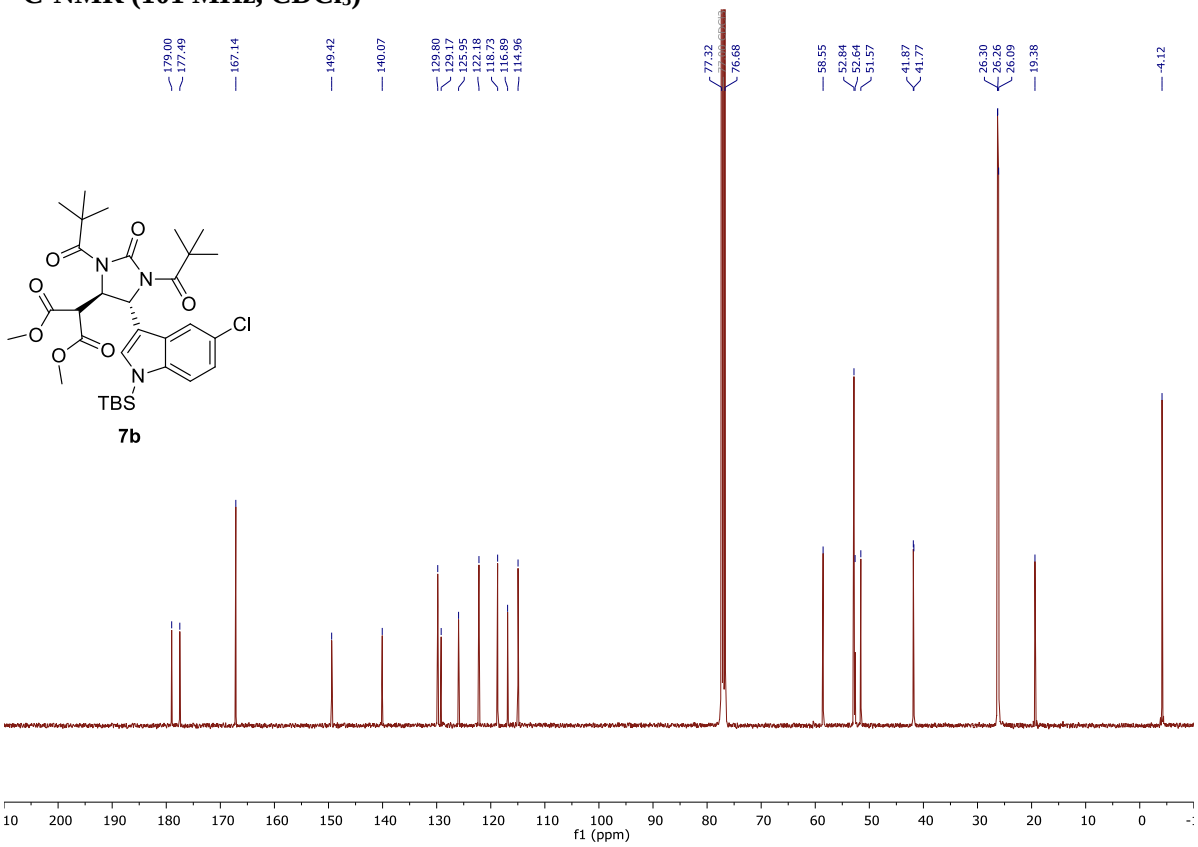
7a

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-chloro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7b)

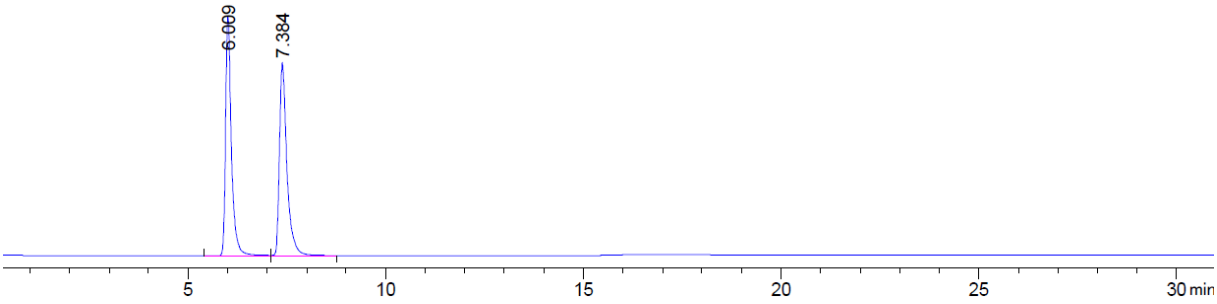
^{1}H-NMR (400 MHz, $CDCl_3$)



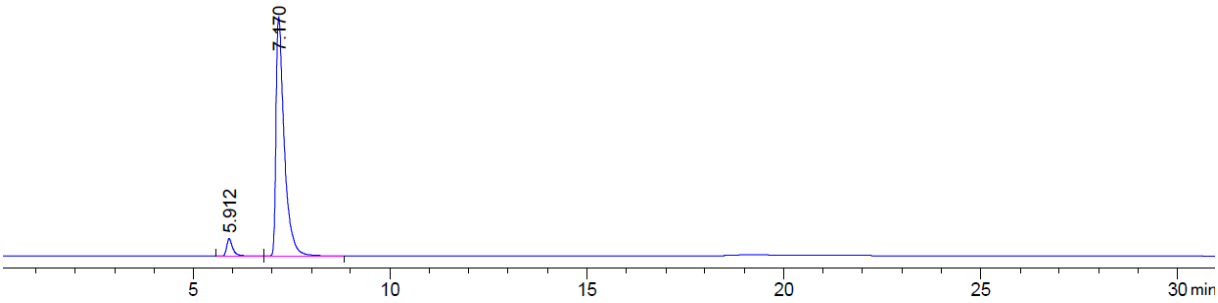
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

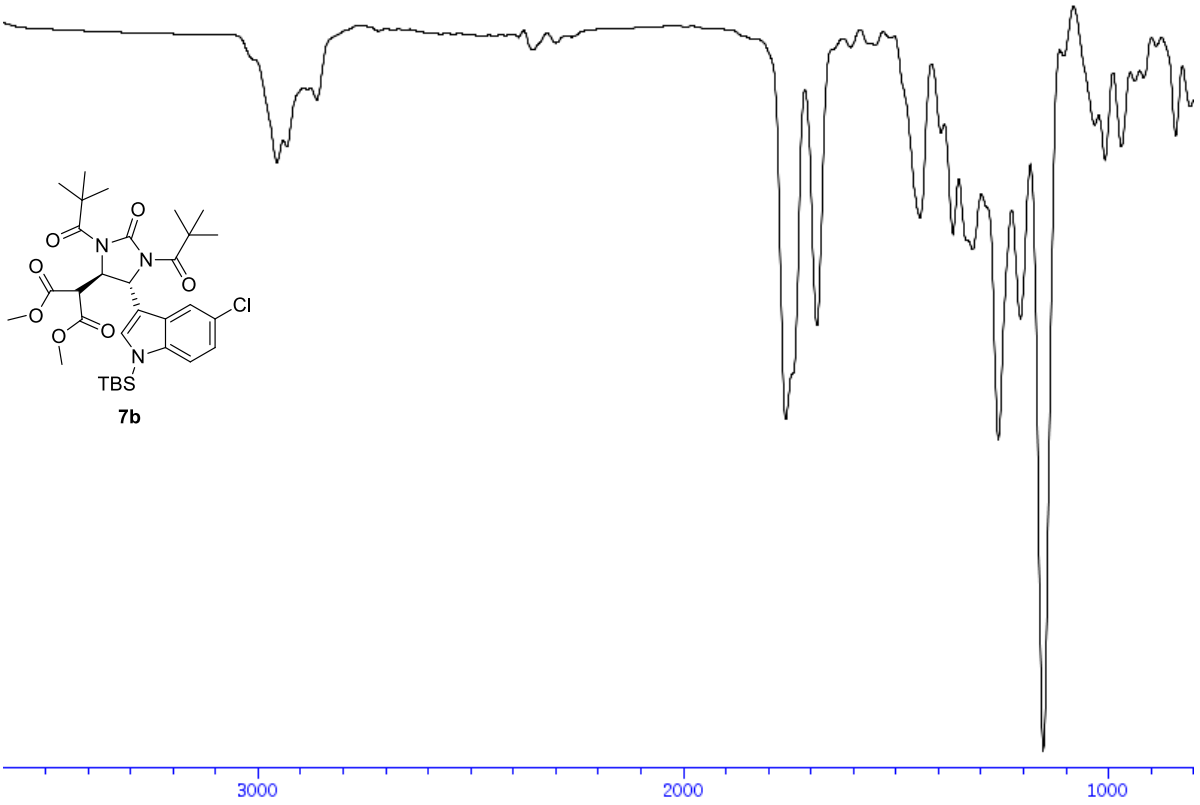


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.009	BB	0.1511	1485.86963	145.59550	49.2526
2	7.384	BB	0.1946	1530.96472	117.05157	50.7474



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.912	BB	0.1556	449.42056	43.13351	4.9834
2	7.170	BB	0.2155	8568.84375	589.71967	95.0166

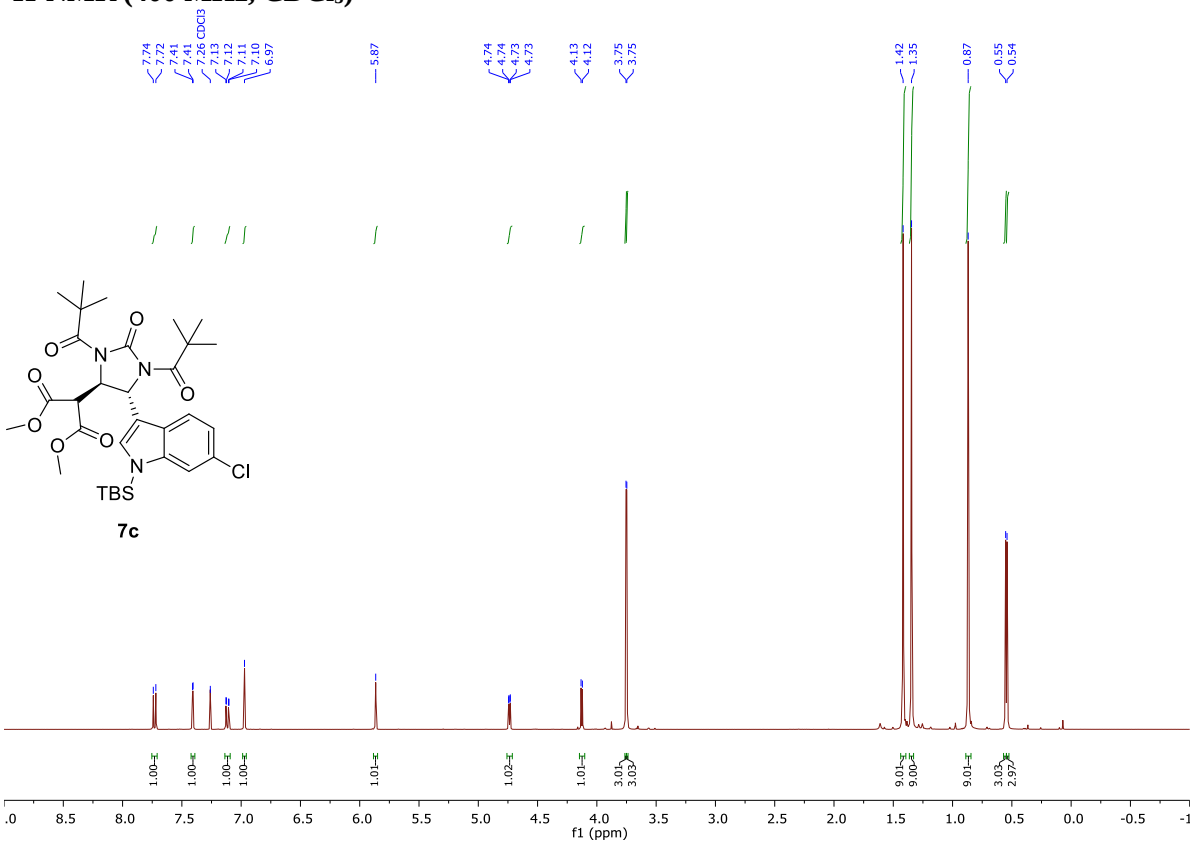
IR



7b

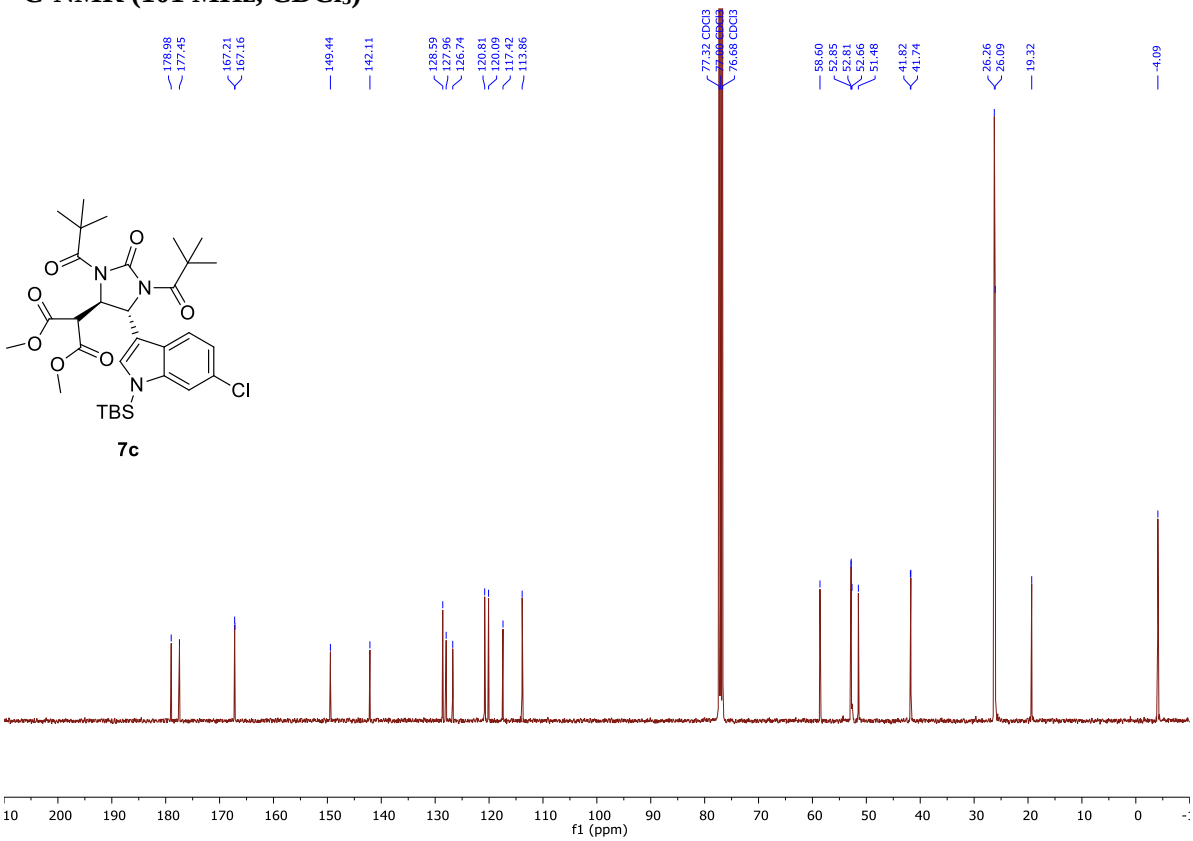
Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-chloro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7c)

^{1}H-NMR (400 MHz, $CDCl_3$)



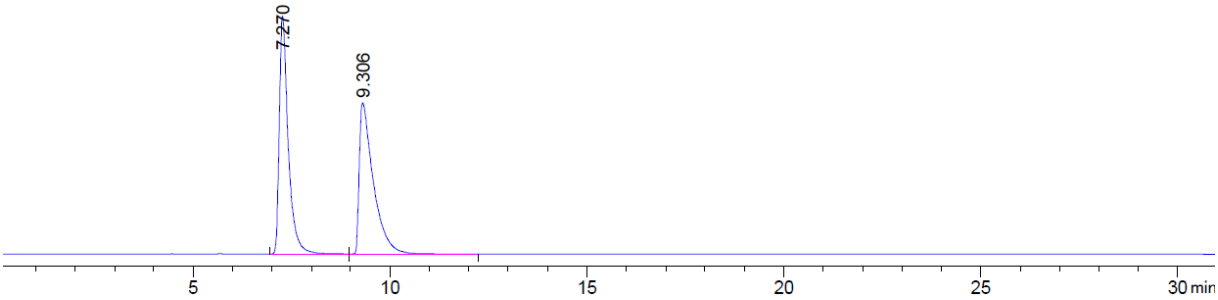
7c

^{13}C-NMR (101 MHz, $CDCl_3$)

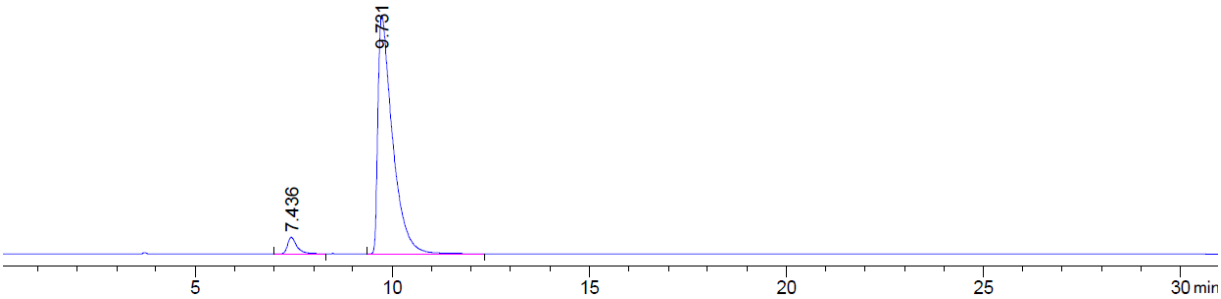


7c

HPLC

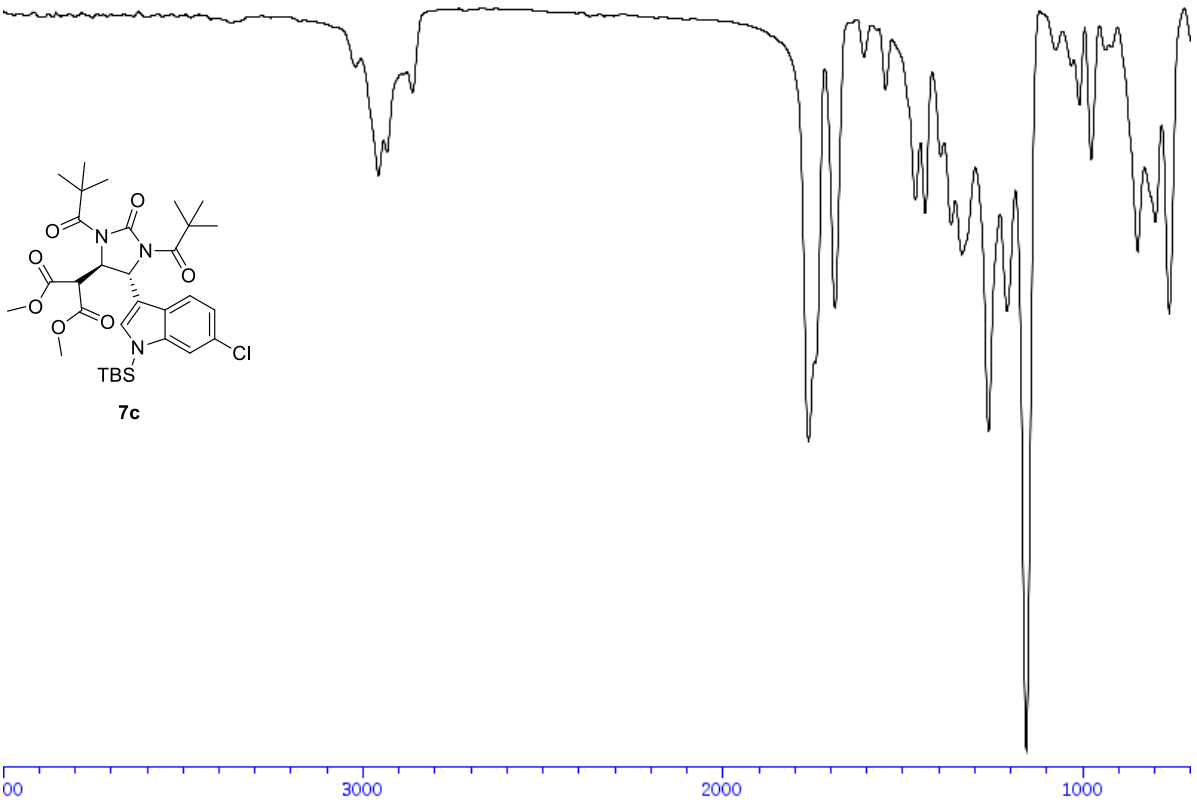


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.270	BB	0.2323	2512.69824	159.02888	50.0272
2	9.306	BB	0.3577	2509.96826	101.08558	49.9728



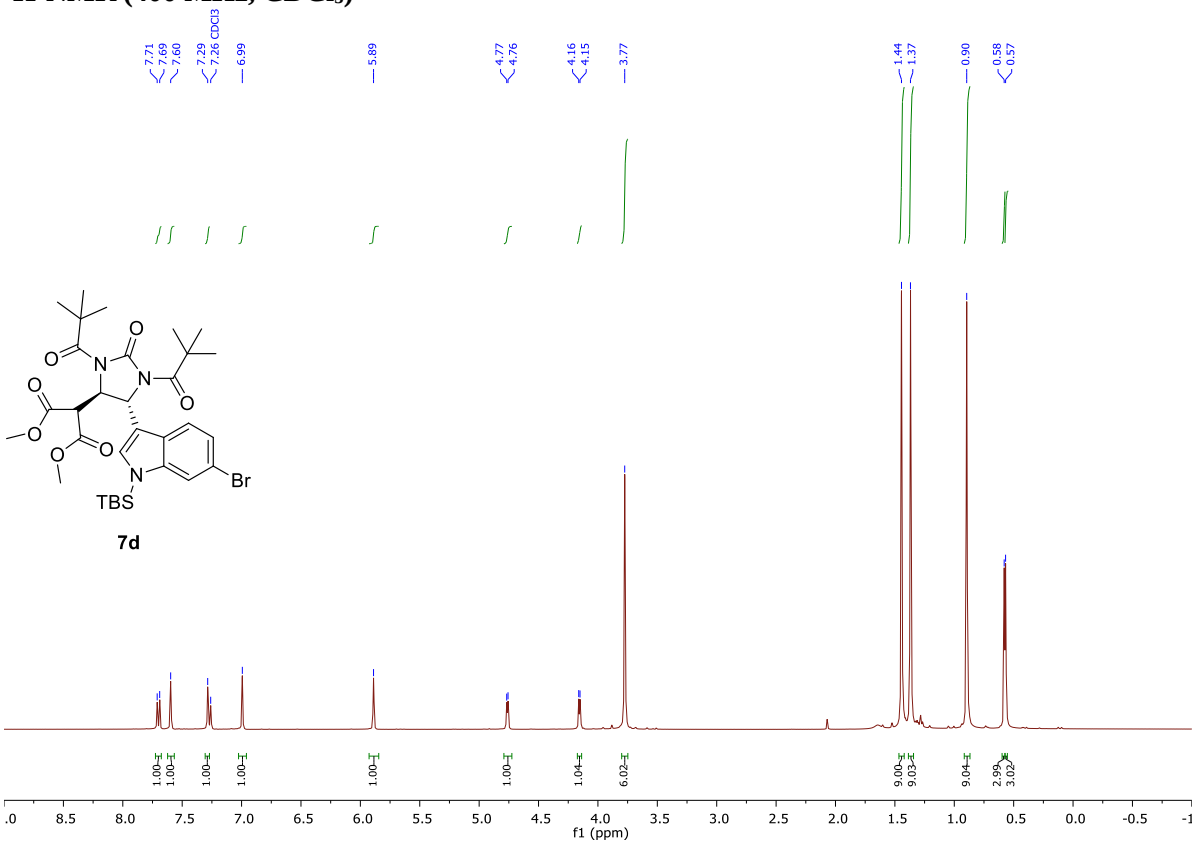
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.436	BB	0.2437	163.03163	9.92031	4.2598
2	9.731	BB	0.3714	3664.21167	142.75908	95.7402

IR

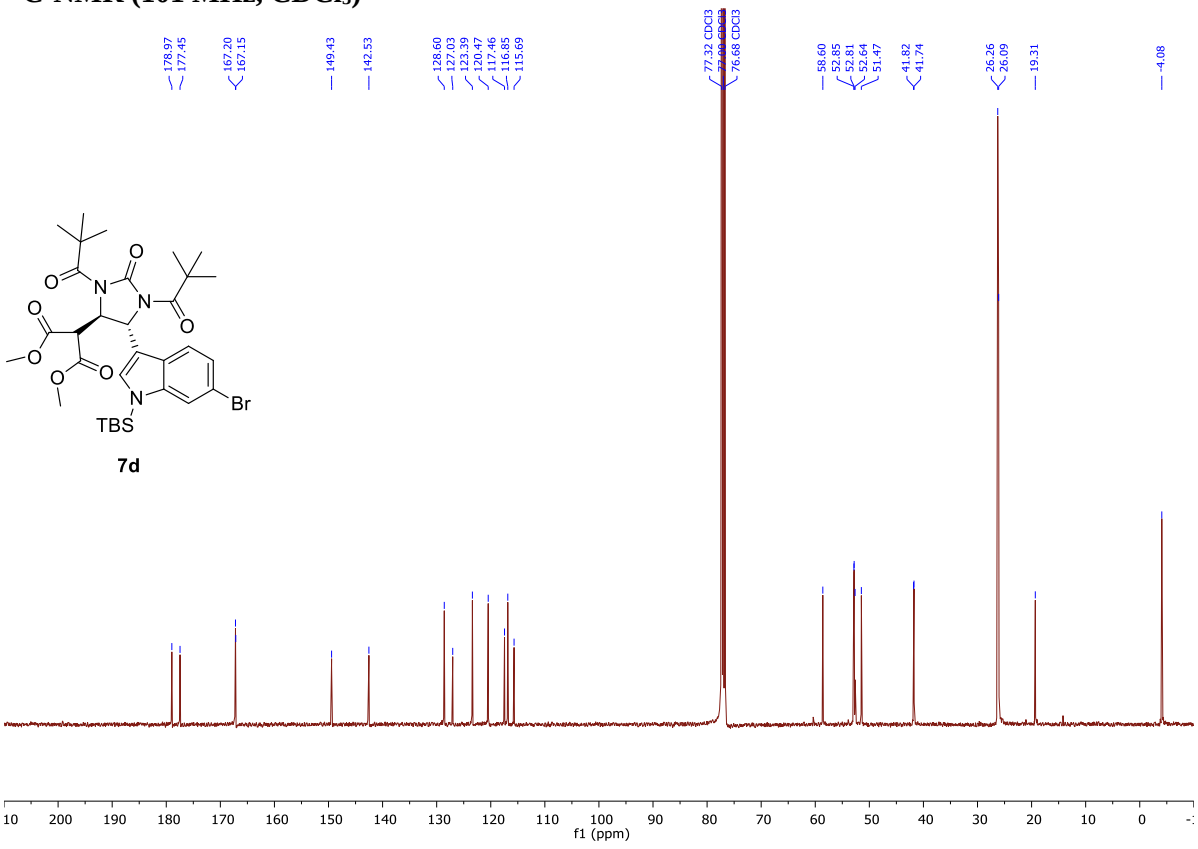


Dimethyl 2-(5-(6-bromo-1-(*tert*-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7d)

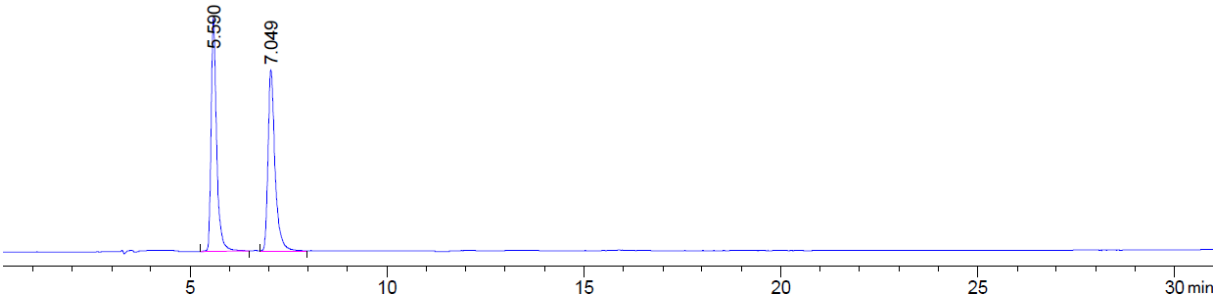
^{1}H-NMR (400 MHz, $CDCl_3$)



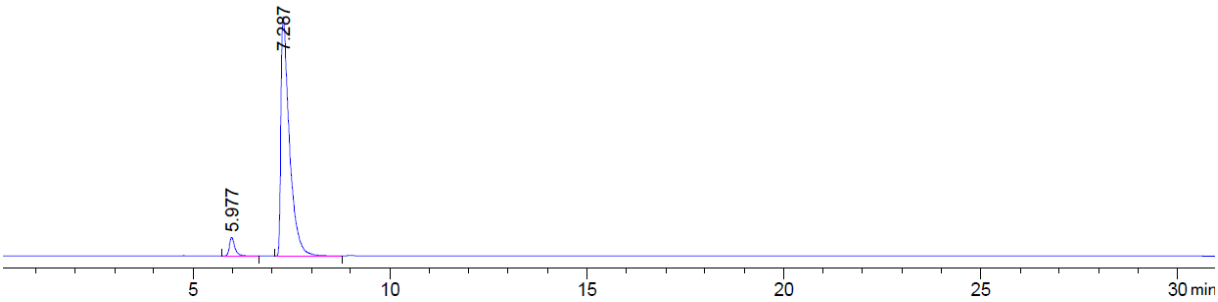
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

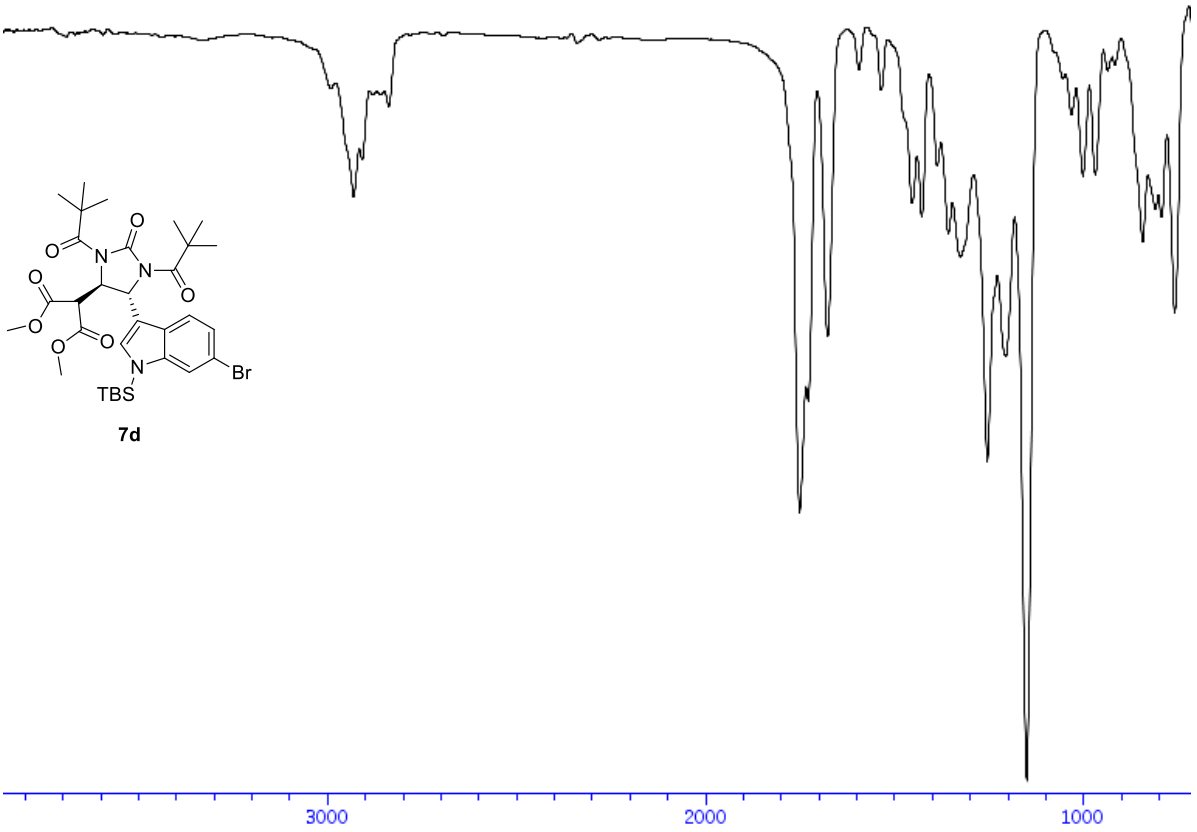


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.590	BB	0.1442	80.67544	8.38803	50.3437
2	7.049	BB	0.1841	79.57391	6.44182	49.6563



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.977	BB	0.1456	260.92438	26.78724	4.7736
2	7.287	BB	0.2183	5205.04199	344.46219	95.2264

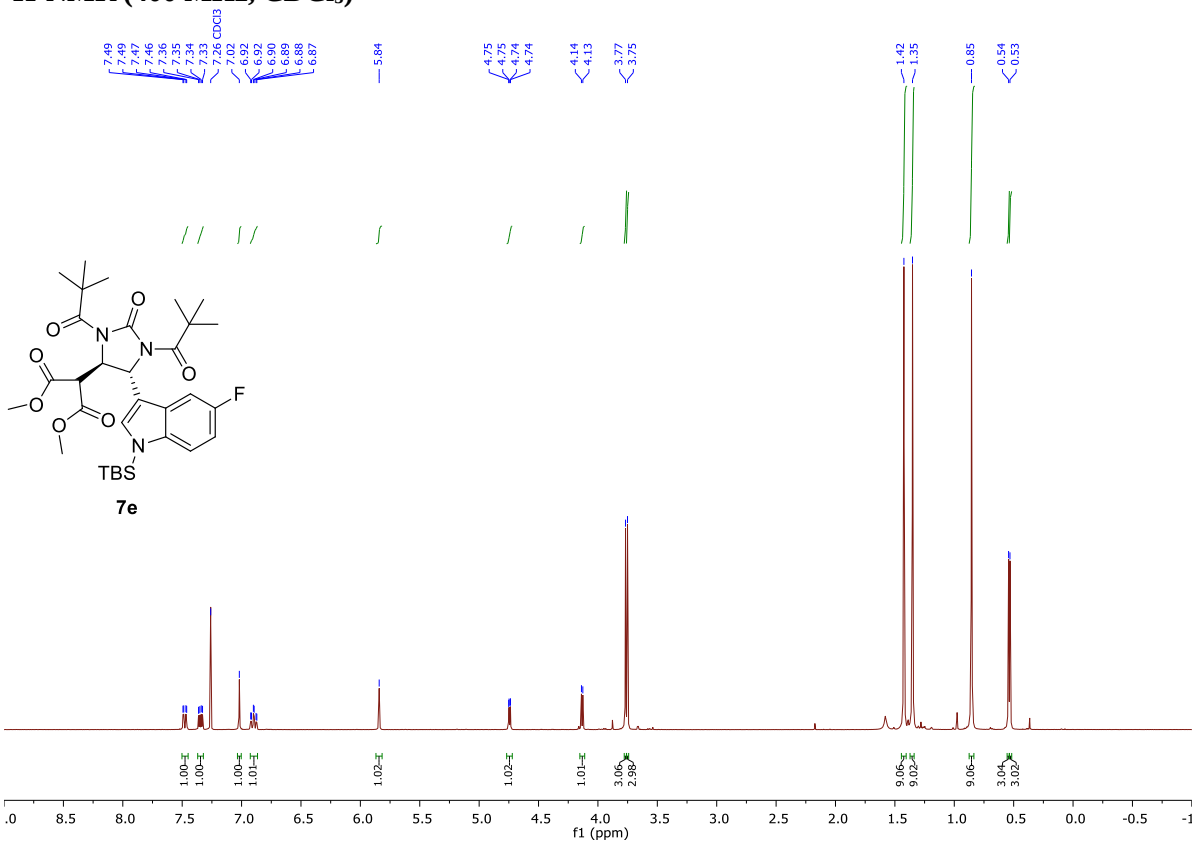
IR



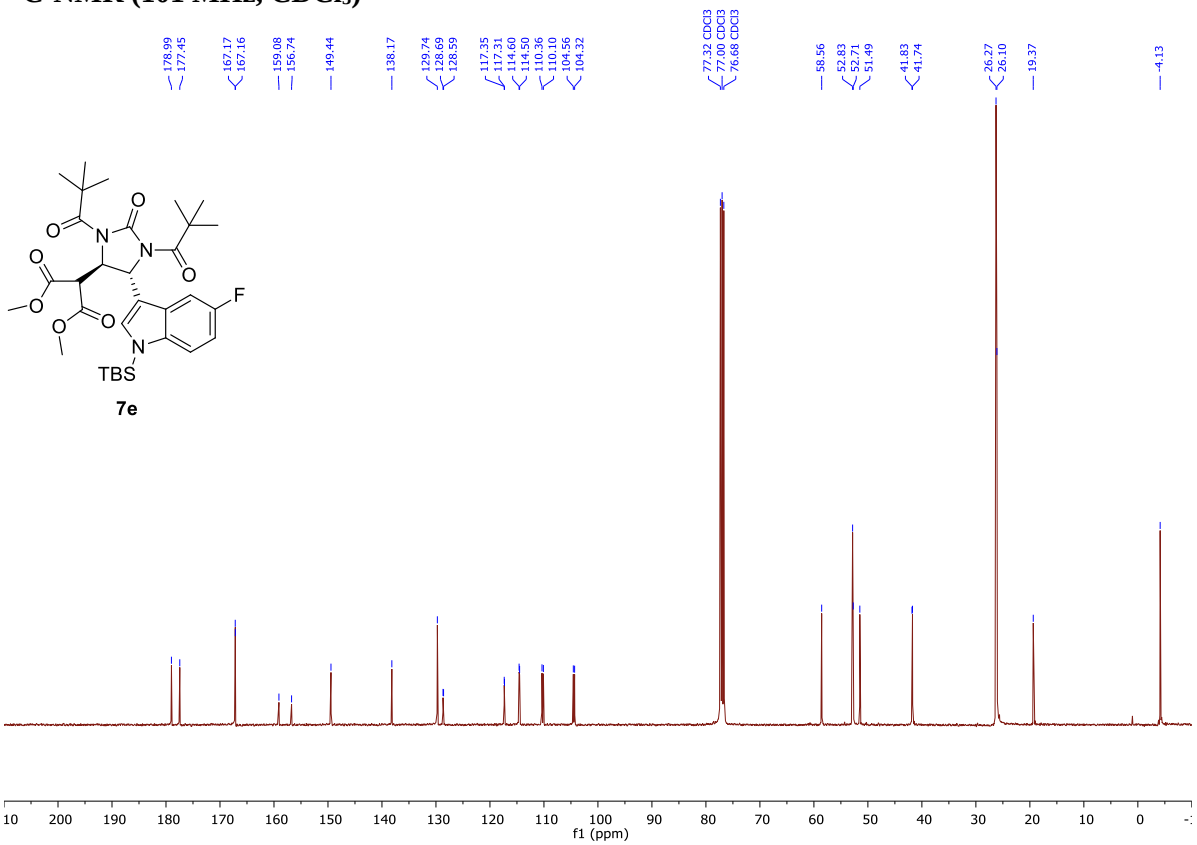
7d

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-fluoro-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7e)

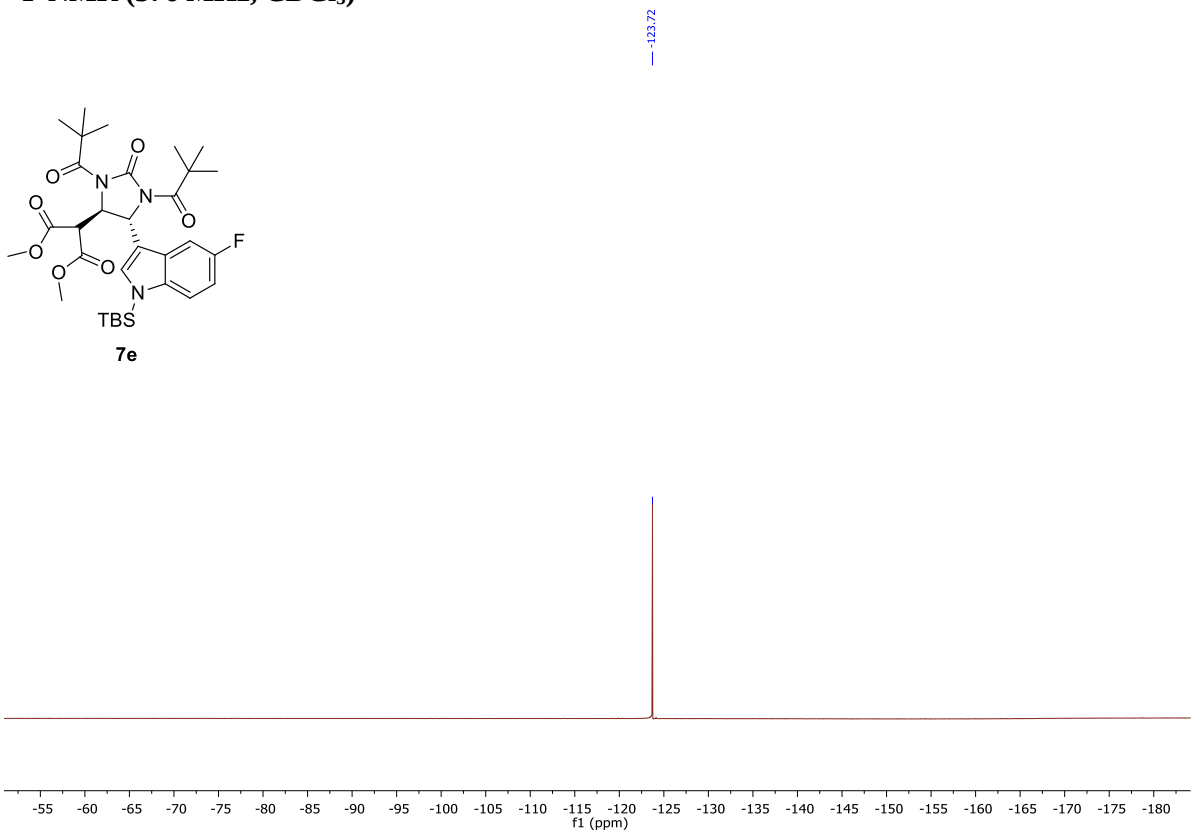
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)

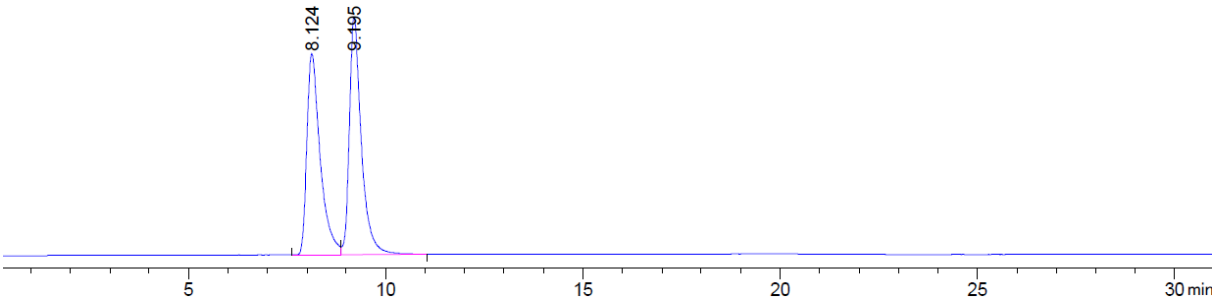


^{19}F NMR (376 MHz, $CDCl_3$)

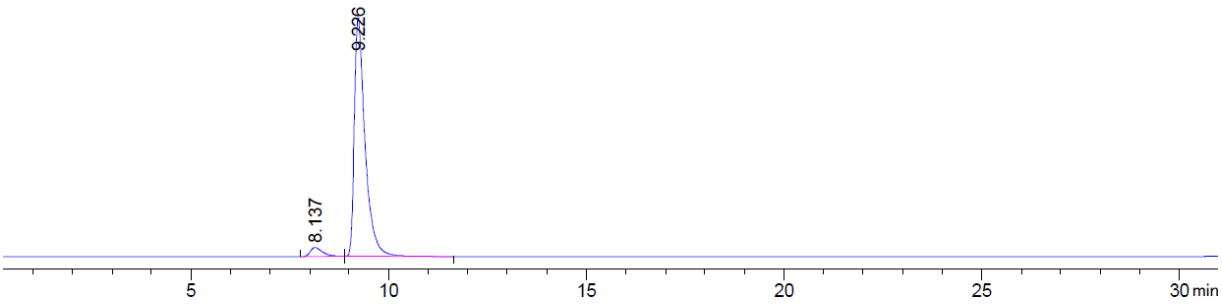


7e

HPLC

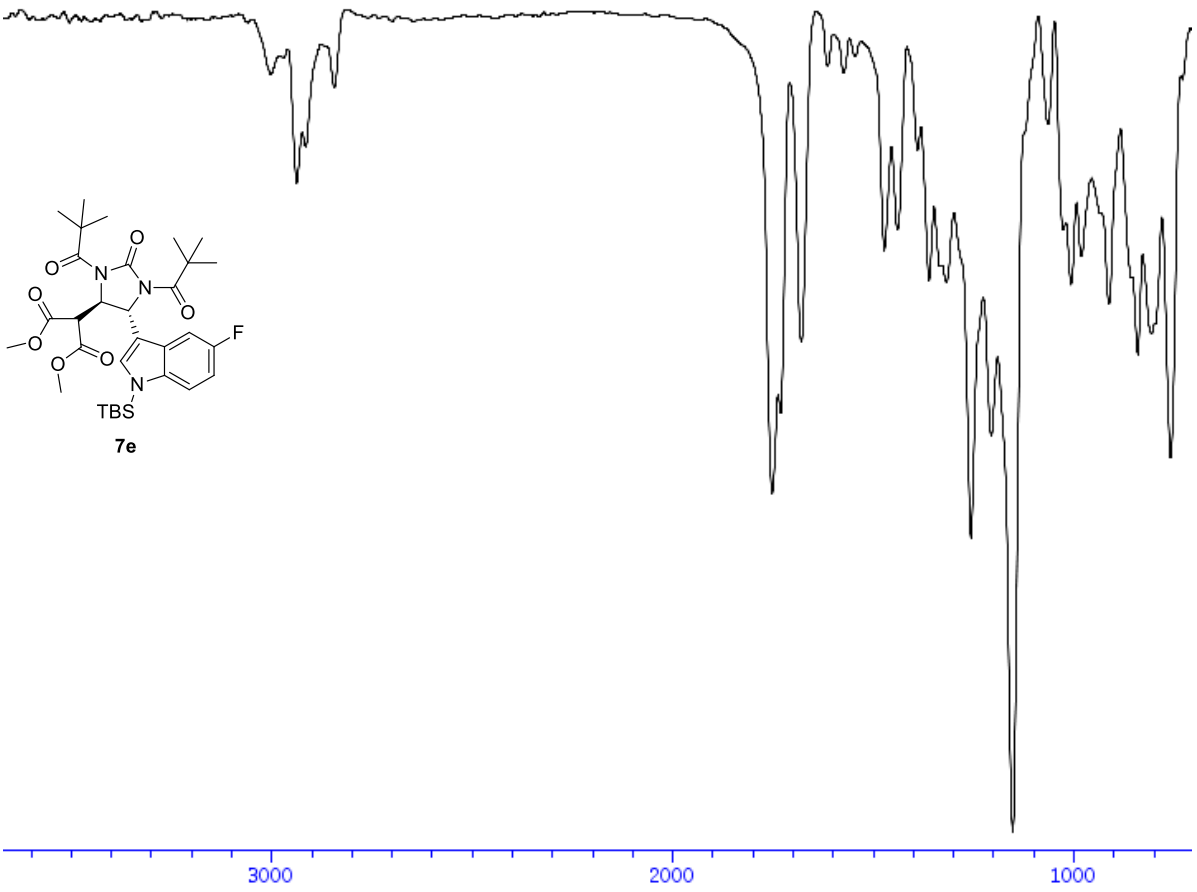


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.124	BB	0.3381	265.59882	11.82125	49.1117
2	9.195	BB	0.3011	275.20651	13.77244	50.8883



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.137	BB	0.3192	86.86350	4.09916	4.0819
2	9.226	BB	0.2800	2041.17041	108.23043	95.9181

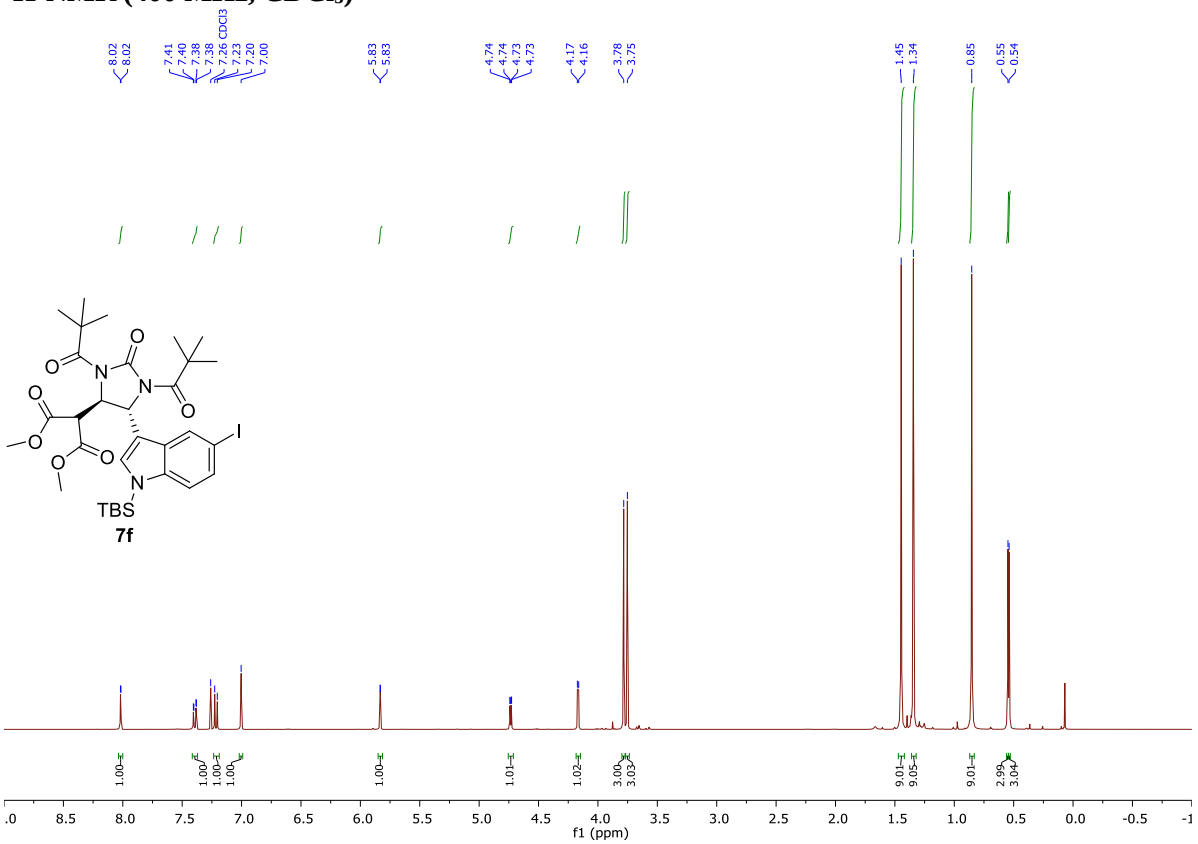
IR



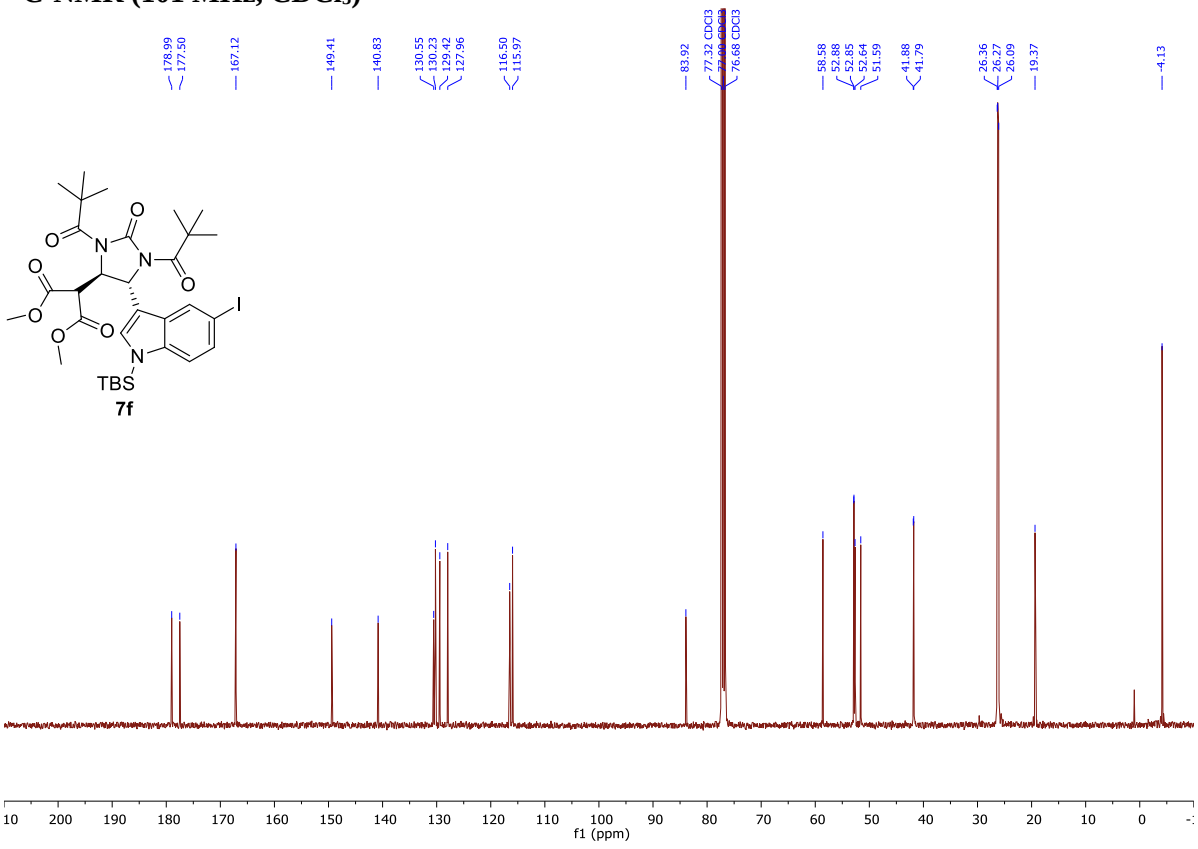
7e

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-iodo-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7f)

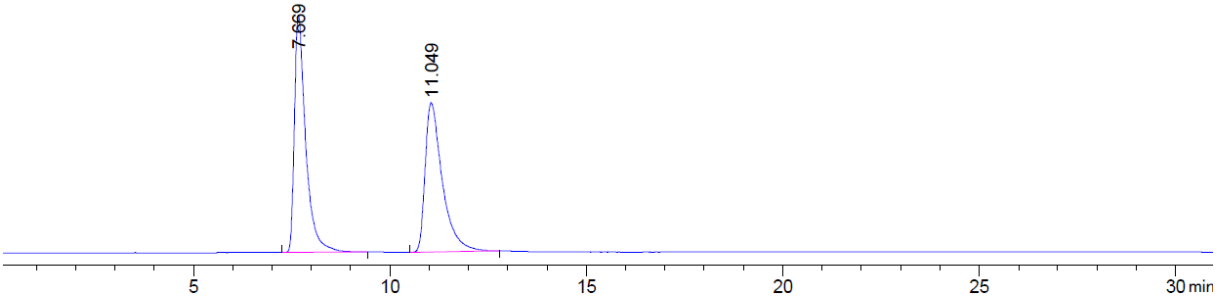
^{1}H-NMR (400 MHz, $CDCl_3$)



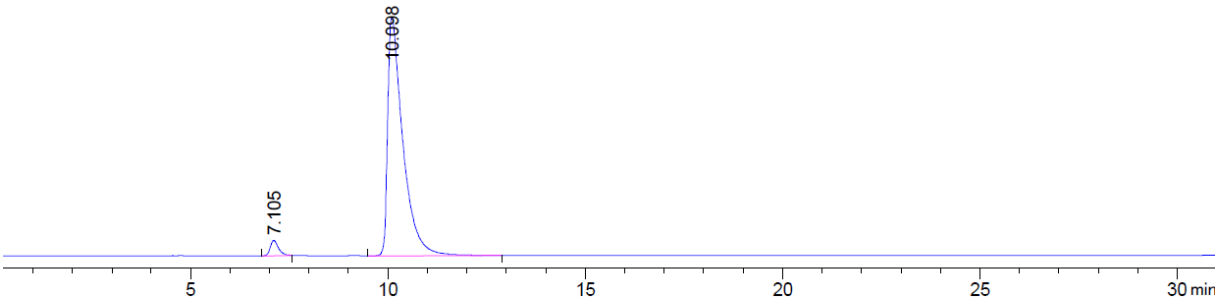
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

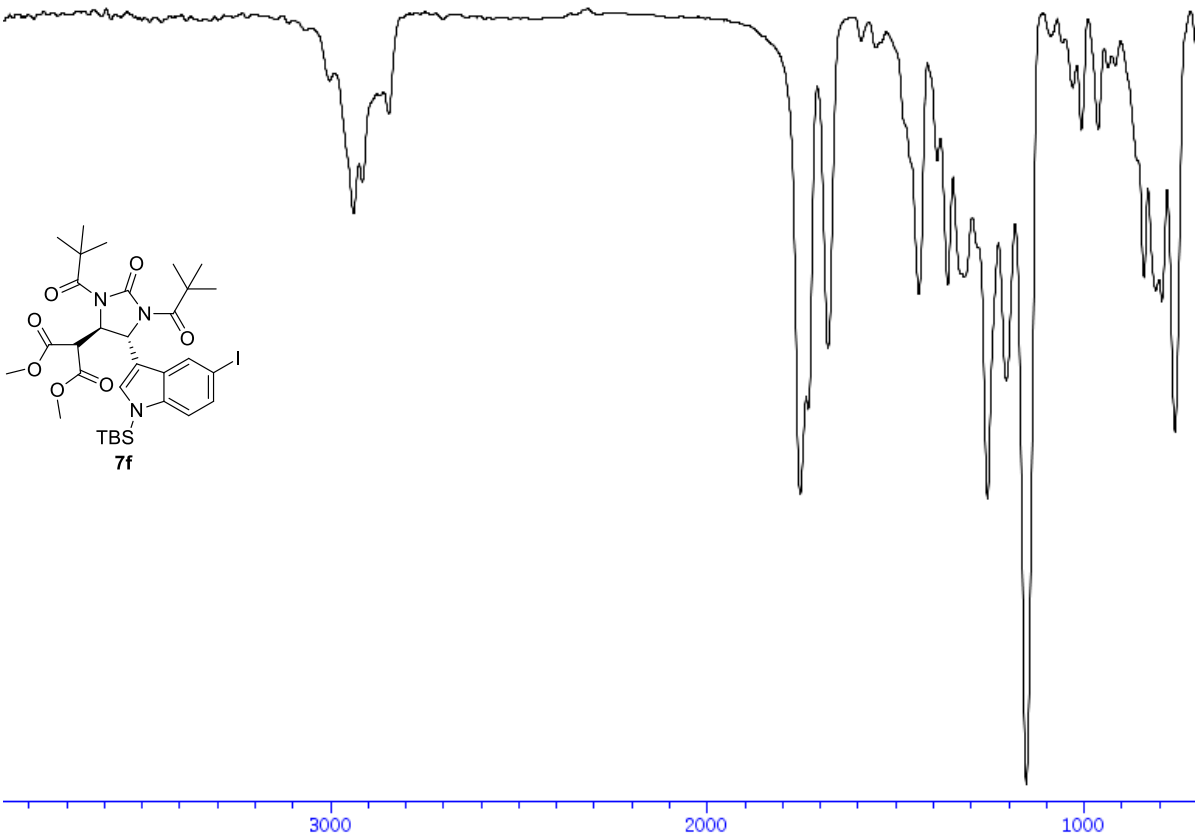


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.669	BB	0.2964	964.52948	47.99747	51.0310
2	11.049	BB	0.4520	925.55603	30.33042	48.9690



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.105	BB	0.2174	171.00633	11.91986	3.3194
2	10.098	BB	0.3886	4980.64990	185.87810	96.6806

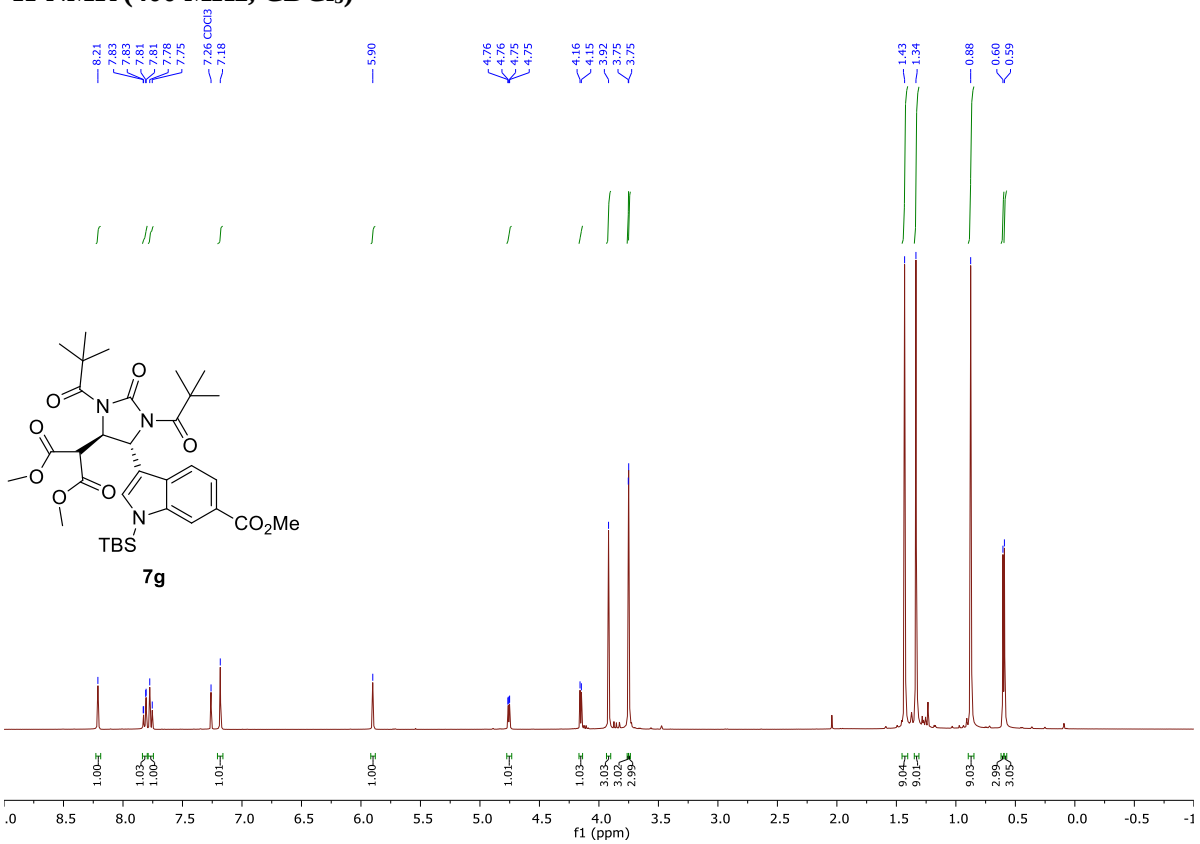
IR



7f

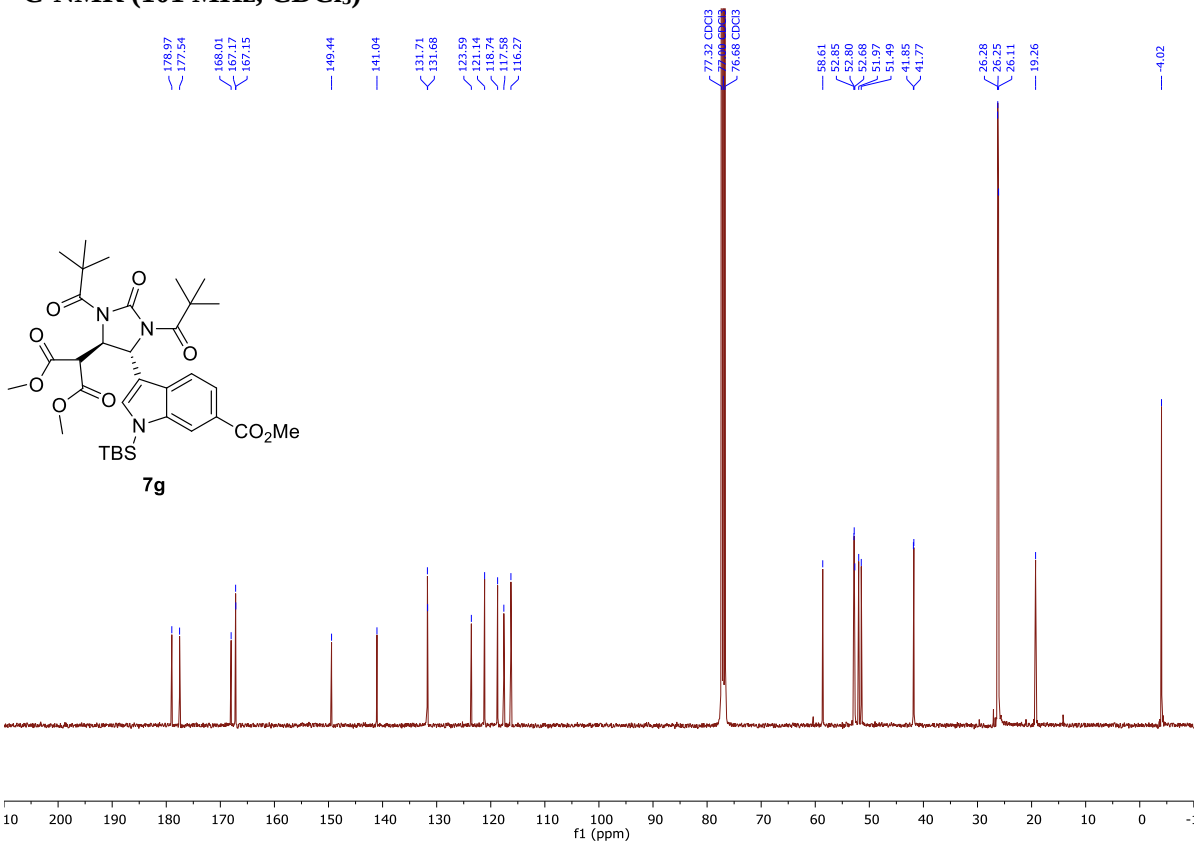
Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-(methoxycarbonyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7g)

^{1}H-NMR (400 MHz, $CDCl_3$)



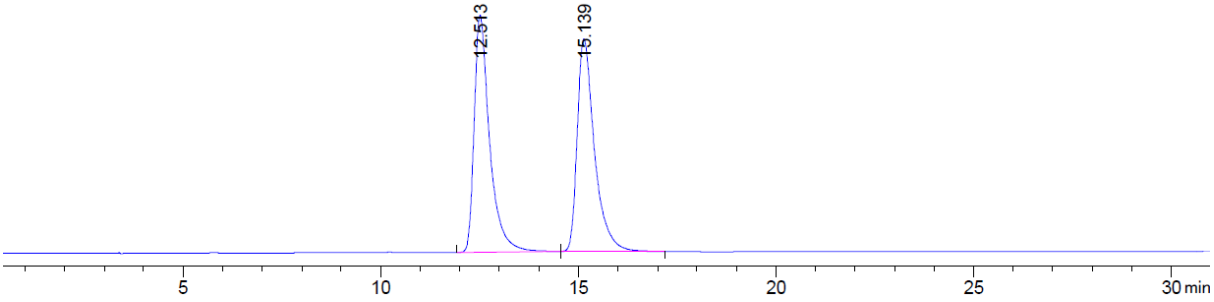
7g

^{13}C-NMR (101 MHz, $CDCl_3$)

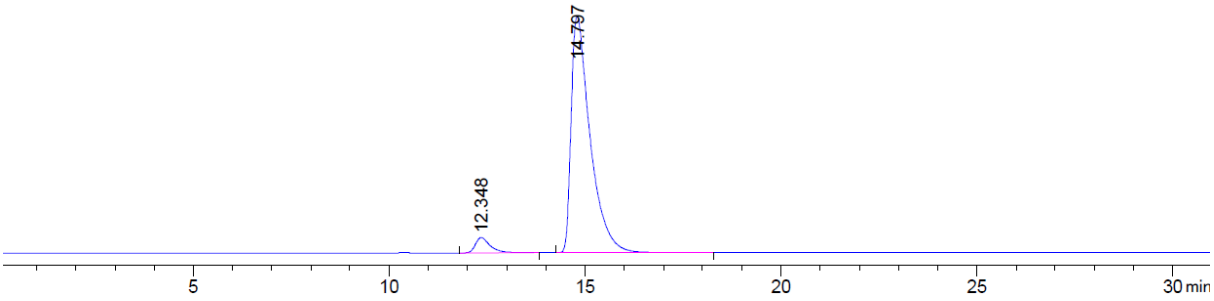


7g

HPLC

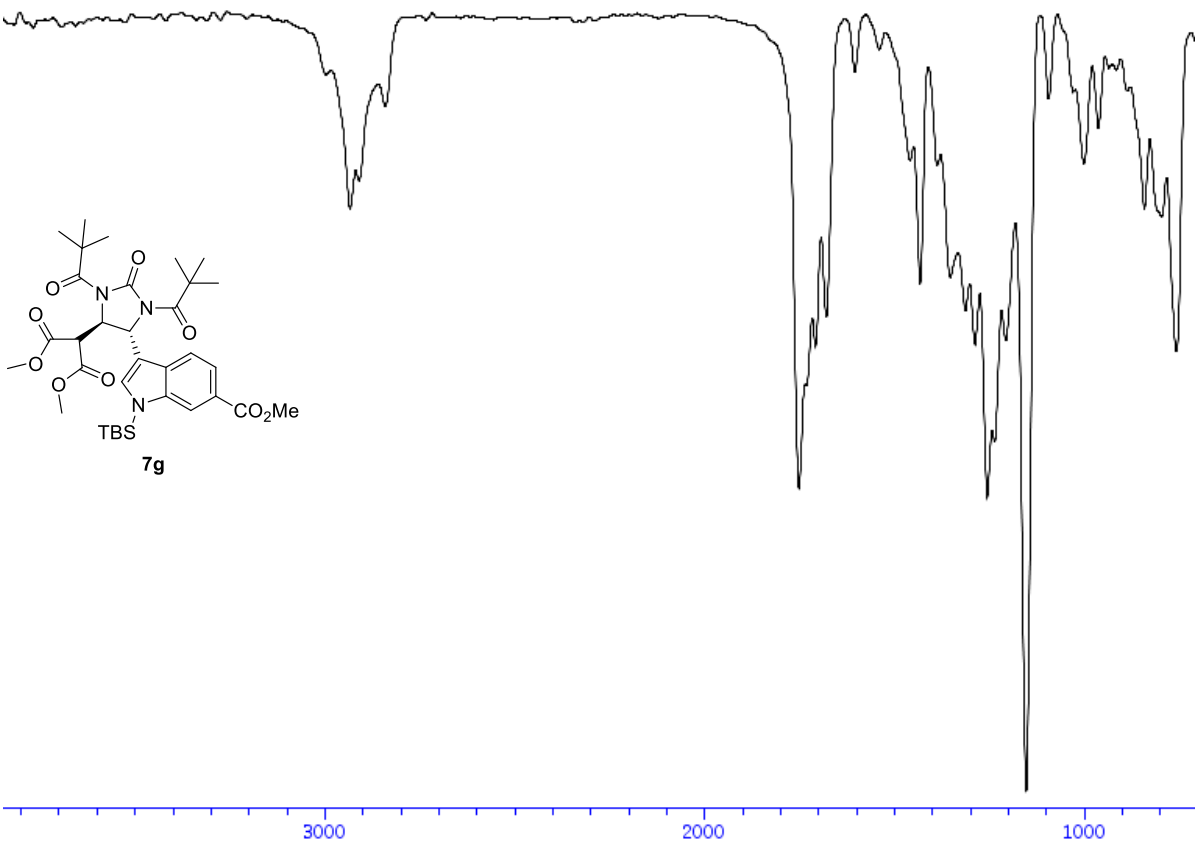


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.513	BB	0.4019	829.11749	30.61956	49.9670
2	15.139	BB	0.4549	830.21429	27.44681	50.0330



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.348	BB	0.3962	244.50339	9.19690	4.8755
2	14.797	BB	0.4971	4770.45361	141.57822	95.1245

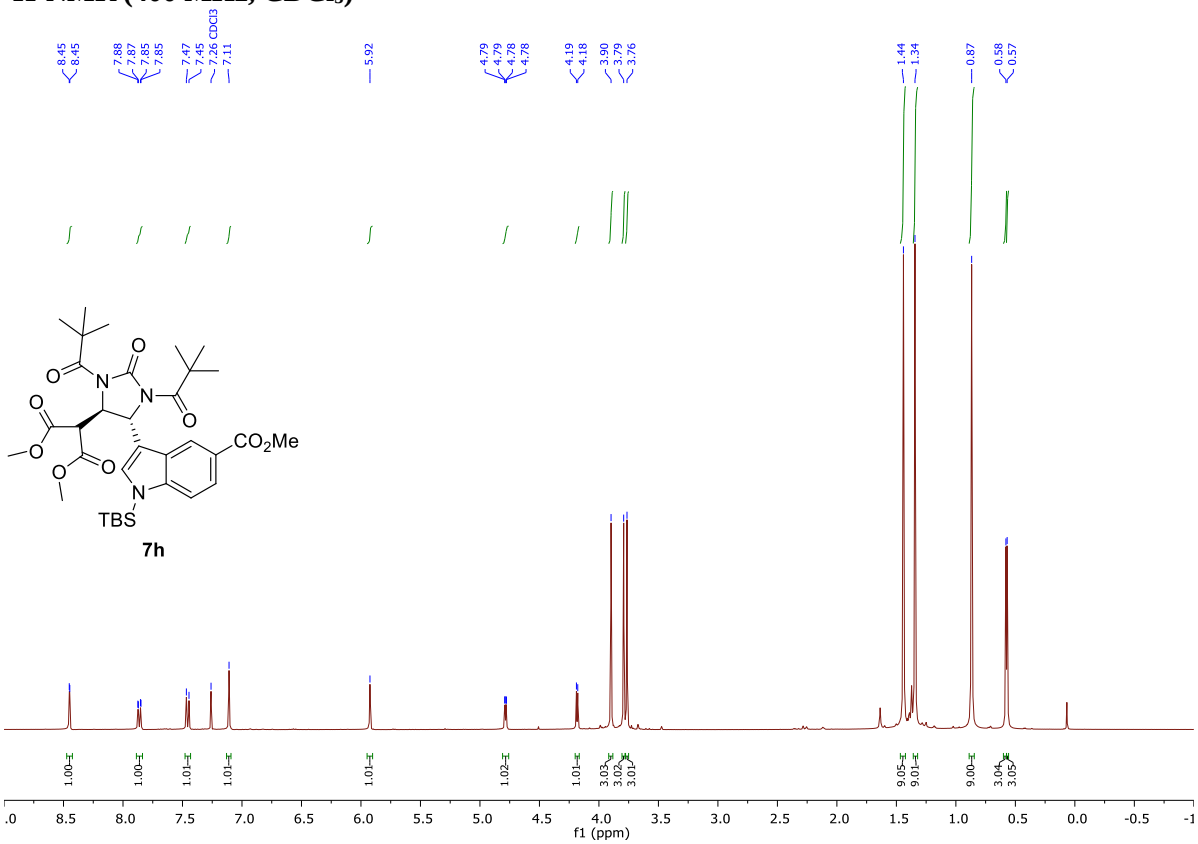
IR



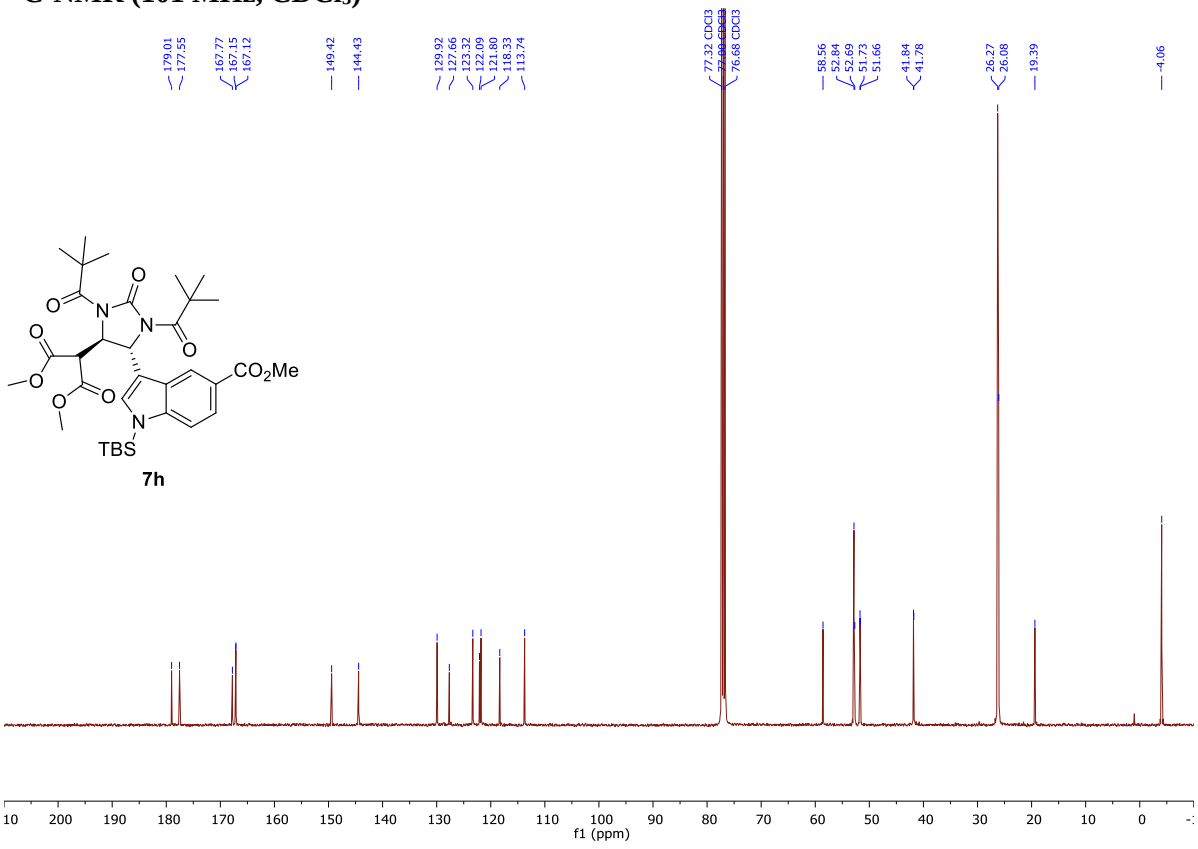
7g

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-(methoxycarbonyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7h)

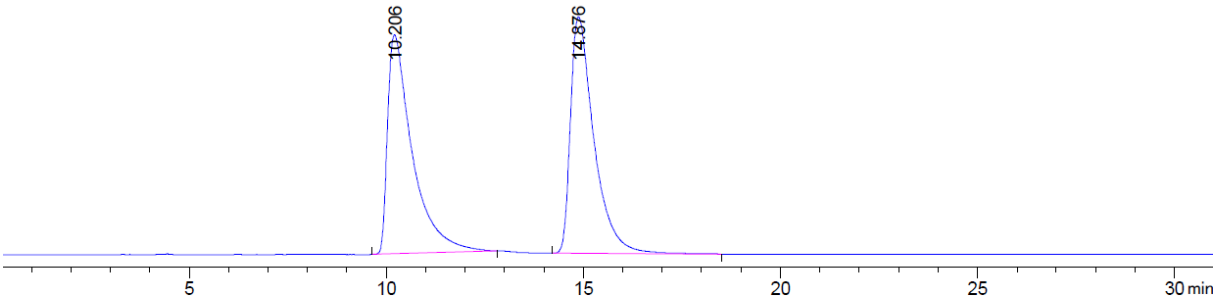
^{1}H-NMR (400 MHz, $CDCl_3$)



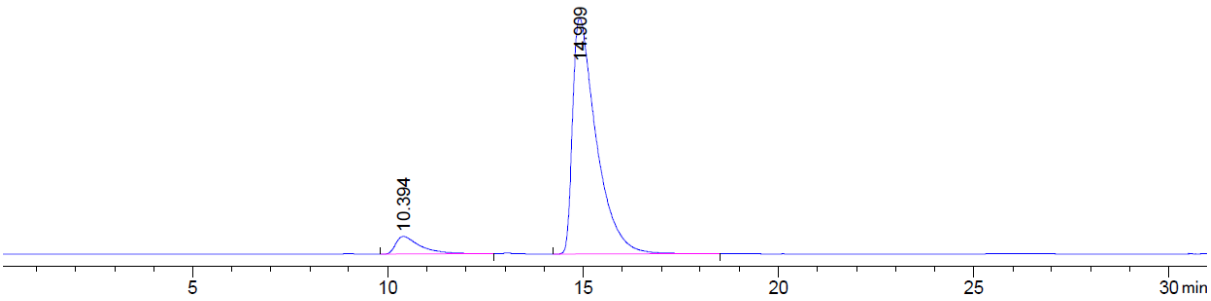
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

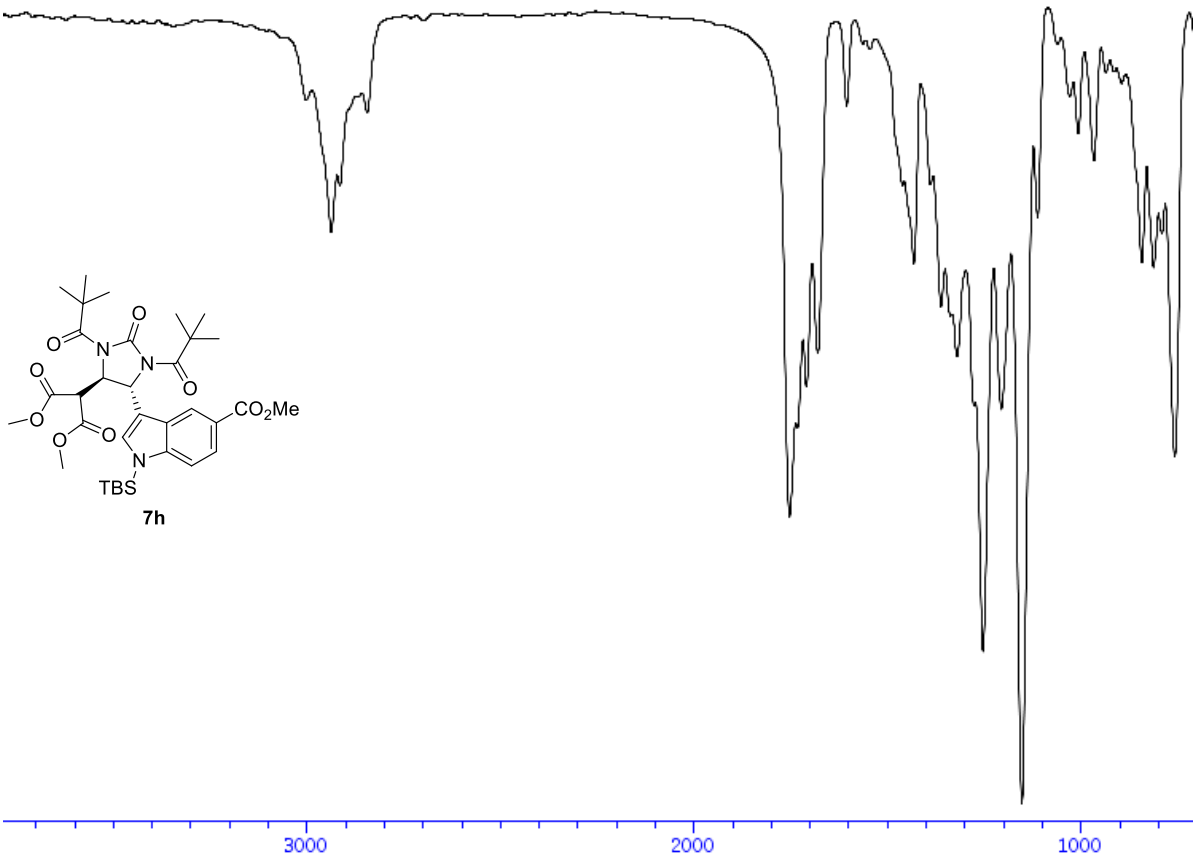


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.206	BB	0.6360	1644.50745	37.61931	49.4411
2	14.876	BB	0.6170	1681.68542	40.61745	50.5589



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.394	BB	0.6441	386.09814	8.76246	7.1864
2	14.908	BB	0.6218	4986.51953	118.29451	92.8136

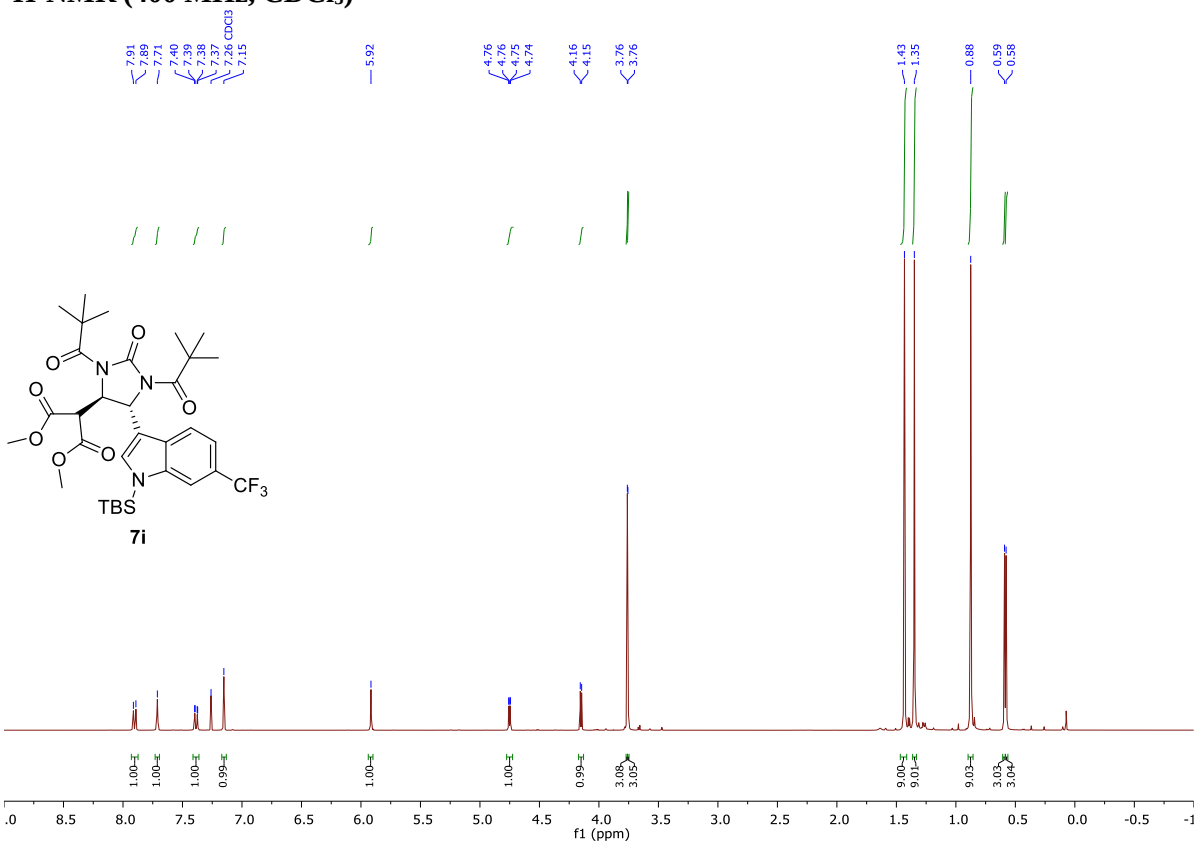
IR



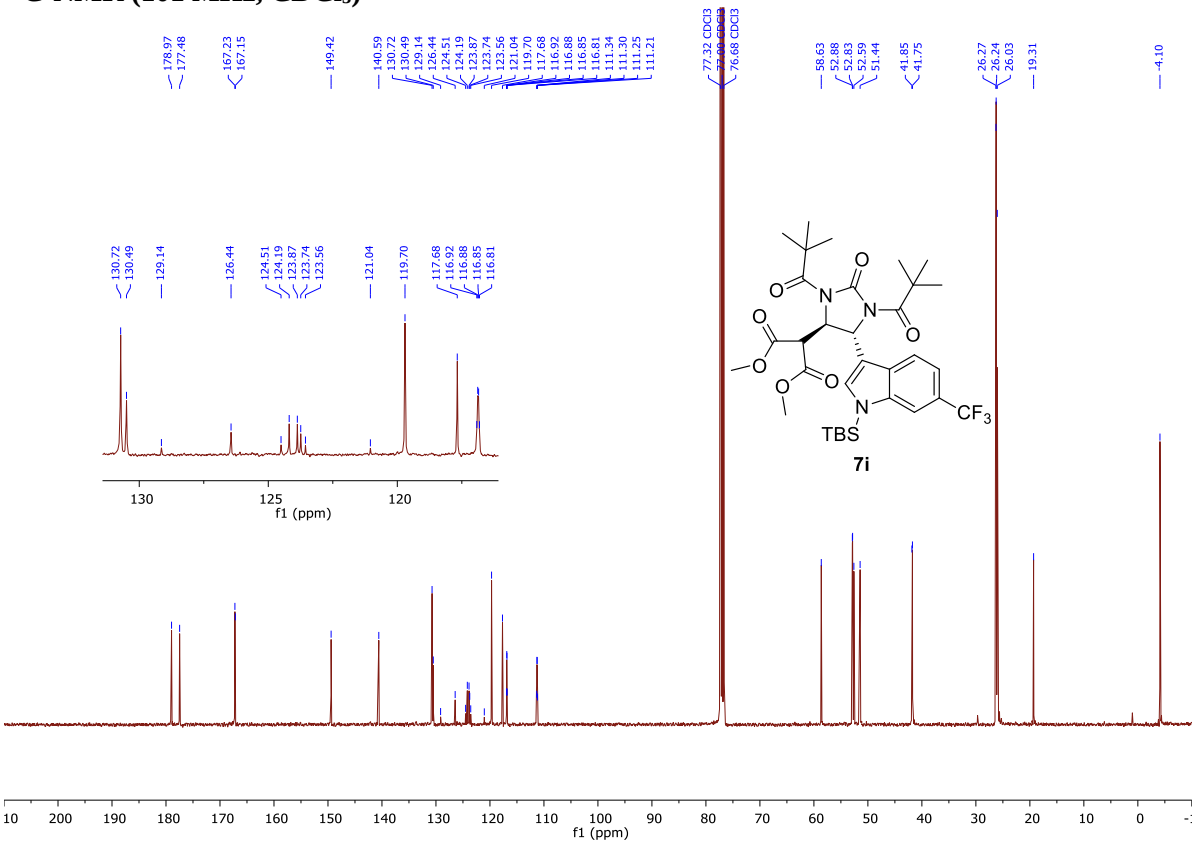
7h

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-(trifluoromethyl)-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7i)

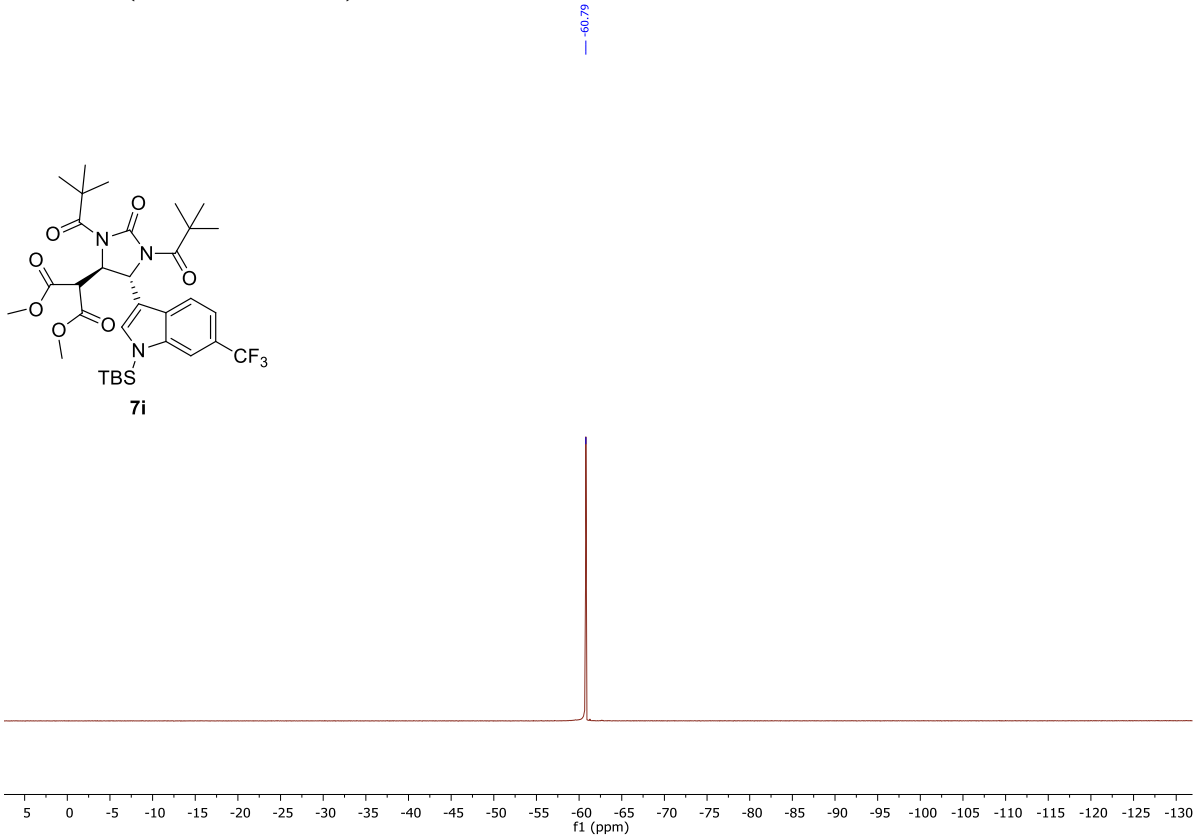
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)

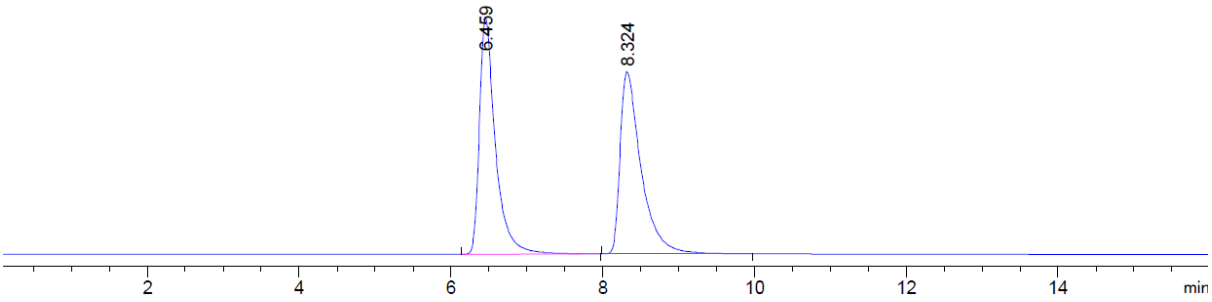


^{19}F NMR (376 MHz, $CDCl_3$)

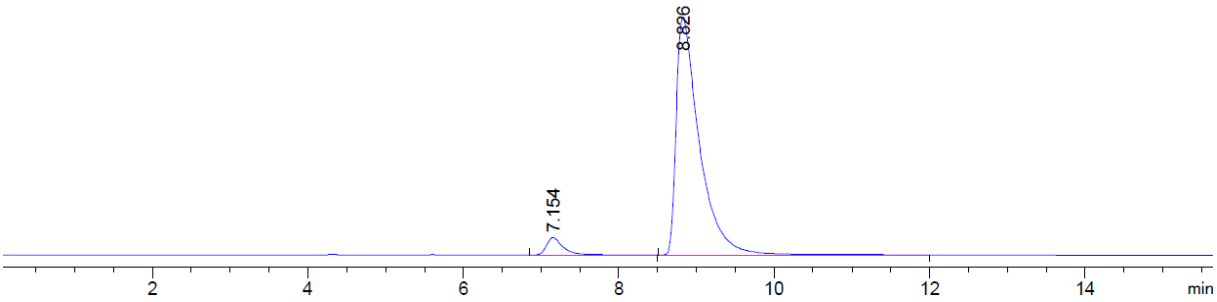


7i

HPLC

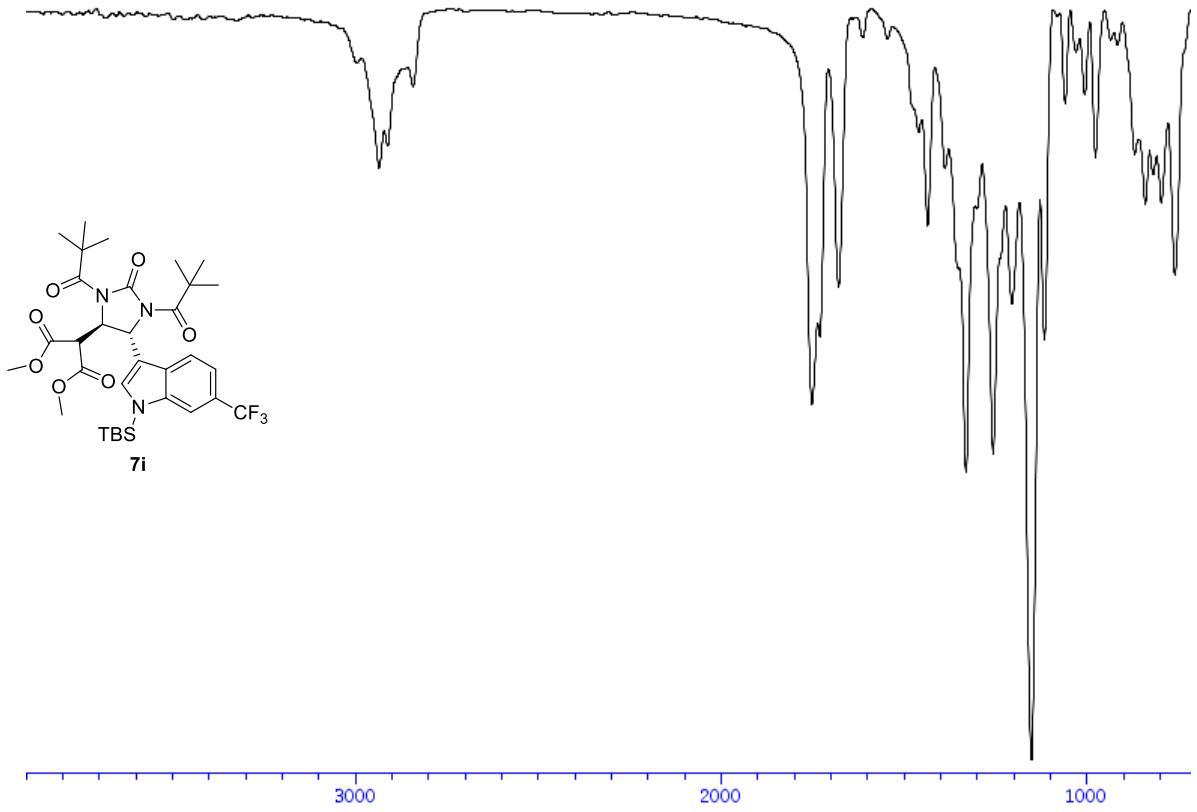


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.459	BB	0.2167	956.38446	65.38104	49.8848
2	8.324	BB	0.2832	960.80029	50.21458	50.1152



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.154	BB	0.2205	163.94270	10.96255	4.9705
2	8.826	BB	0.3037	3134.36255	151.32201	95.0295

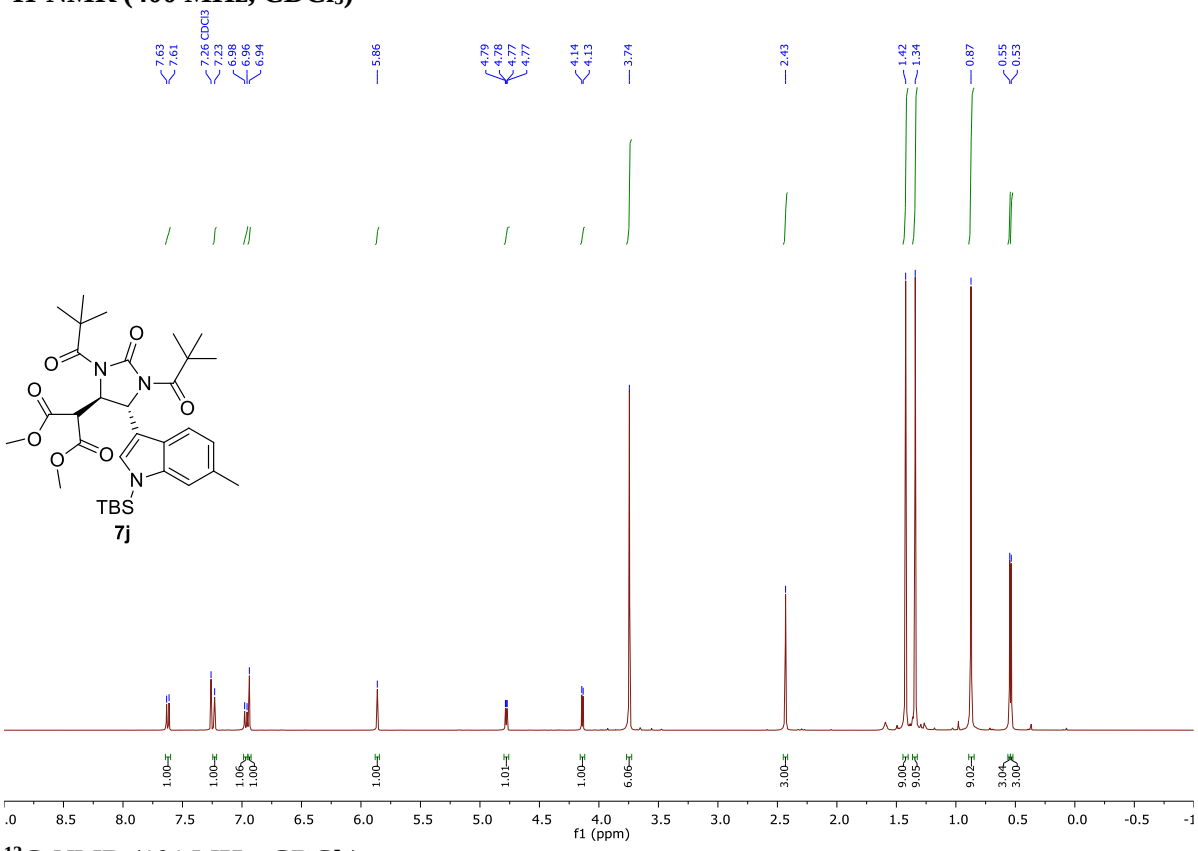
IR



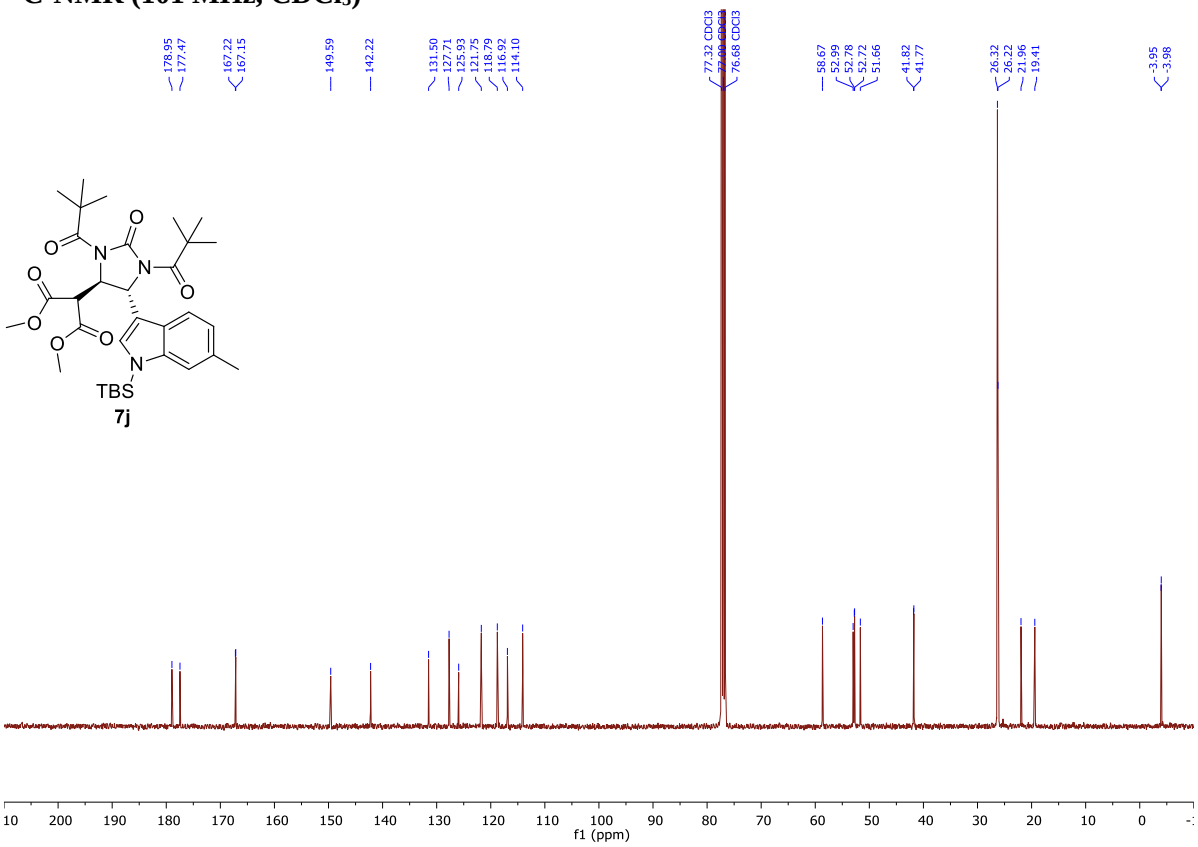
7i

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-methyl-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7j)

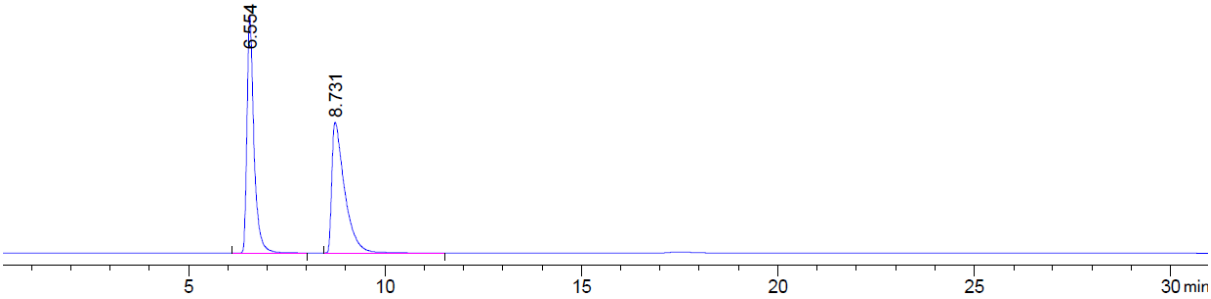
^{1}H-NMR (400 MHz, $CDCl_3$)



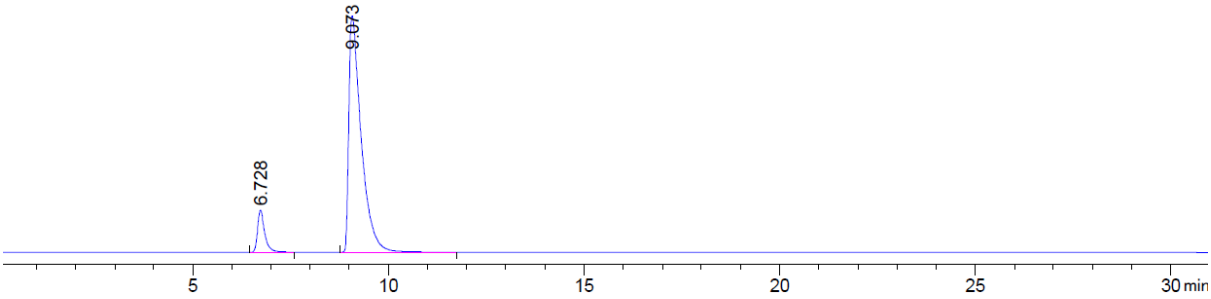
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

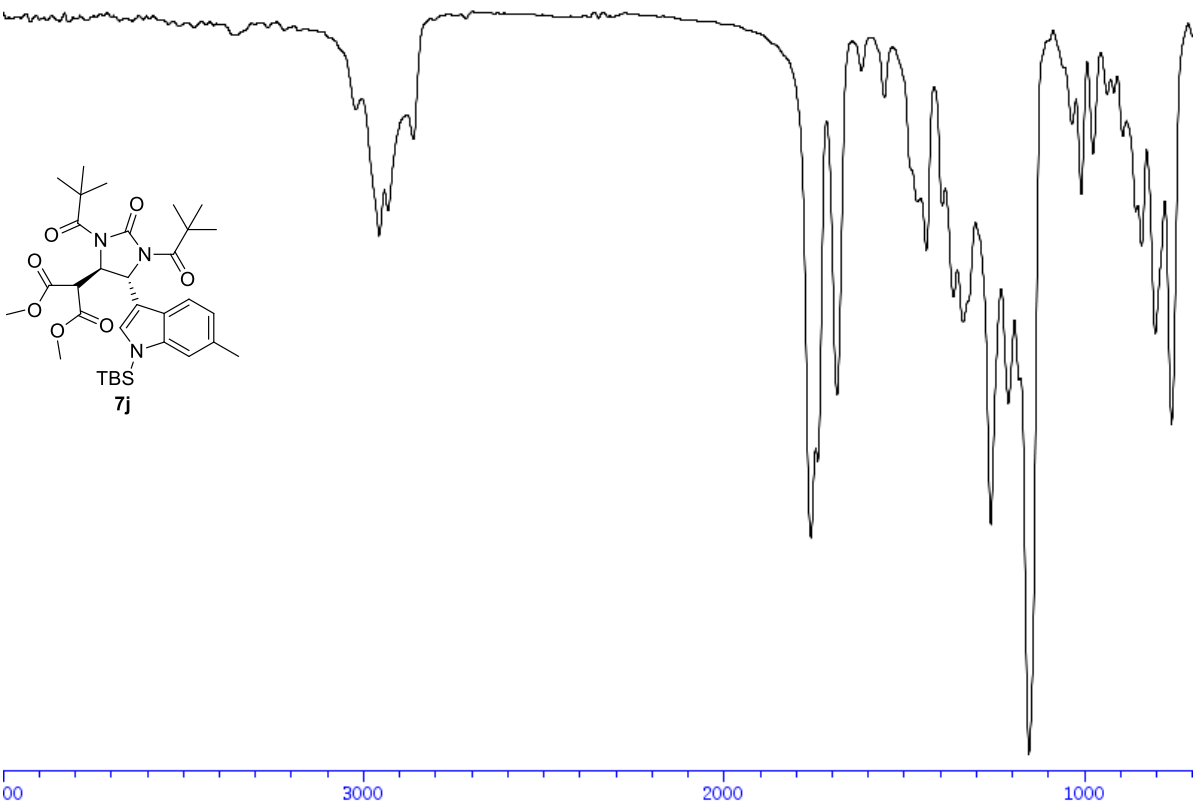


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.554	BB	0.1850	2565.46973	206.34976	49.8906
2	8.731	BB	0.3317	2576.72021	113.16083	50.1094



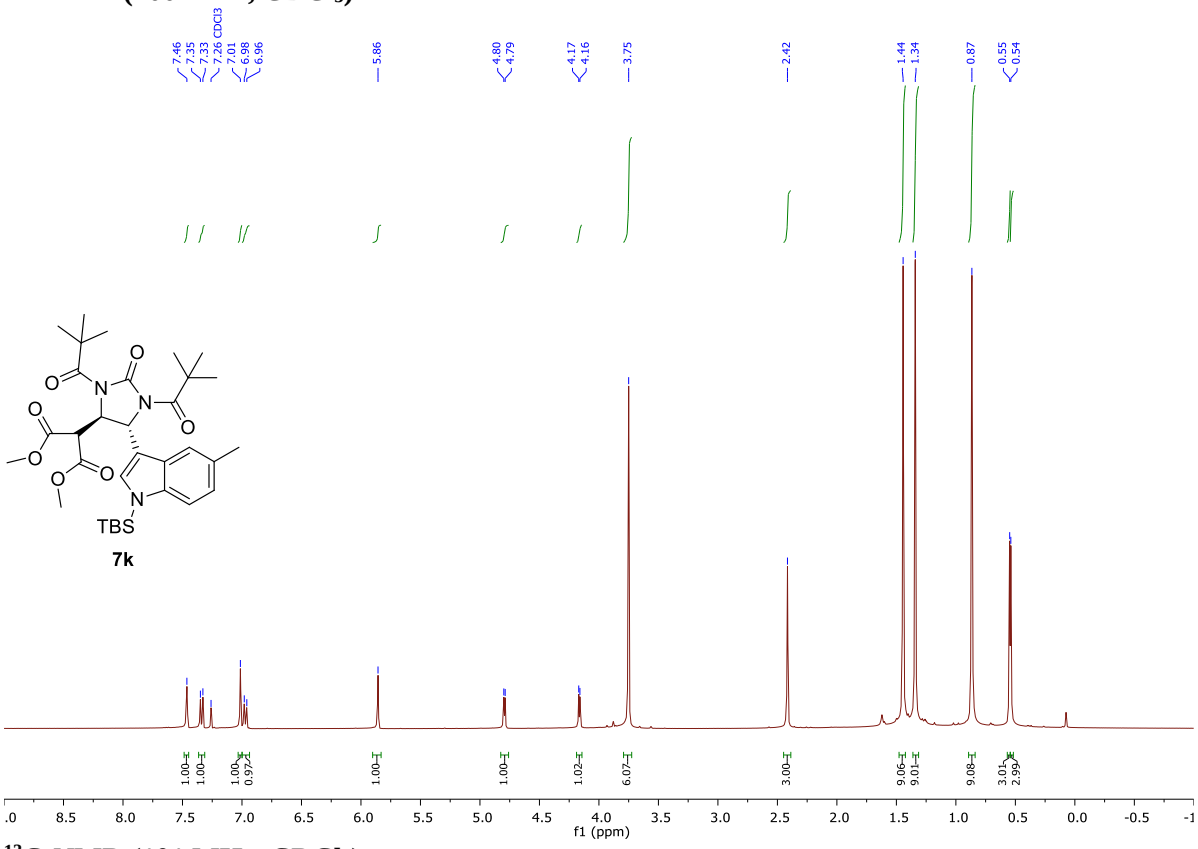
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.728	BB	0.1888	301.38214	23.94639	9.2705
2	9.073	BB	0.3242	2949.60498	134.32072	90.7295

IR

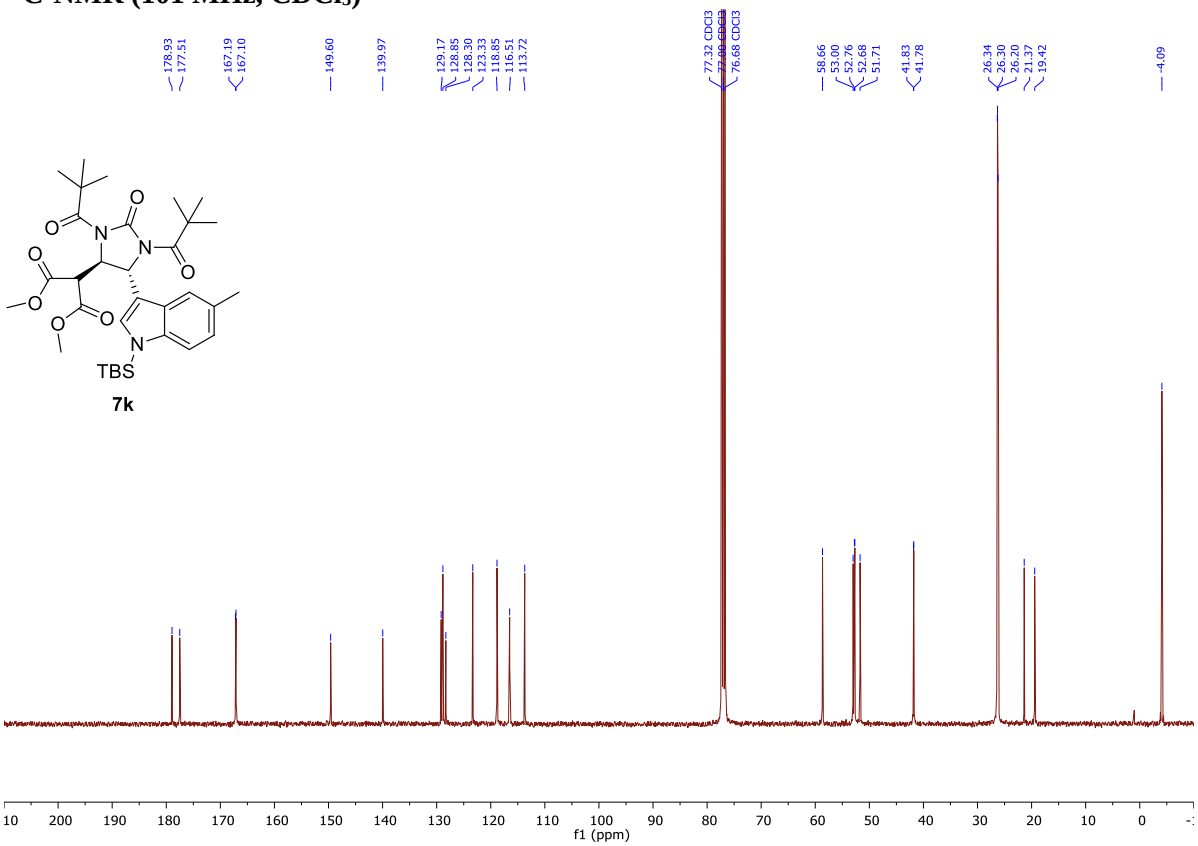


Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-5-methyl-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7k)

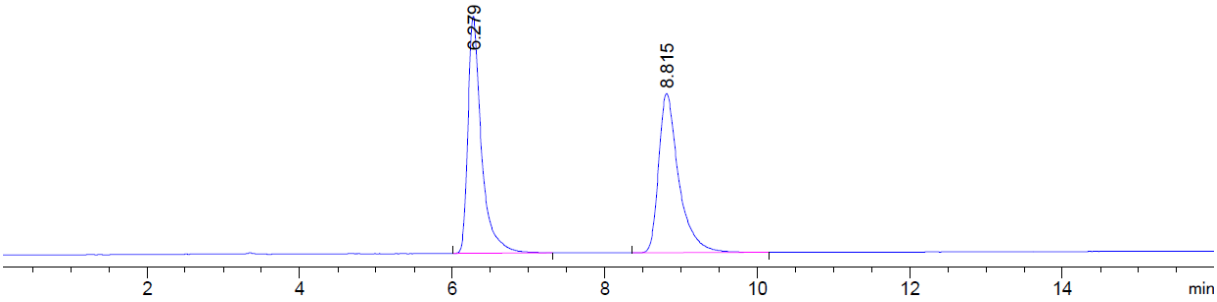
^{1}H-NMR (400 MHz, $CDCl_3$)



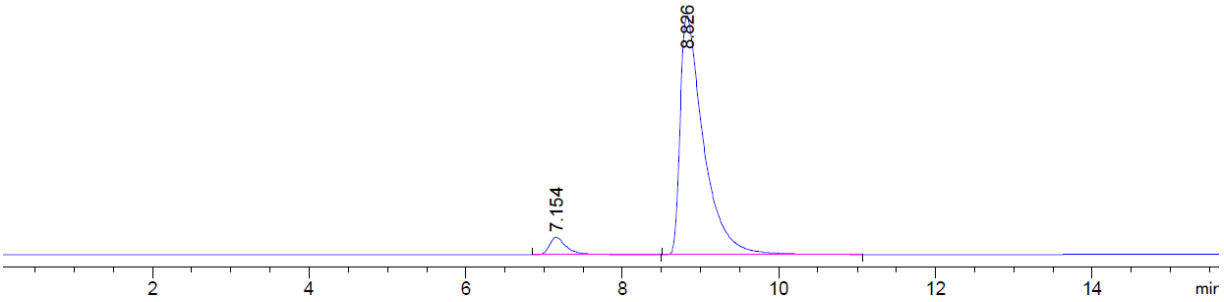
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

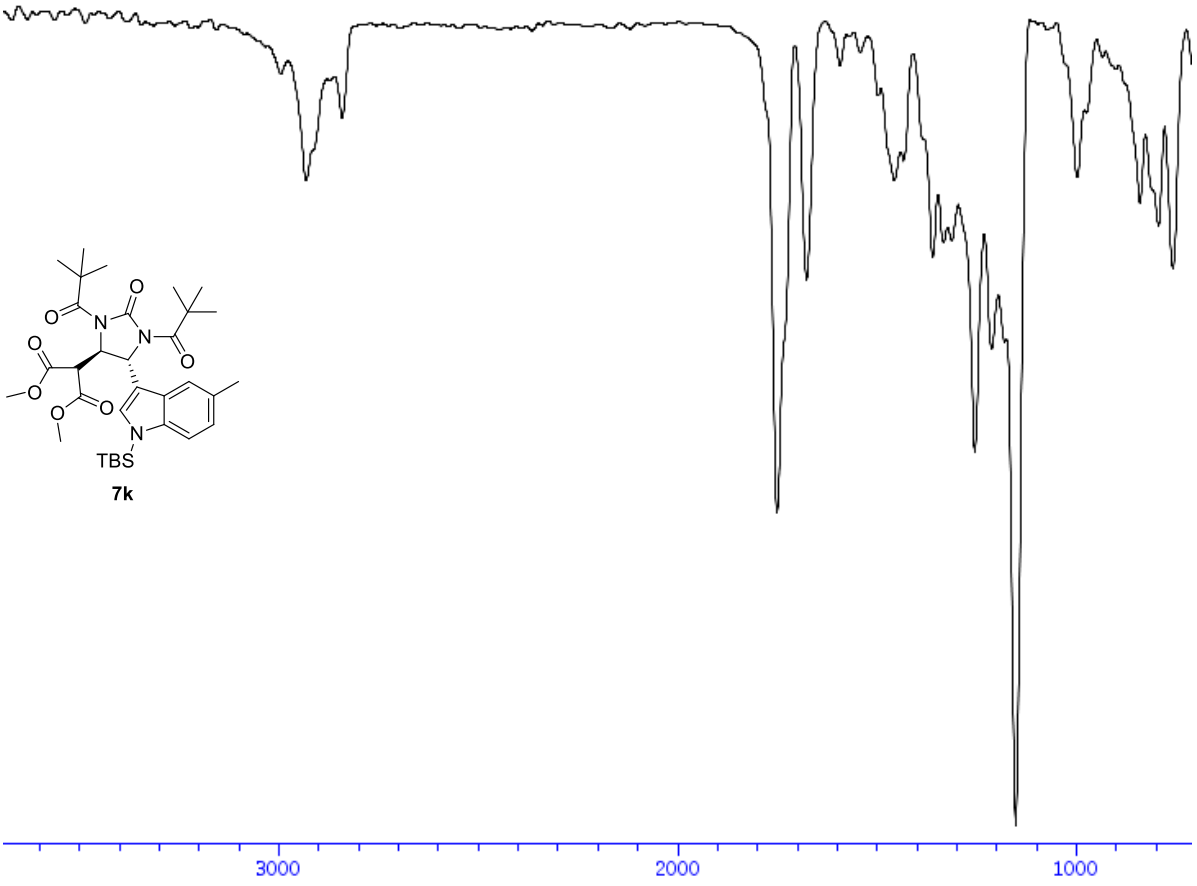


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.279	BB	0.1814	172.03889	13.99507	49.9280
2	8.815	BB	0.2743	172.53520	9.39392	50.0720



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.154	BB	0.2205	163.94270	10.96255	4.9705
2	8.826	BB	0.3037	3134.36255	151.32201	95.0295

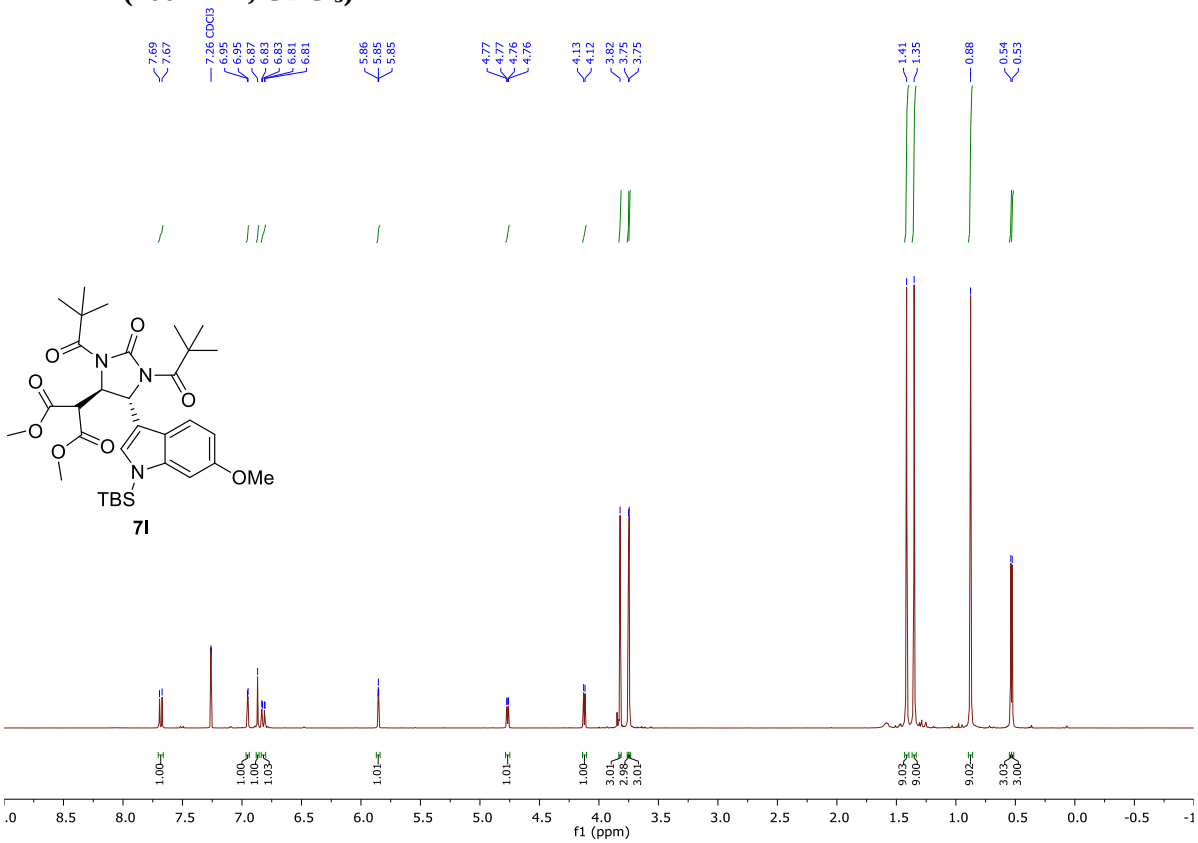
IR



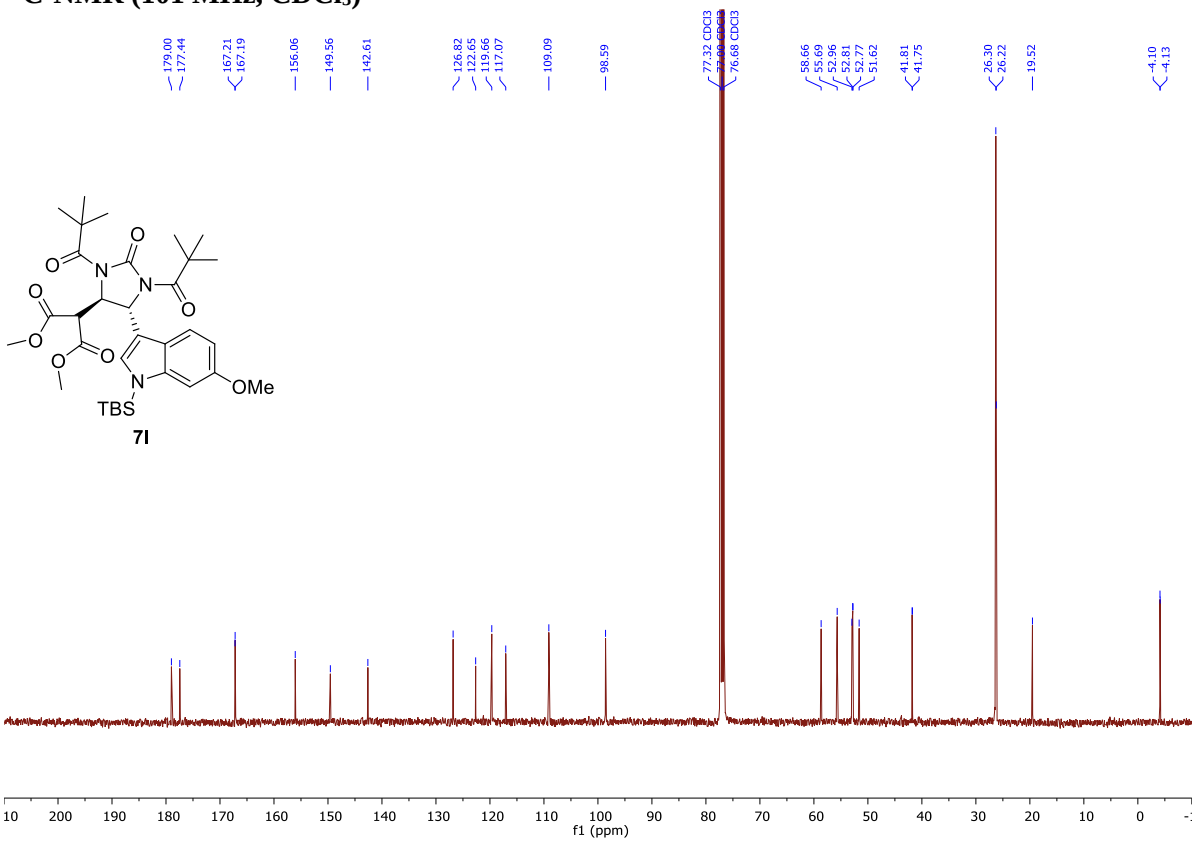
7k

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-methoxy-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7l)

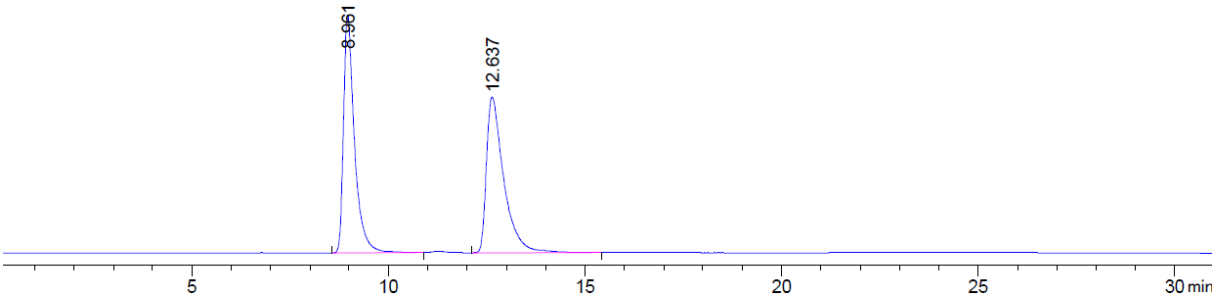
^{1}H-NMR (400 MHz, $CDCl_3$)



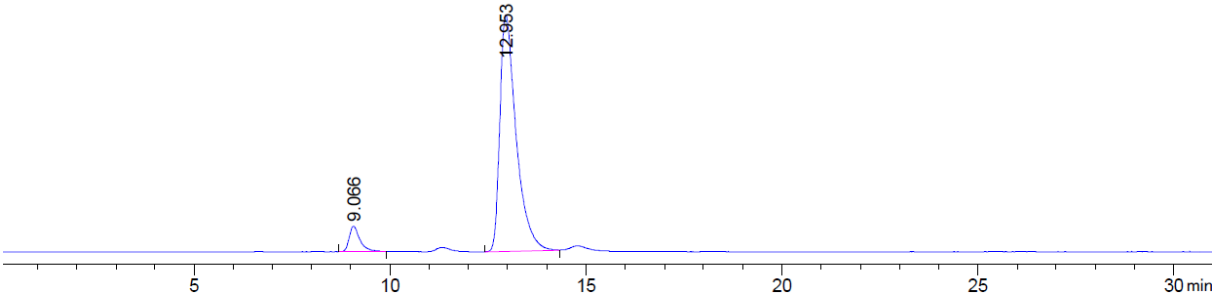
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

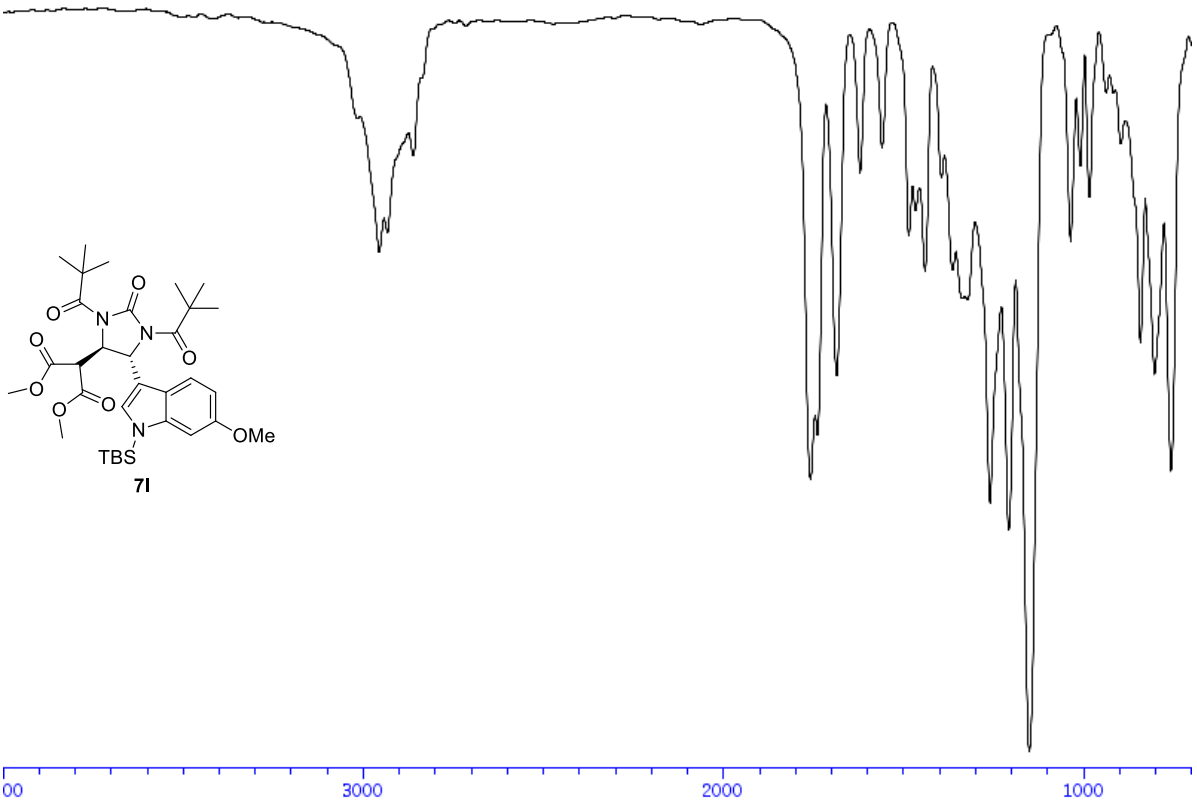


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.961	BB	0.2862	1095.87964	56.52717	49.1825
2	12.637	BB	0.4533	1132.31091	36.97139	50.8175



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.066	BB	0.2795	39.33647	2.07167	6.6039
2	12.953	BB	0.4297	556.31537	19.33605	93.3961

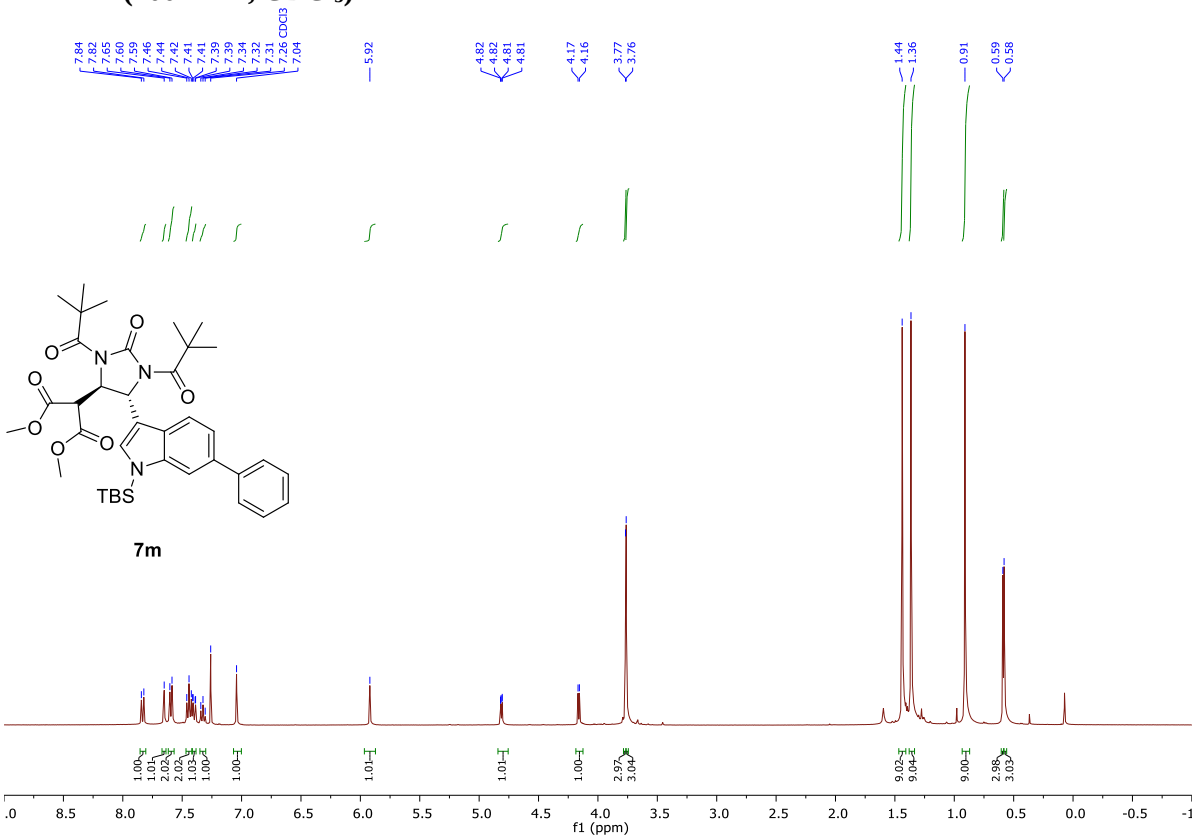
IR



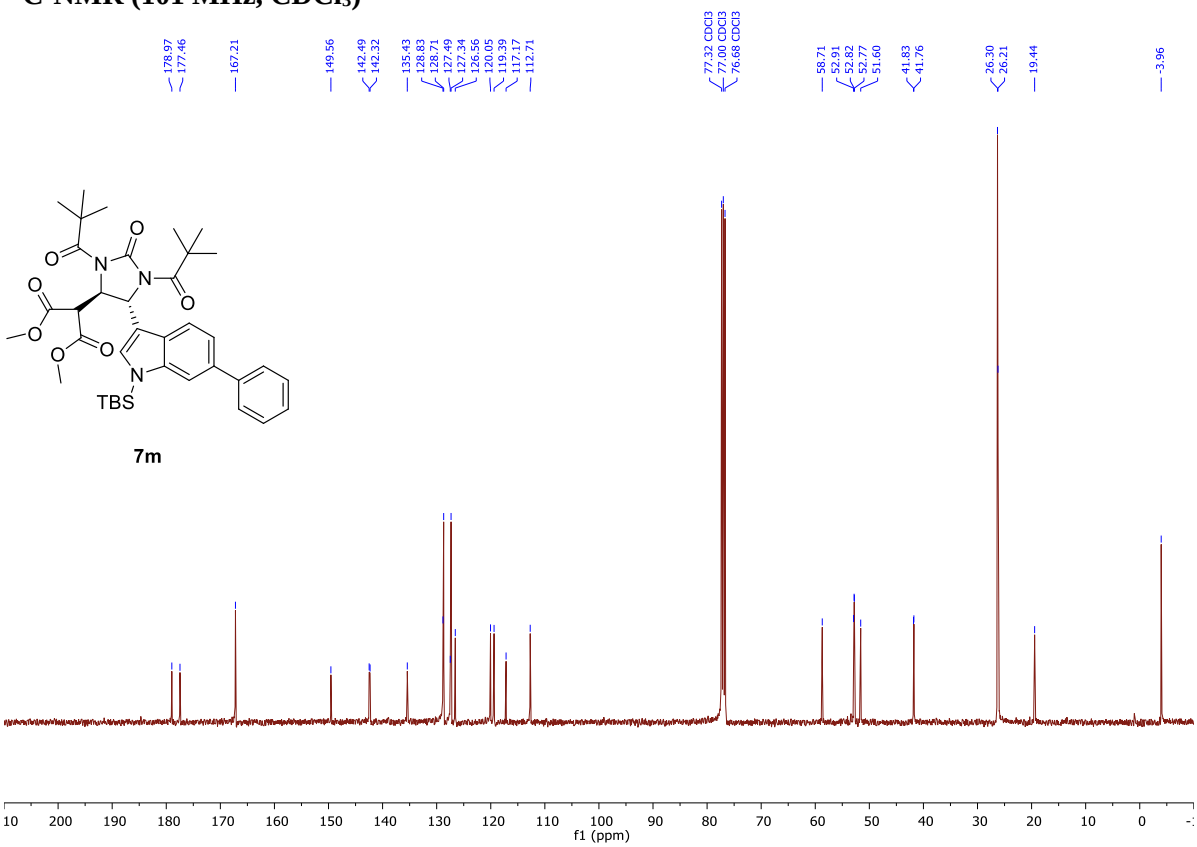
7l

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-6-phenyl-1H-indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7m)

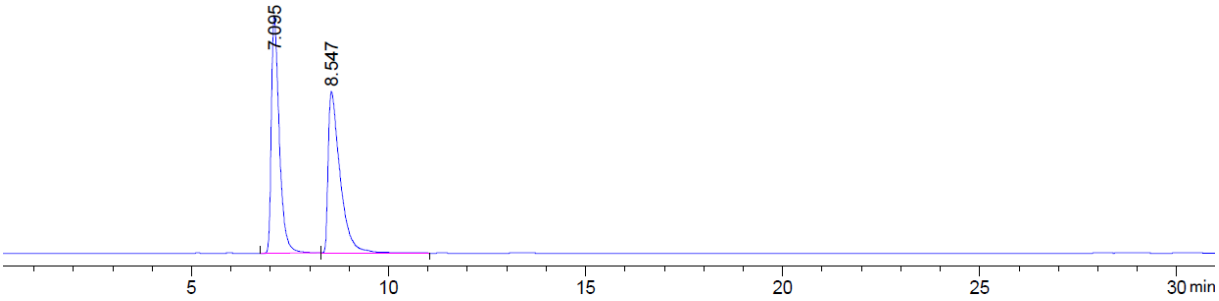
^{1}H-NMR (400 MHz, $CDCl_3$)



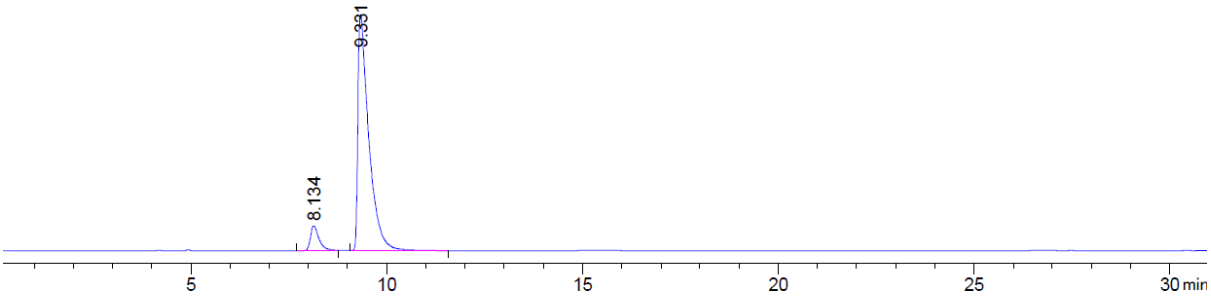
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

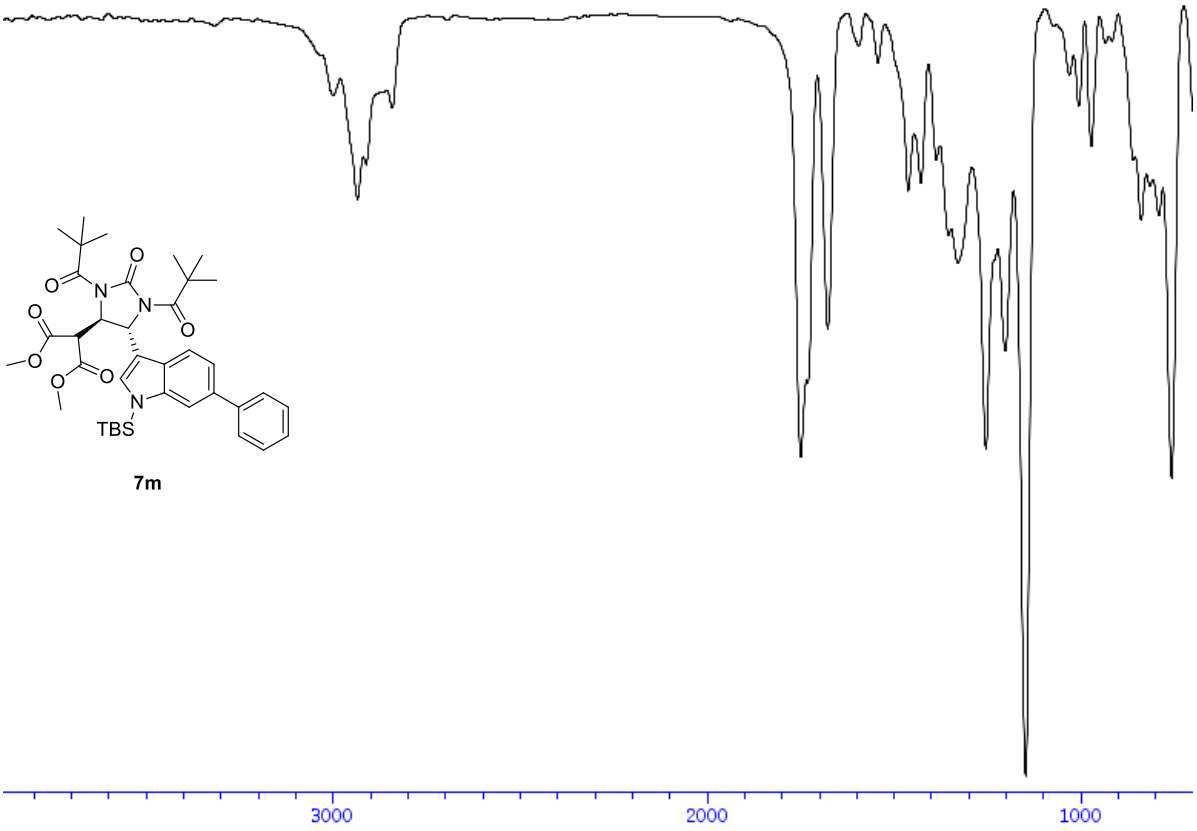


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.095	BB	0.2124	1829.82813	129.89087	49.5743
2	8.547	BB	0.3070	1861.25134	88.62238	50.4257



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.134	BV	0.2283	835.99512	54.70217	7.6815
2	9.331	VB	0.2763	1.00472e4	518.02020	92.3185

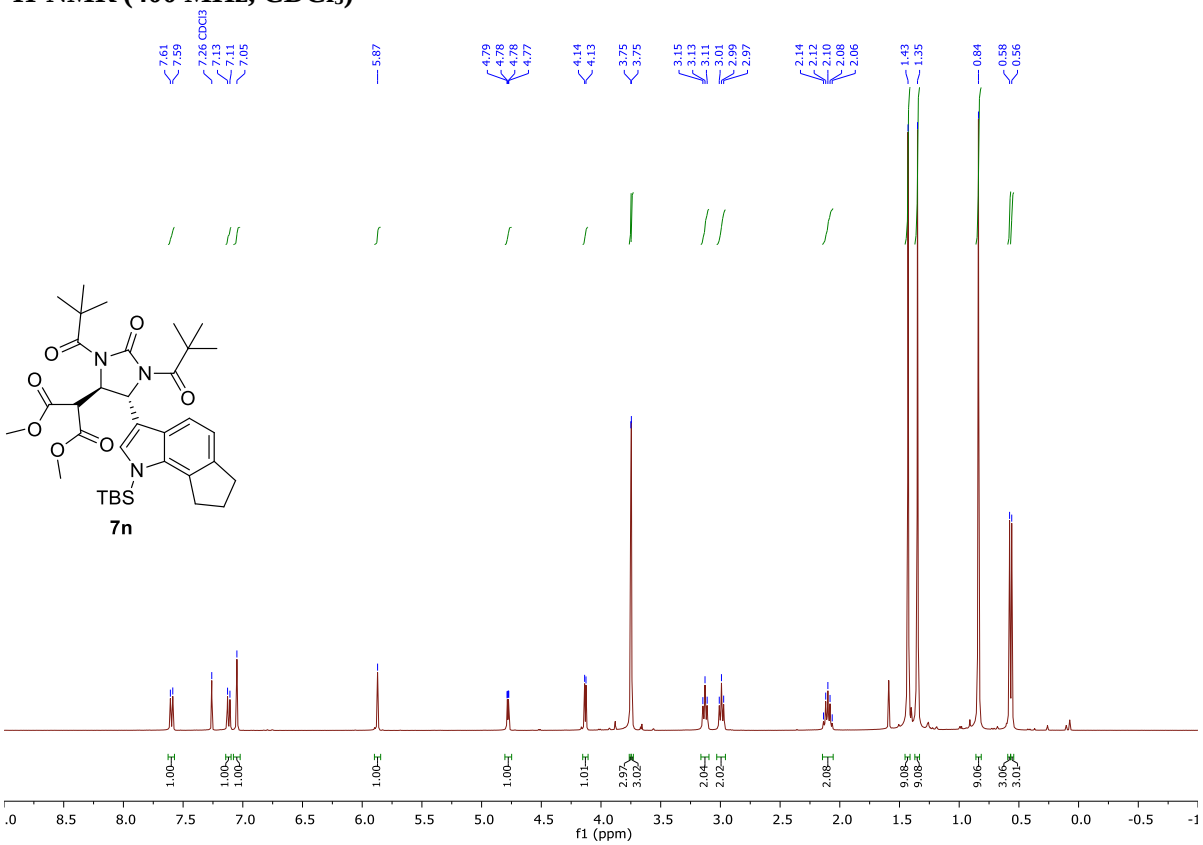
IR



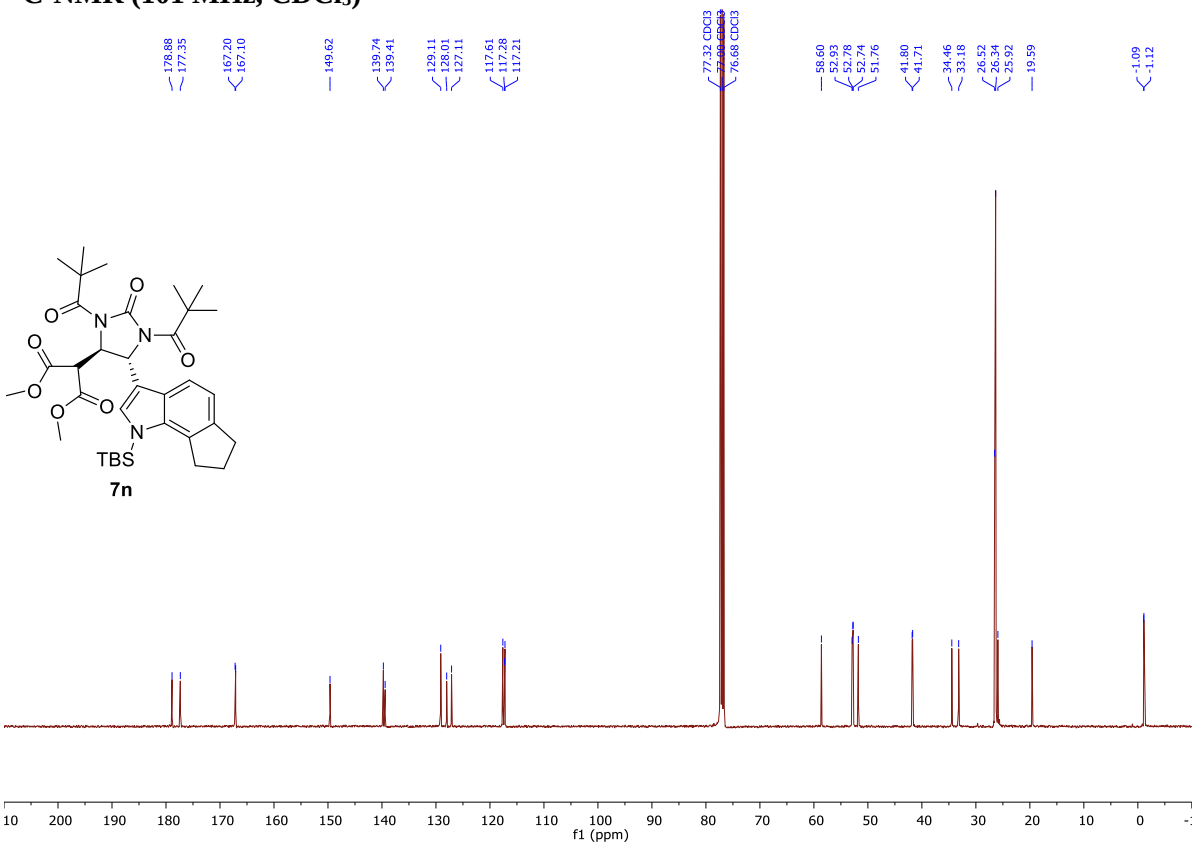
7m

Dimethyl 2-(5-(1-(tert-butyldimethylsilyl)-1,6,7,8-tetrahydrocyclopenta[g]indol-3-yl)-2-oxo-1,3-dipivaloylimidazolidin-4-yl)malonate (7n)

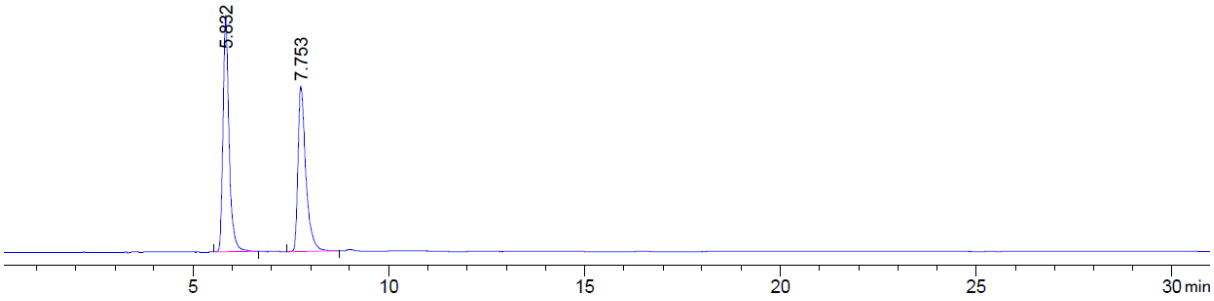
^{1}H-NMR (400 MHz, $CDCl_3$)



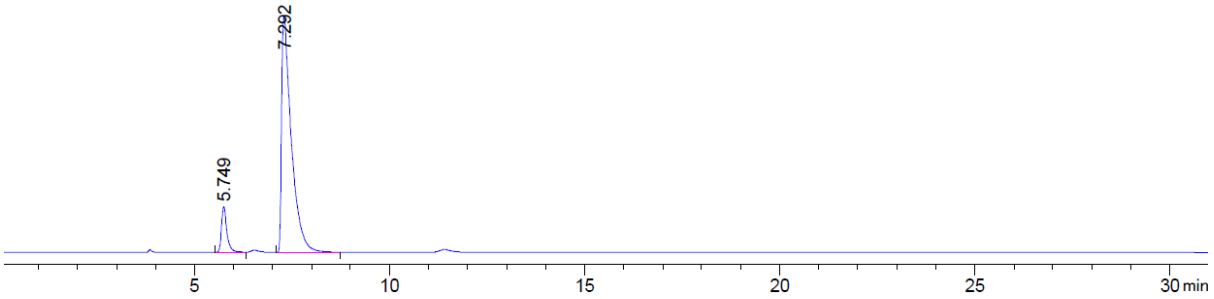
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

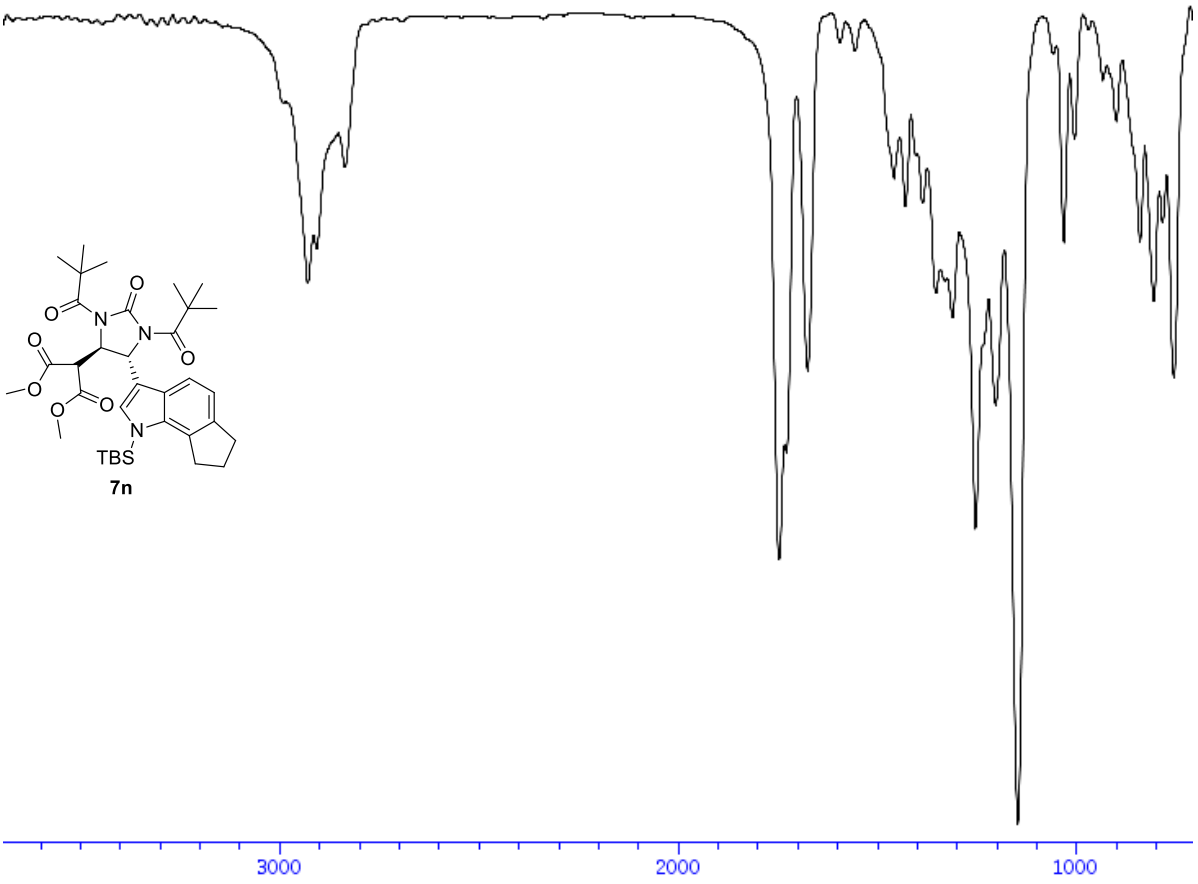


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.832	BB	0.1618	243.42946	22.57959	52.5208
2	7.753	BB	0.2087	220.06186	15.77604	47.4792



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.749	BB	0.1427	818.25580	86.23480	9.5457
2	7.292	BB	0.2437	7753.75977	448.58212	90.4543

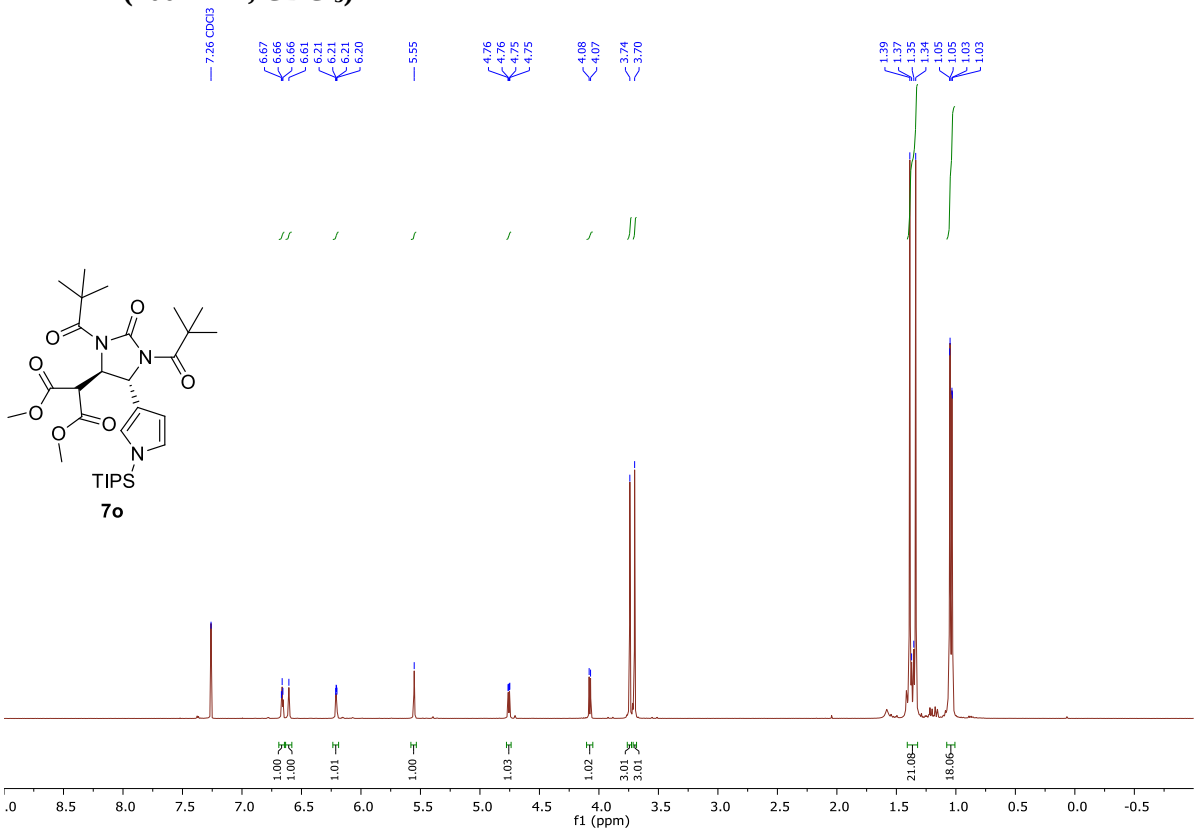
IR

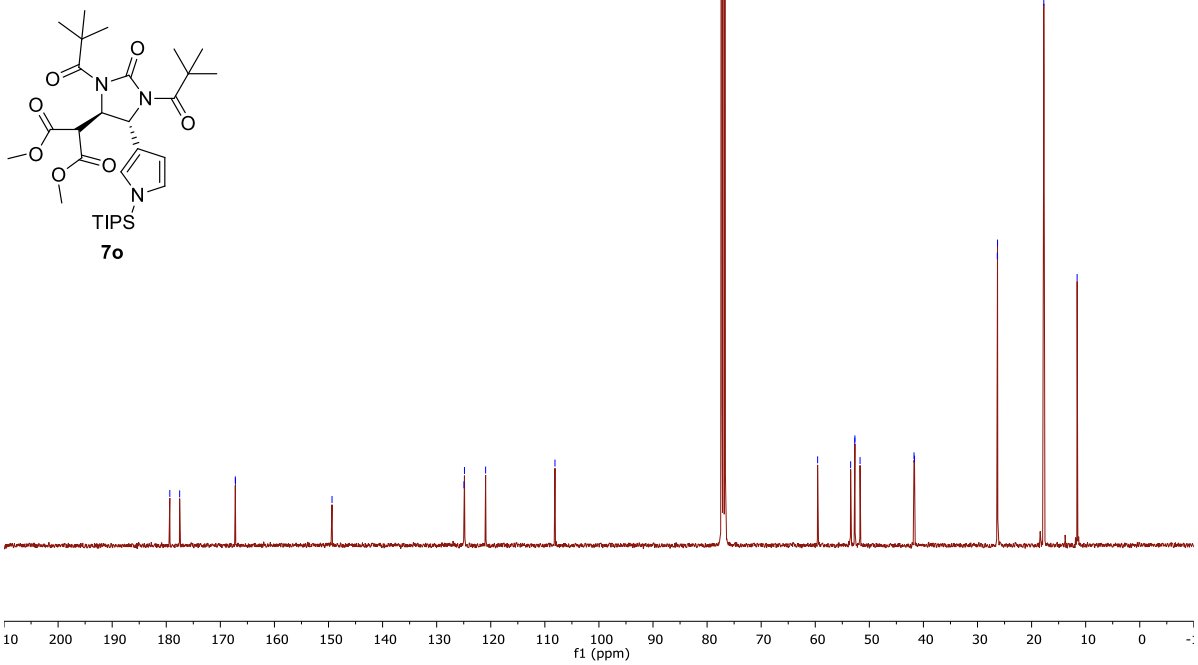


7n

Dimethyl 2-(2-oxo-1,3-dipivaloyl-5-(1-(triisopropylsilyl)-1H-pyrrol-3-yl)imidazolidin-4-yl)malonate (7o)

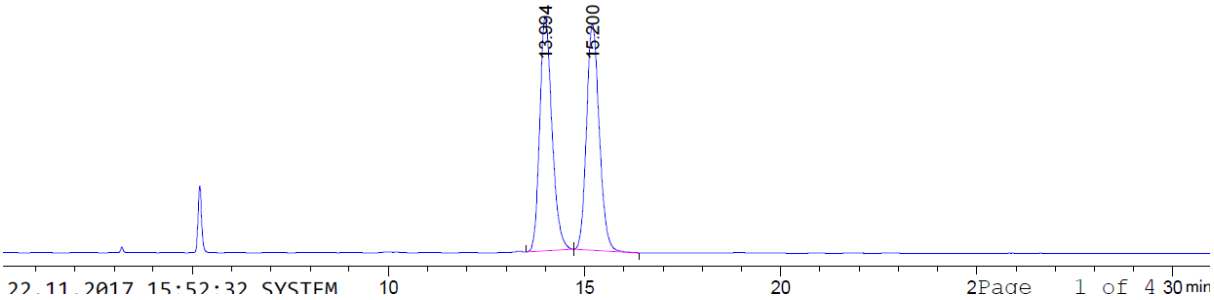
^{1}H-NMR (400 MHz, $CDCl_3$)



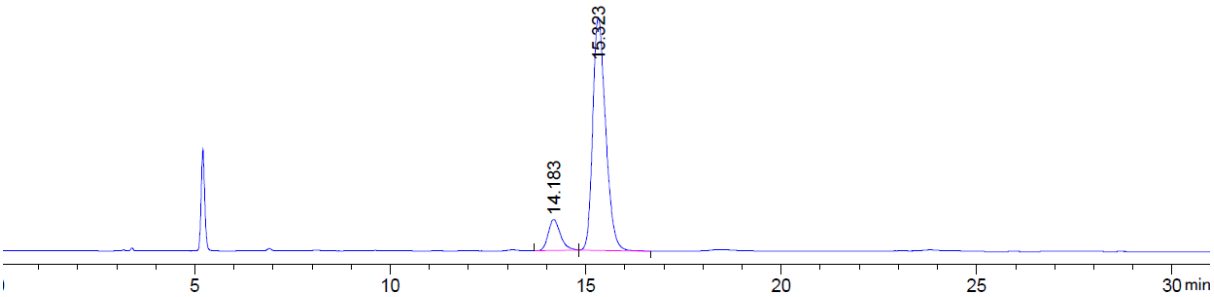


^{13}C-NMR (101 MHz, $CDCl_3$)

HPLC

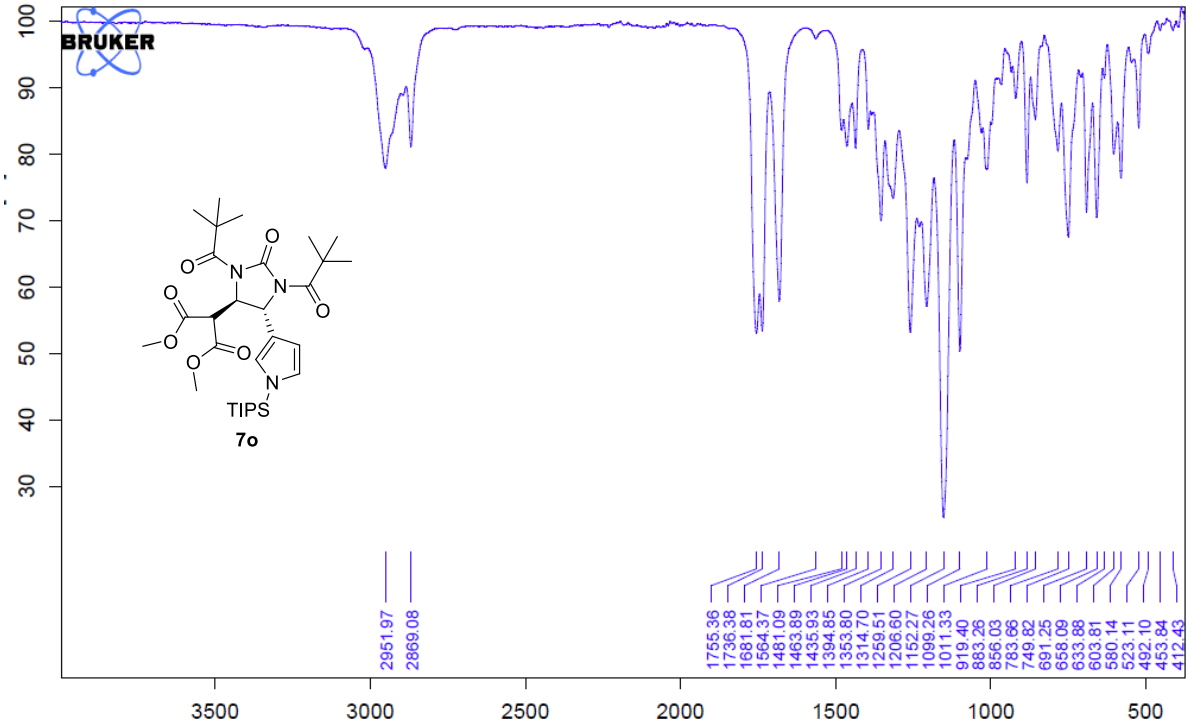


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.994	BB	0.3338	1418.42273	65.21094	49.9431
2	15.200	BB	0.3489	1421.65637	63.08244	50.0569



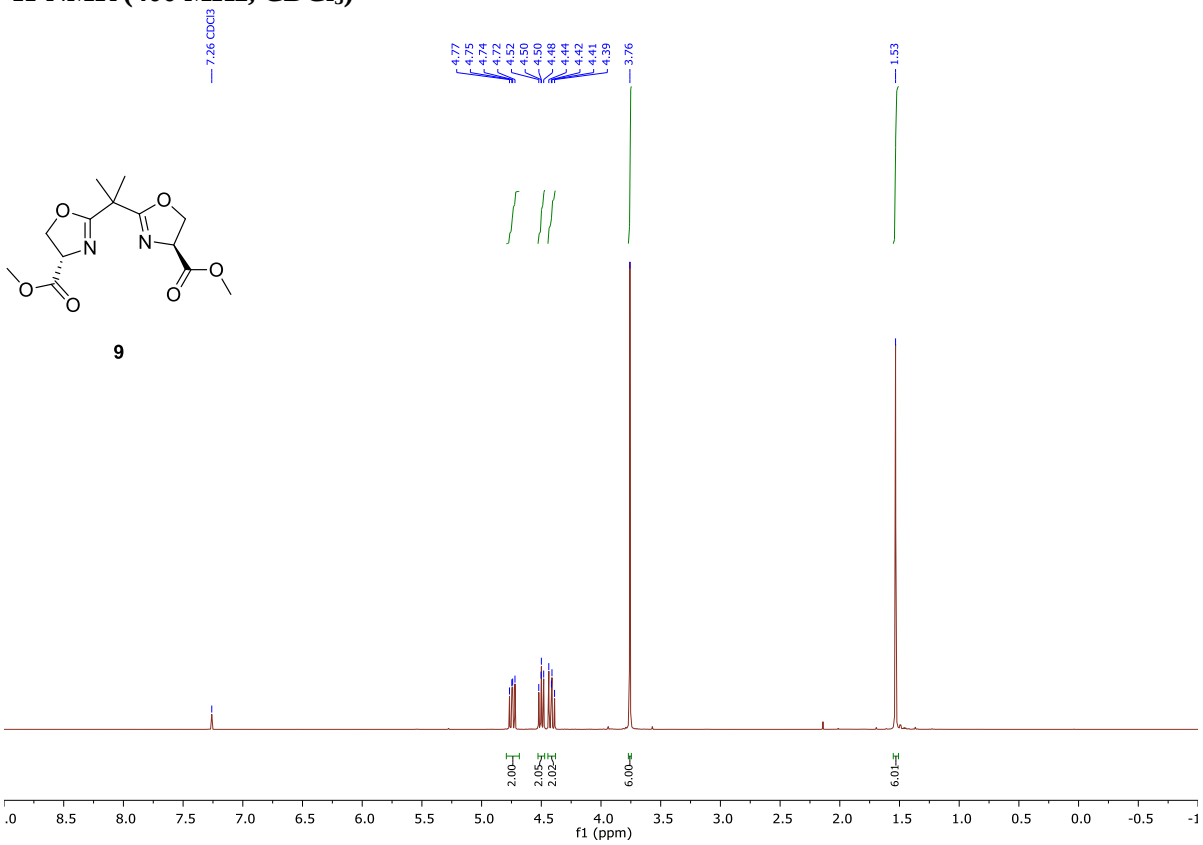
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.183	BB	0.3342	50.63592	2.34280	11.1984
2	15.323	BB	0.3518	401.53619	17.62564	88.8016

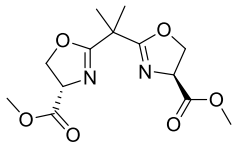
IR


BRUKER
TIPS
7o
2951.97
2869.08
1755.36
1736.38
1681.81
1564.37
1481.09
1463.89
1435.93
1394.85
1353.80
1314.70
1259.51
1206.60
1152.27
1099.26
1011.33
919.40
883.26
856.03
783.66
749.82
691.25
658.09
633.88
603.81
580.14
523.11
492.10
453.84
412.43
100
90
80
70
60
50
40
30
3500
3000
2500
2000
1500
1000
500

(4S,4'S)-dimethyl 2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4-carboxylate) (9)

^{1}H-NMR (400 MHz, $CDCl_3$)



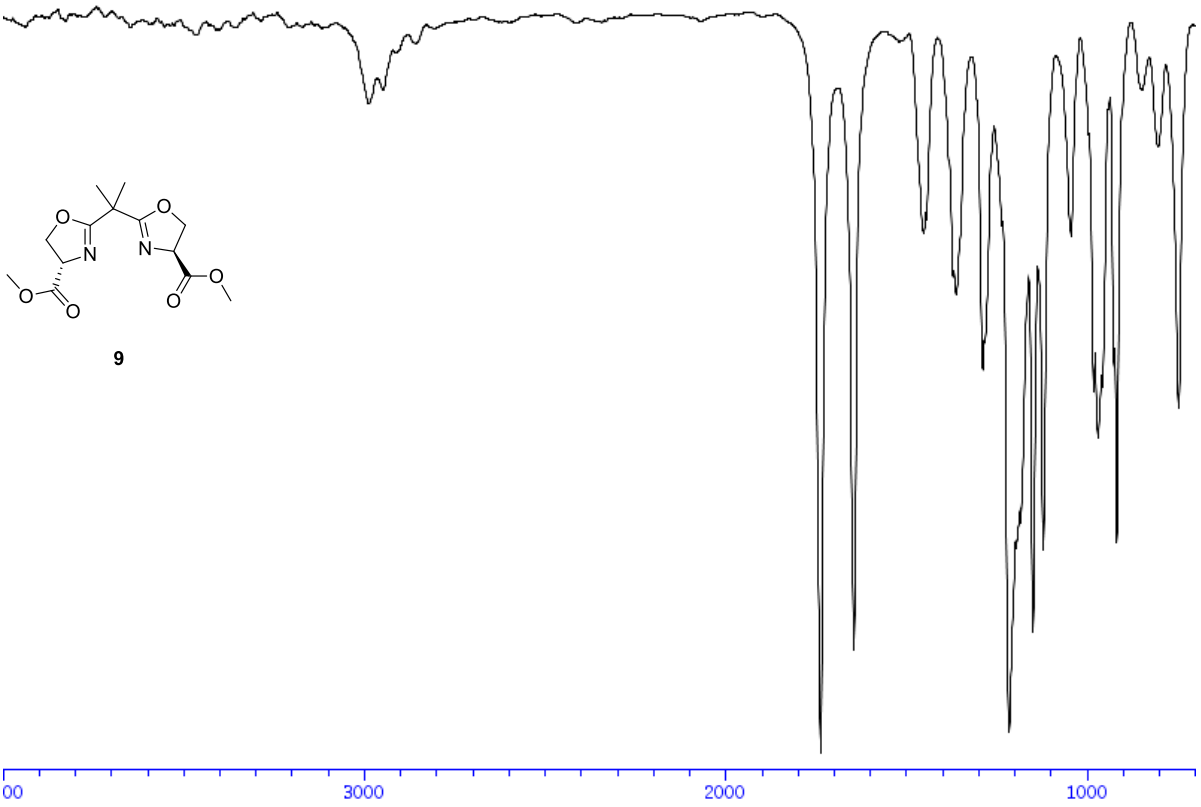


9

^{13}C-NMR (101 MHz, $CDCl_3$)

9

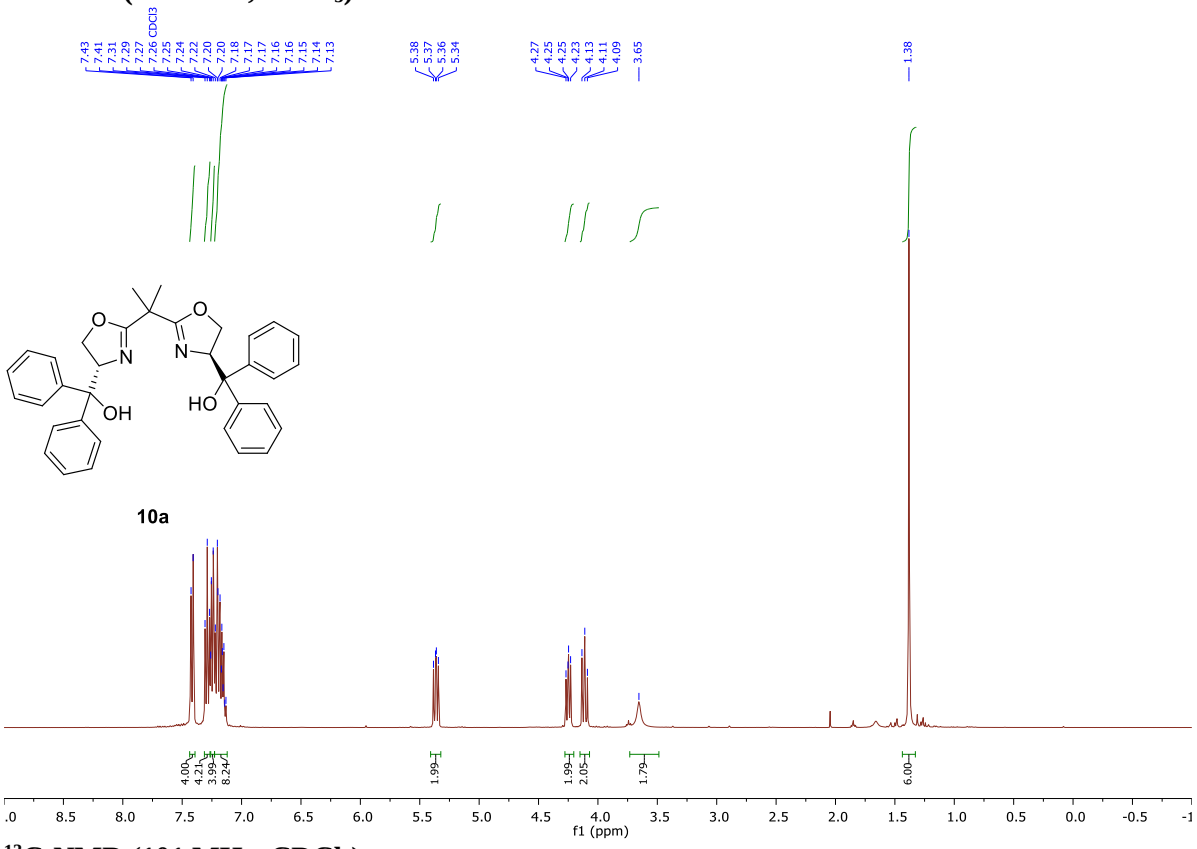
IR



9

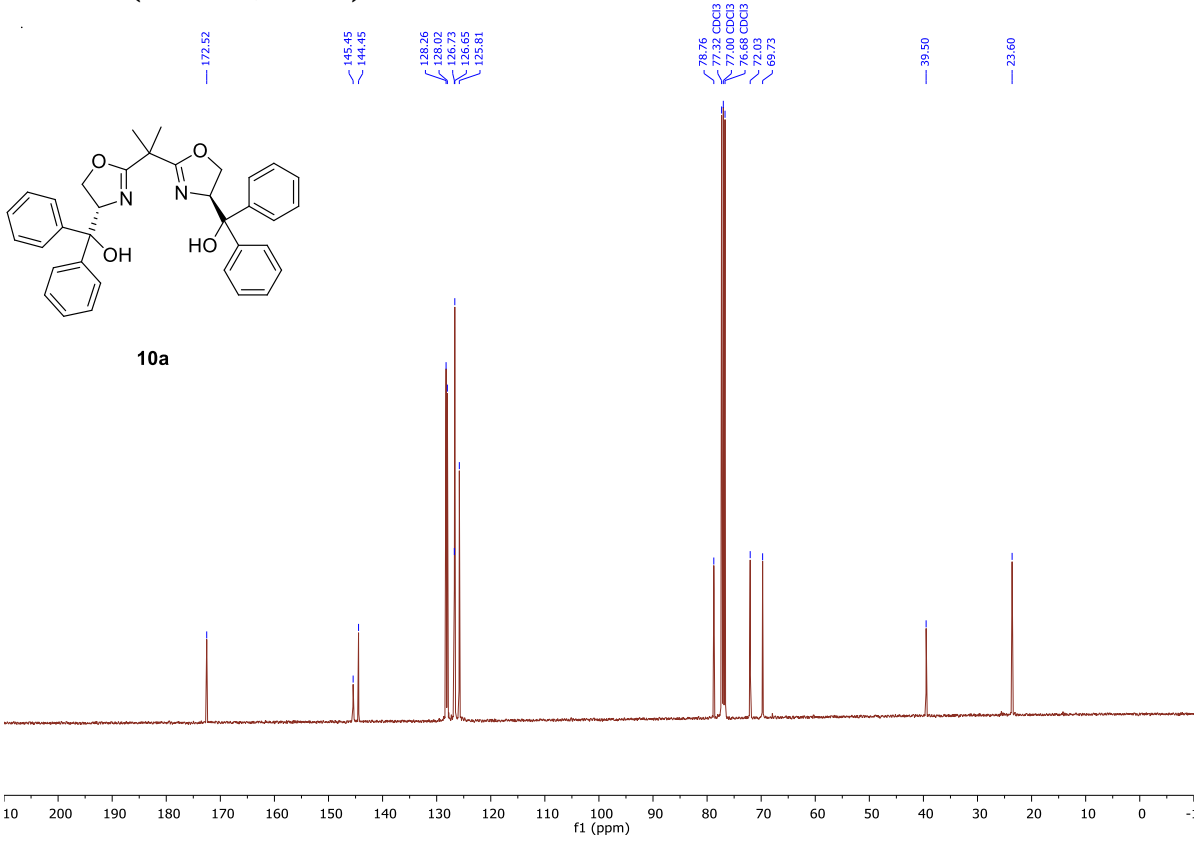
((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(diphenylmethanol) (10a)

^{1}H-NMR (400 MHz, $CDCl_3$)



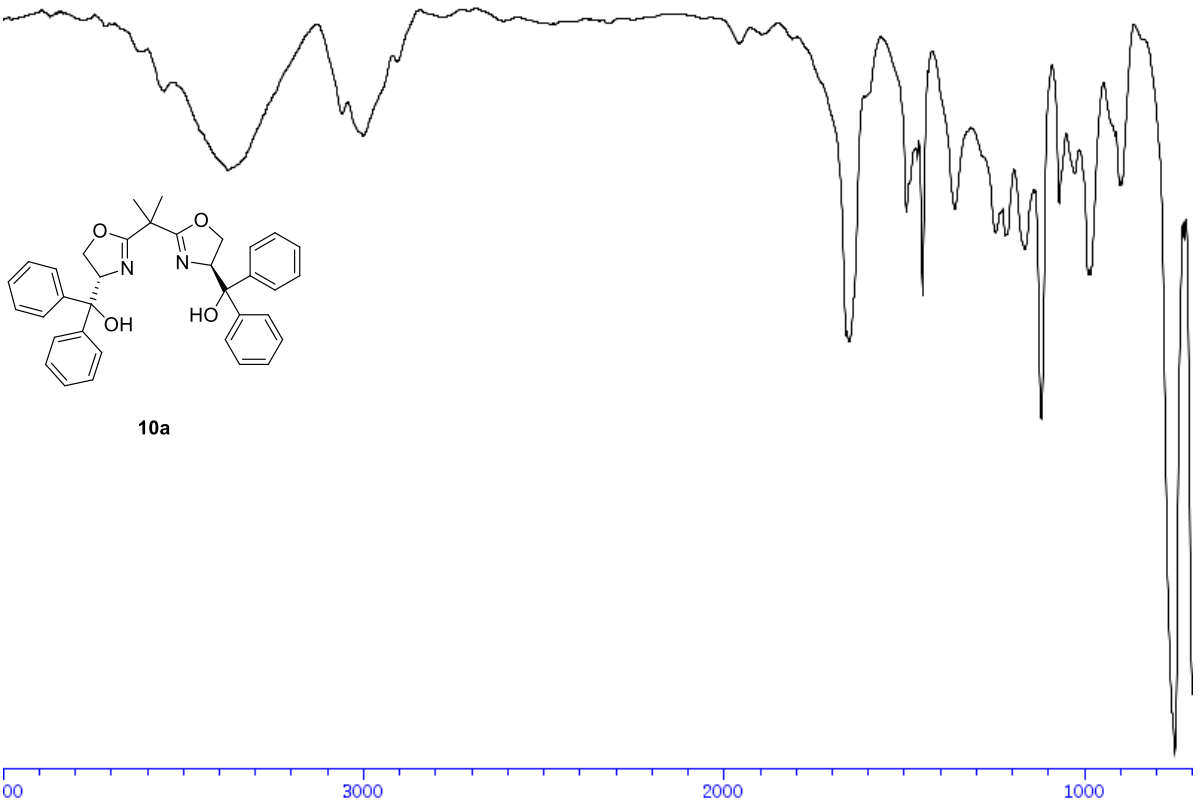
10a

^{13}C-NMR (101 MHz, $CDCl_3$)



10a

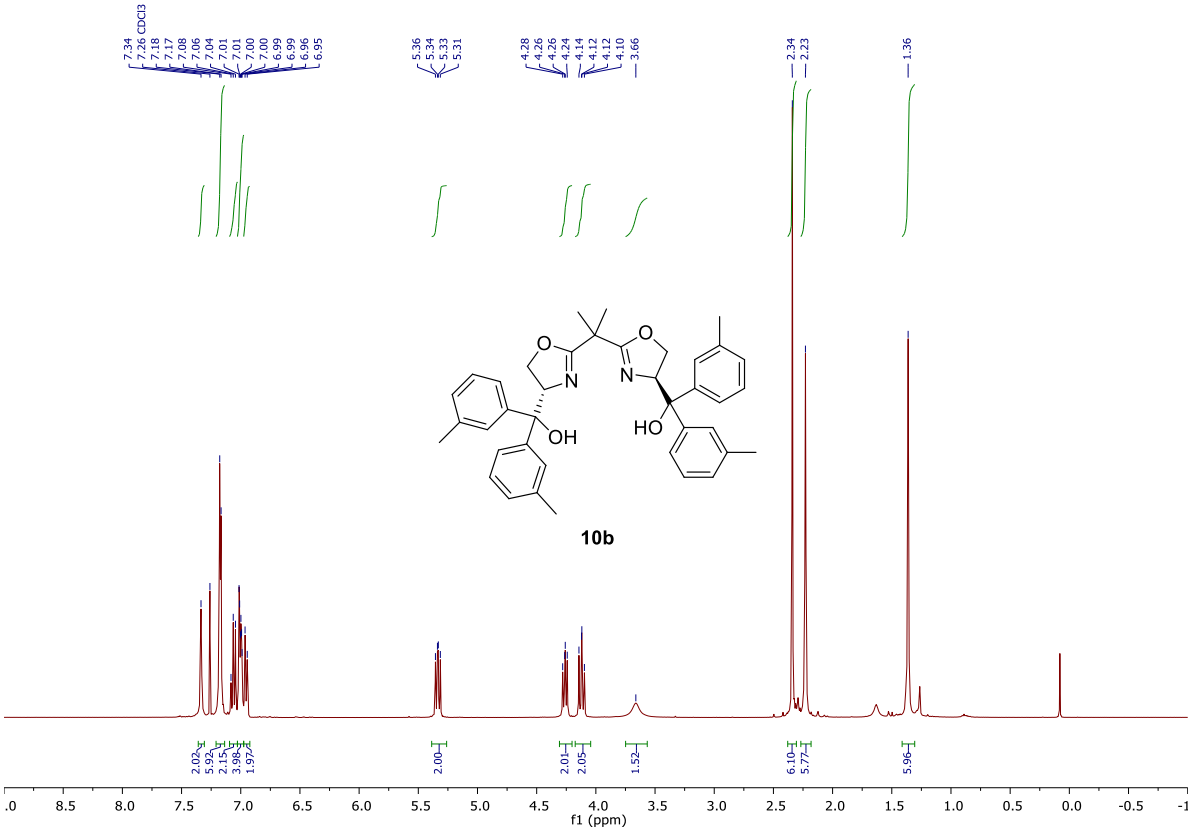
IR



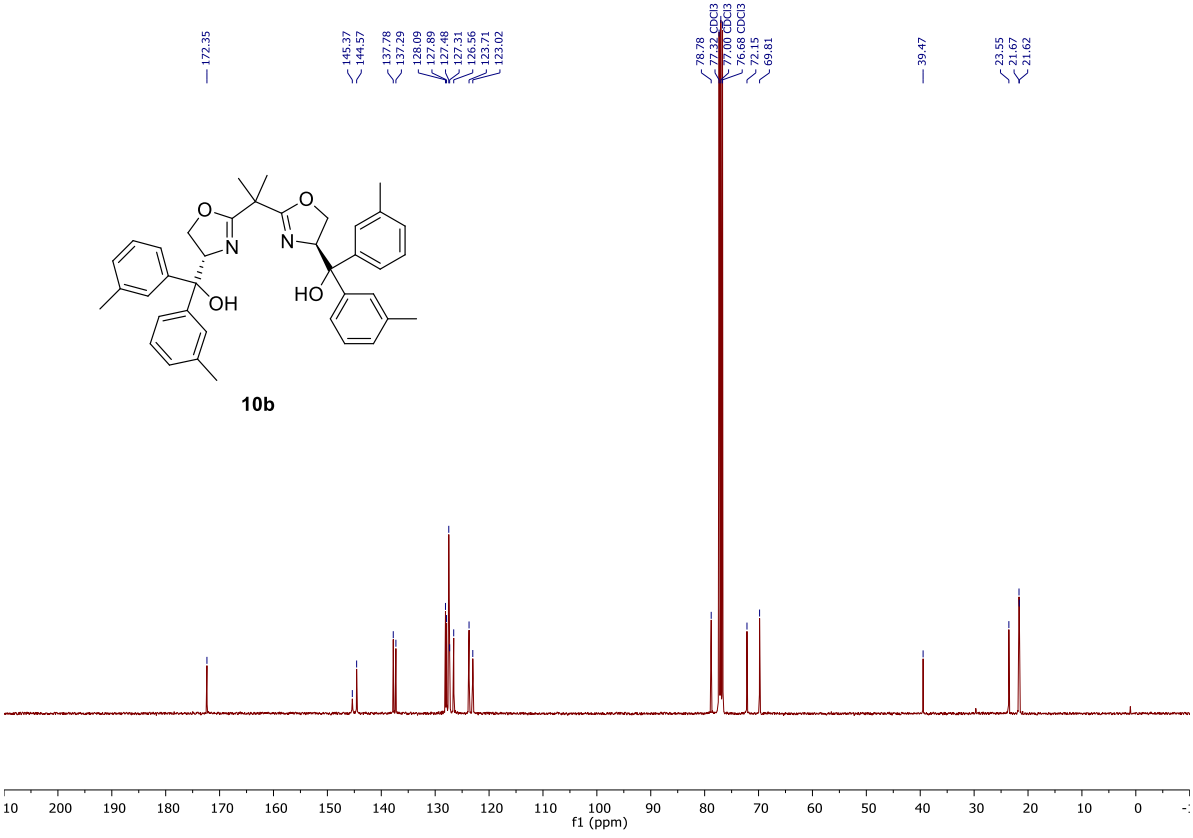
10a

((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di-*m*-tolylmethanol) (10b)

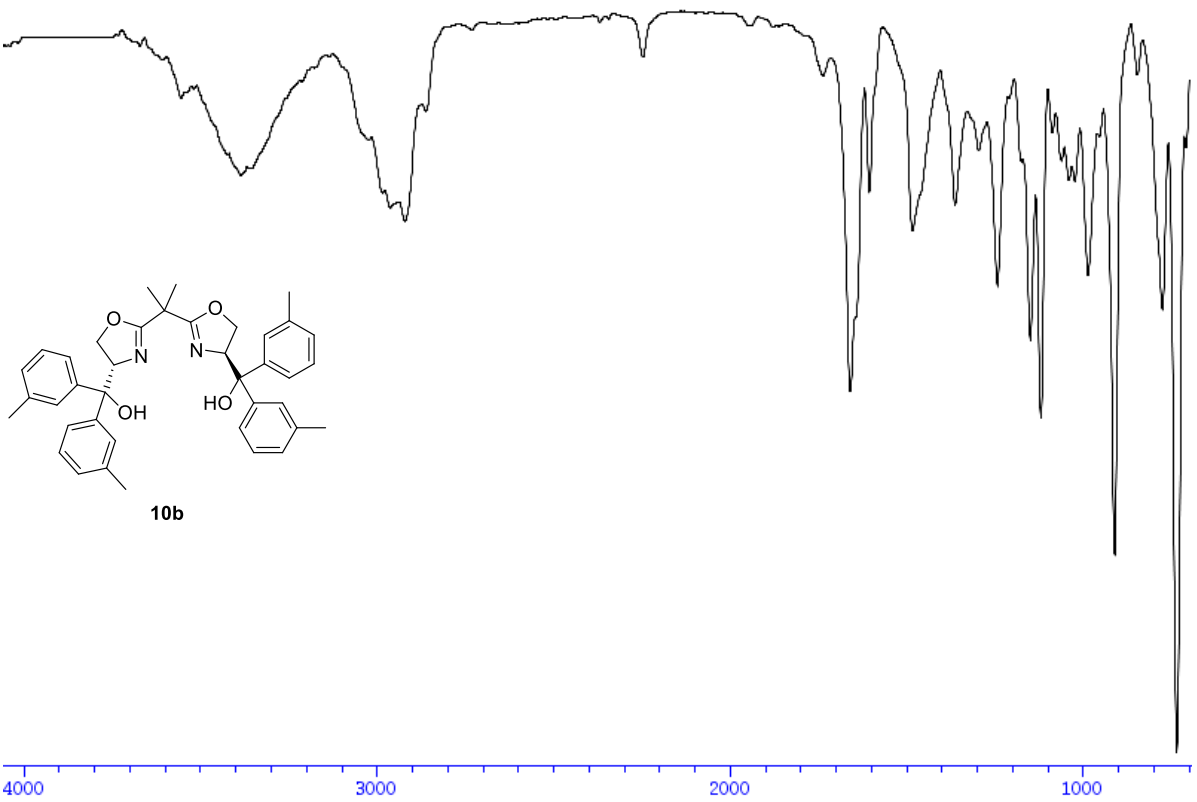
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



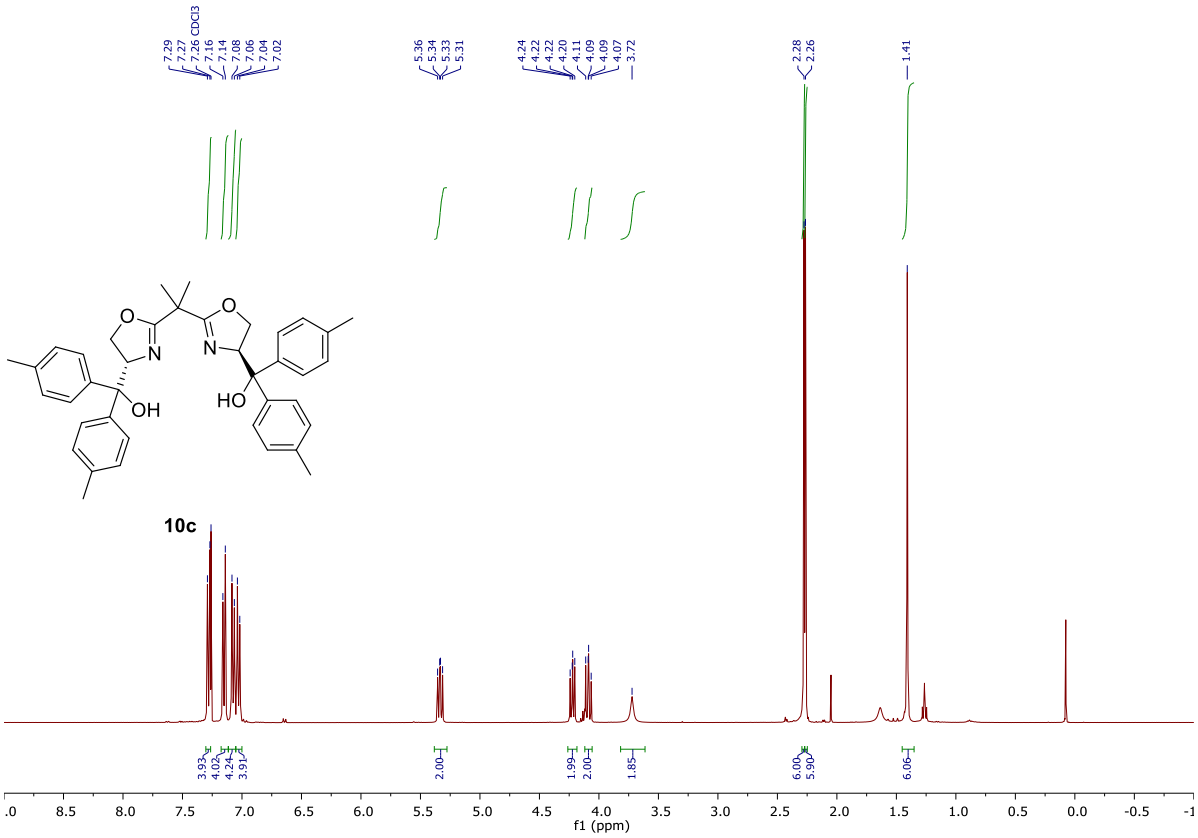
IR



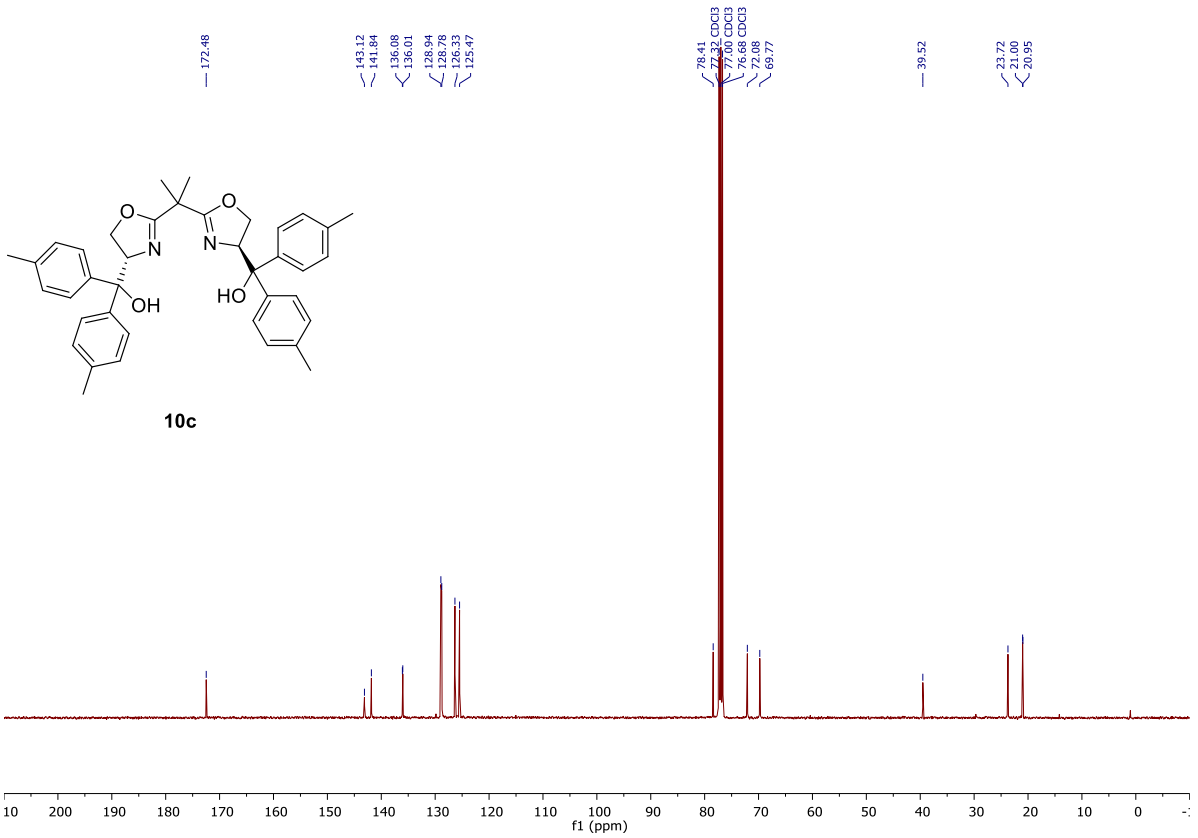
10b

((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di-*p*-tolylmethanol) (10c)

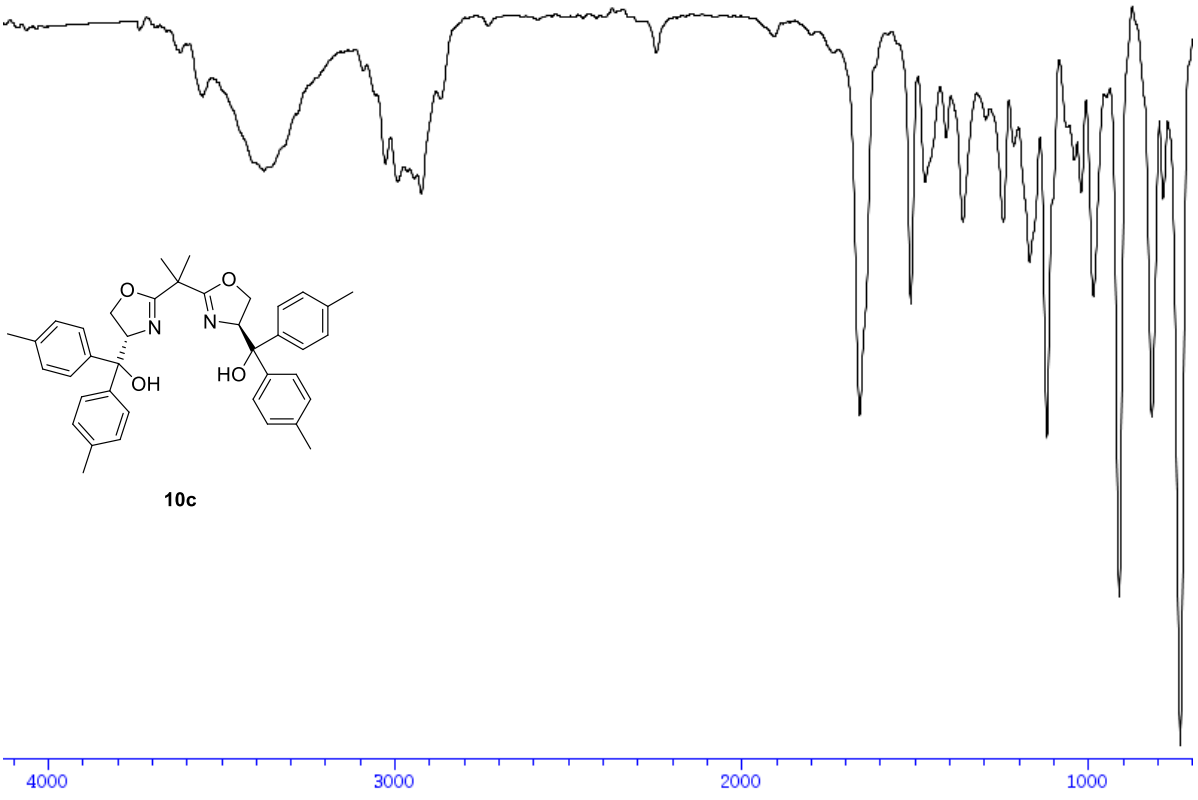
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



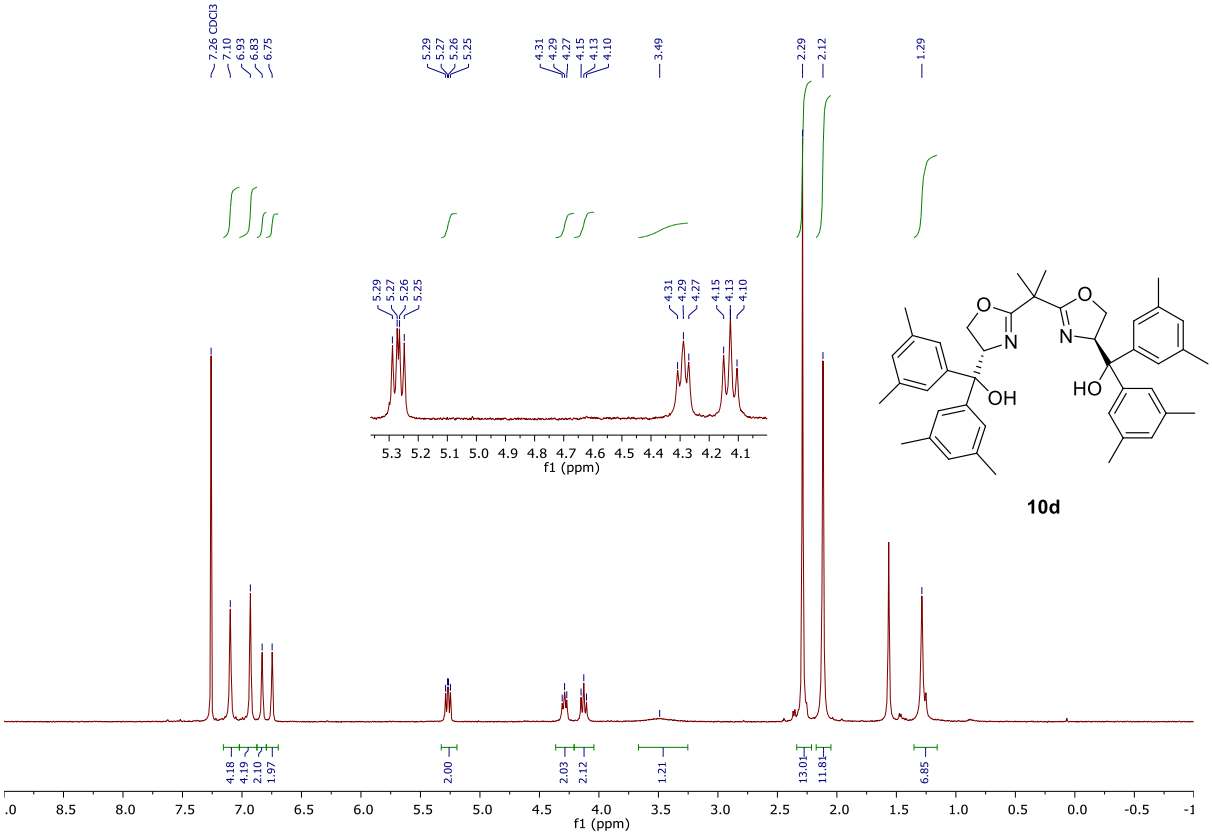
IR



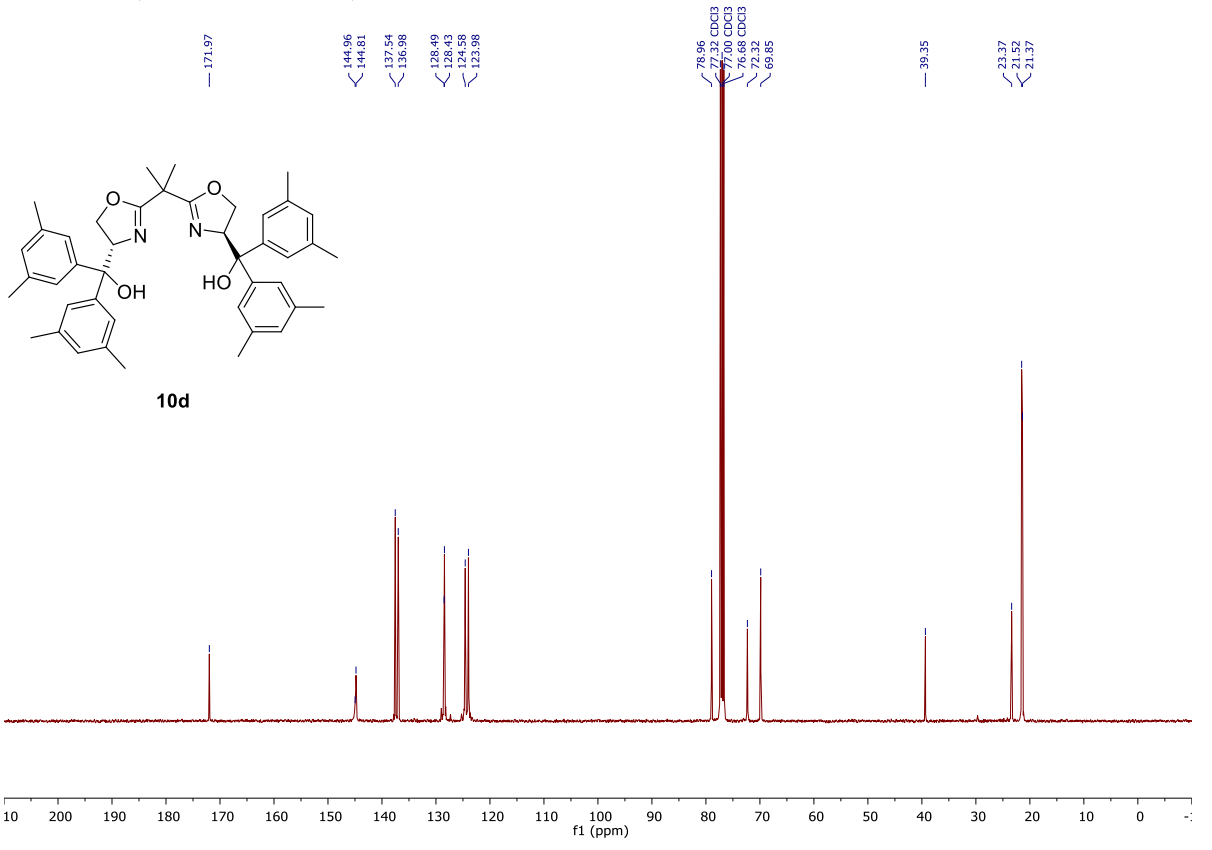
10c

((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-dimethylphenyl)methanol) (10d)

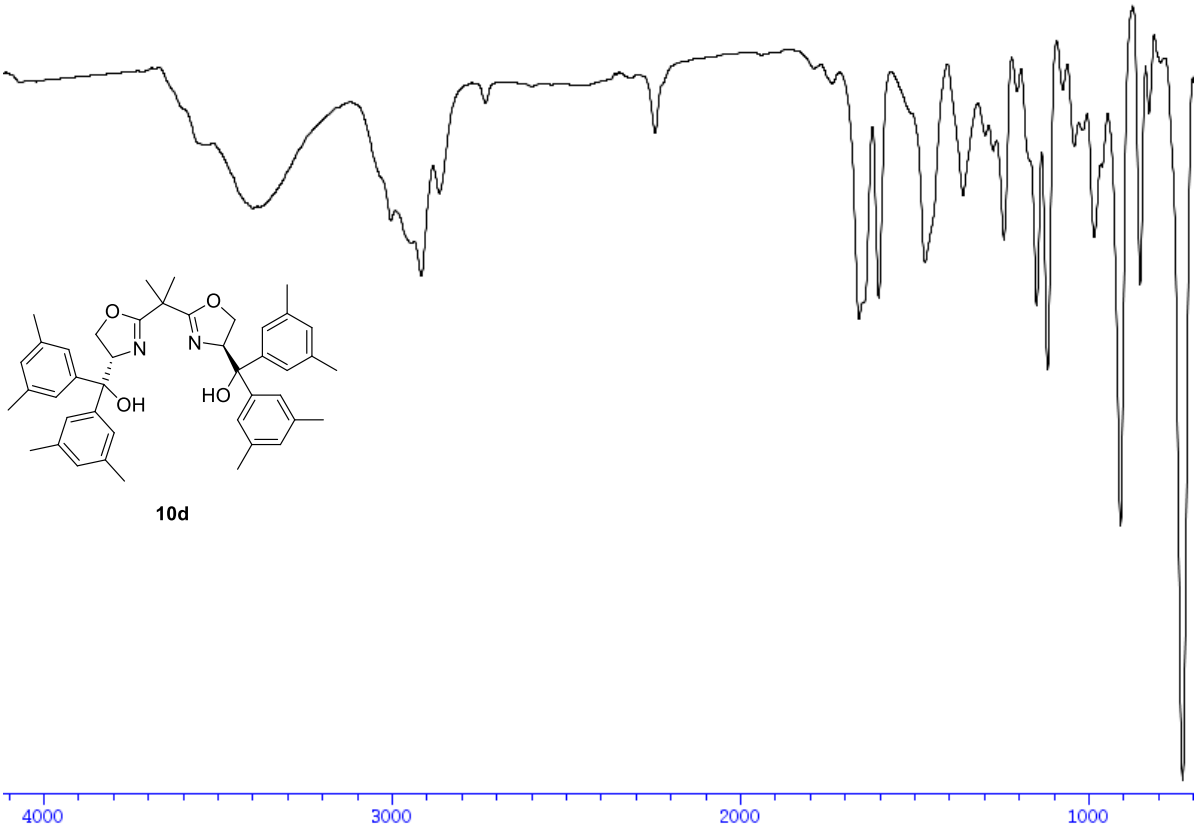
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



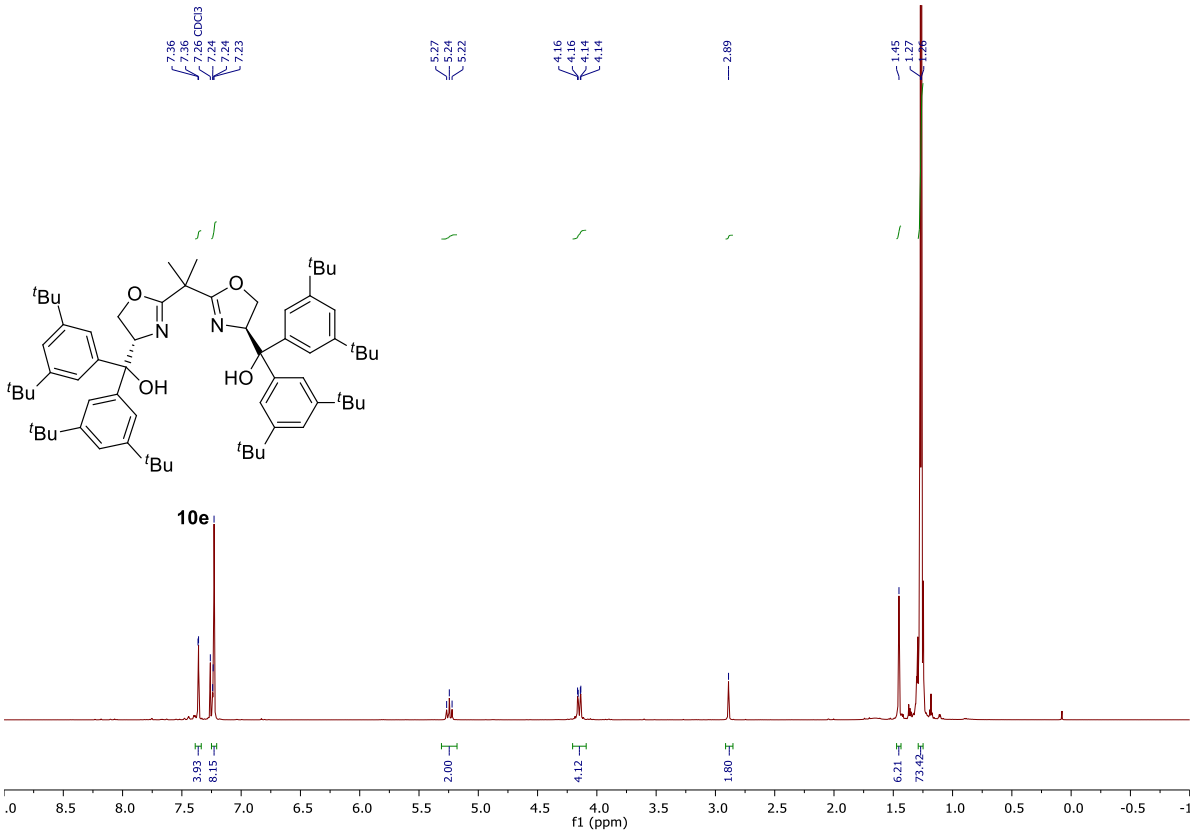
IR



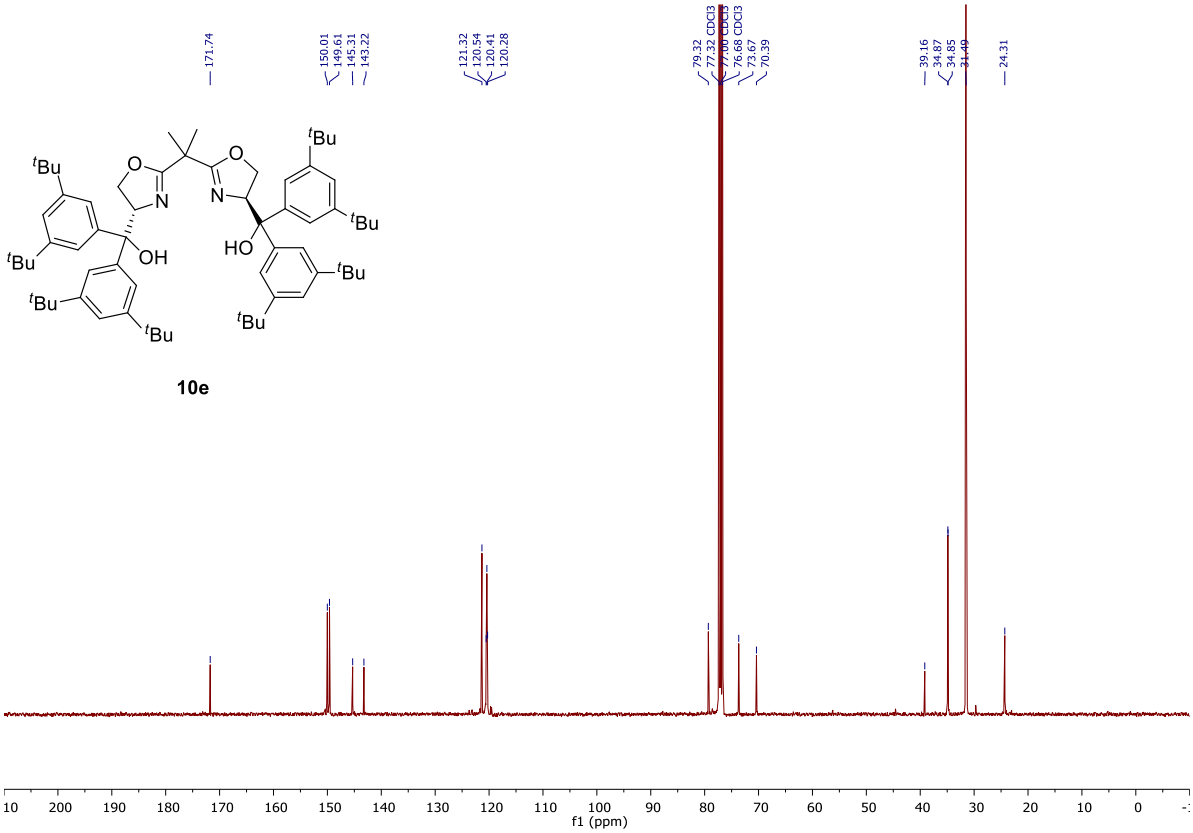
10d

((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-di-*tert*-butylphenyl)methanol) (10e)

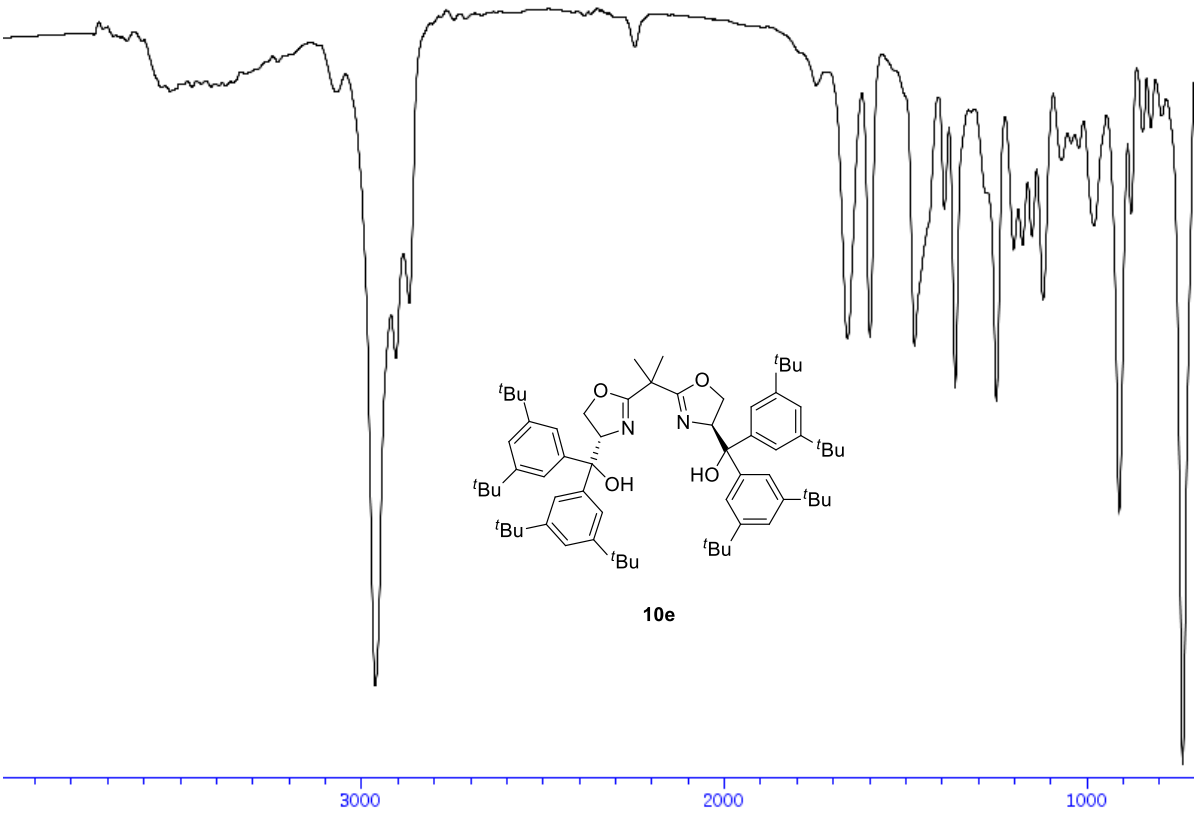
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



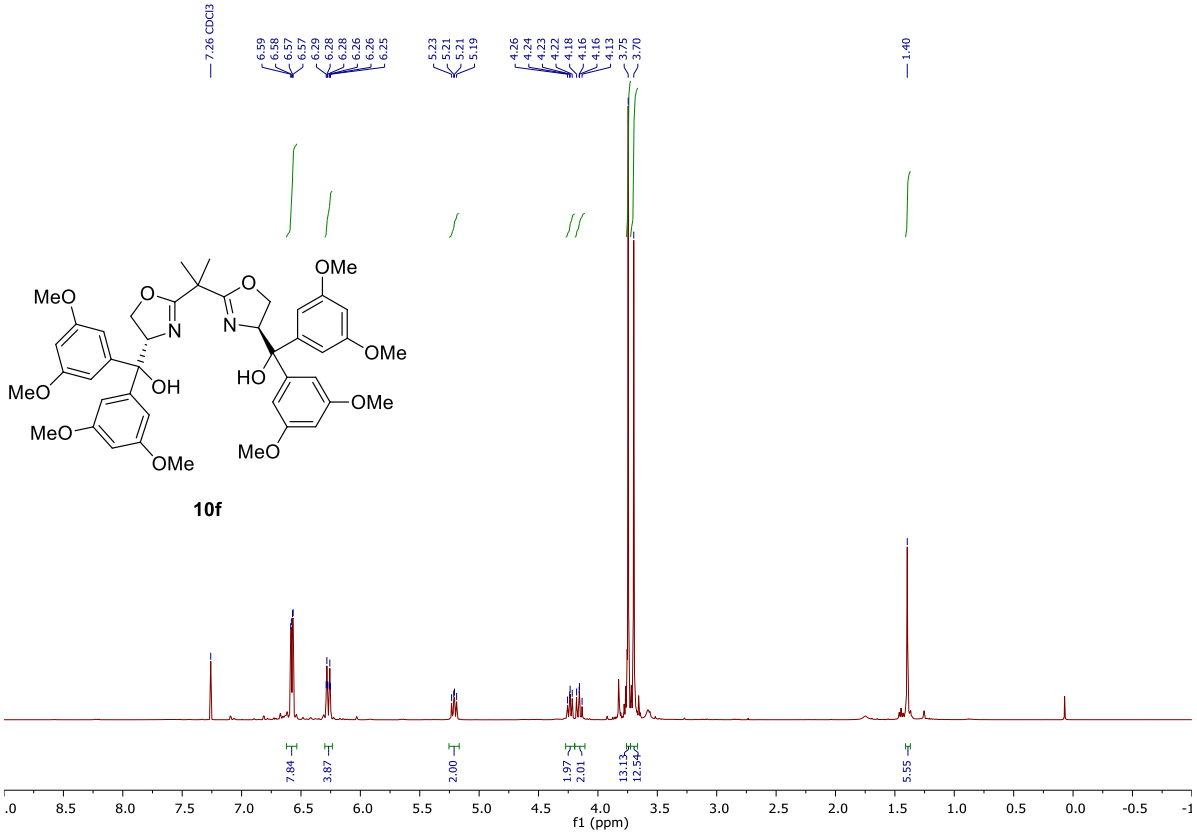
IR



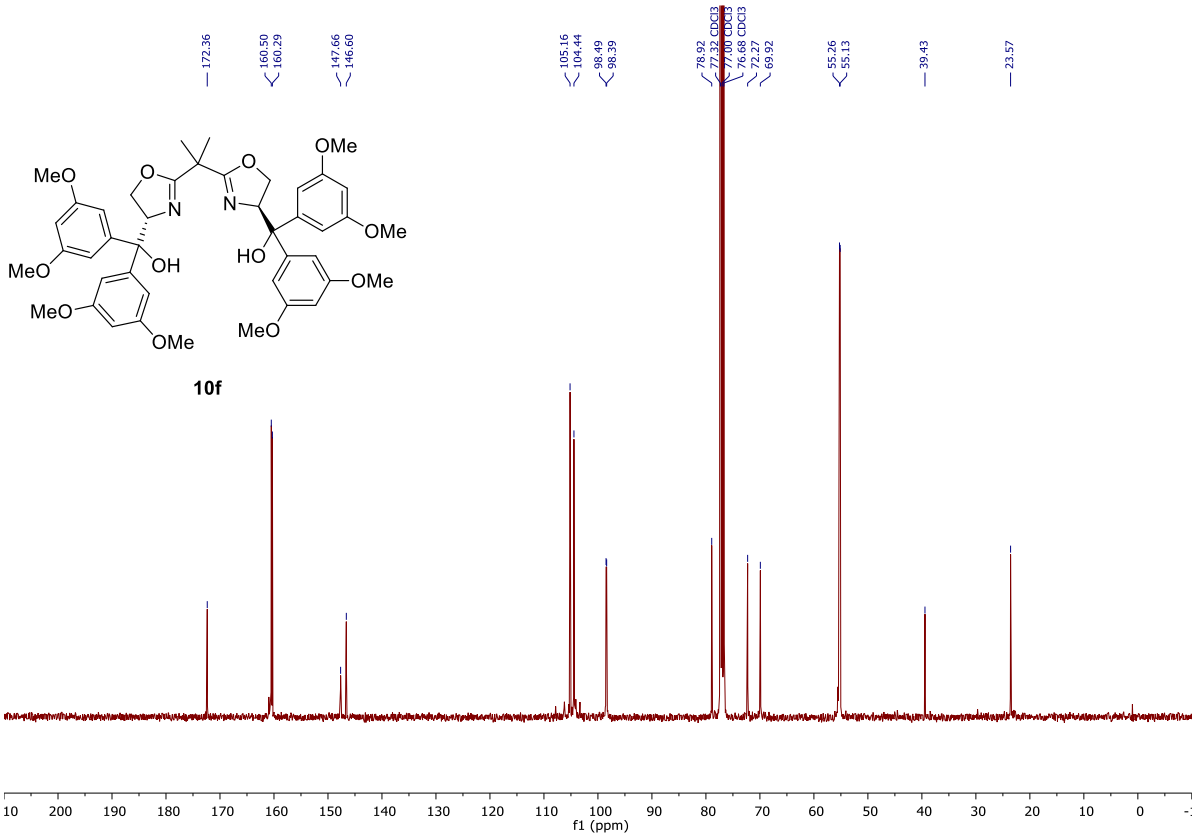
10e

((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-dimethoxyphenyl)methanol) (10f)

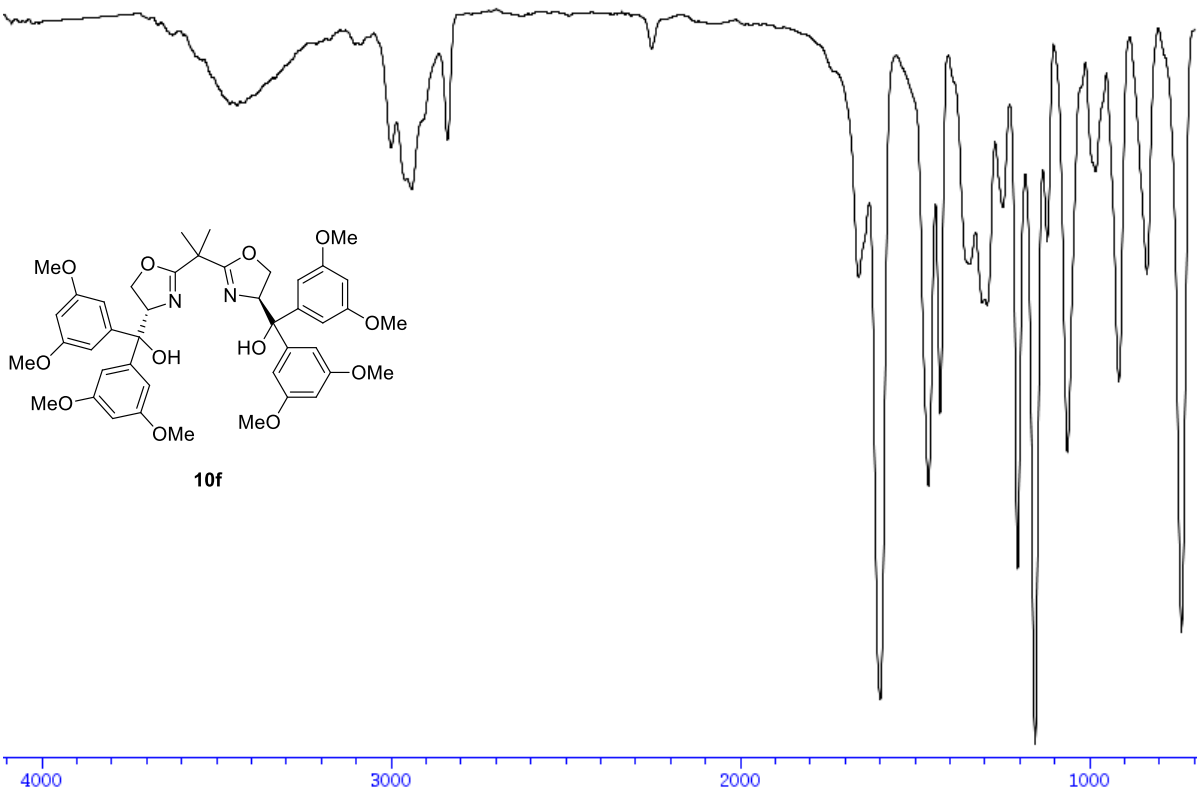
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



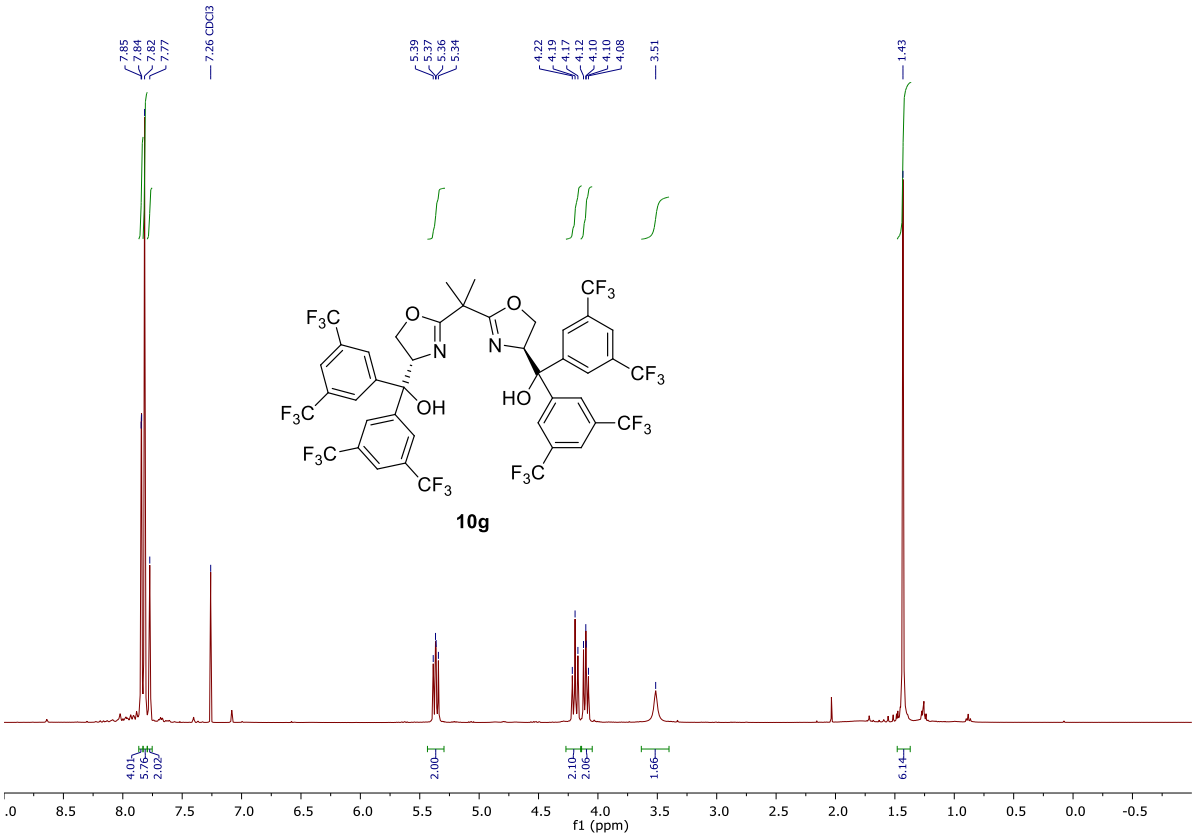
IR



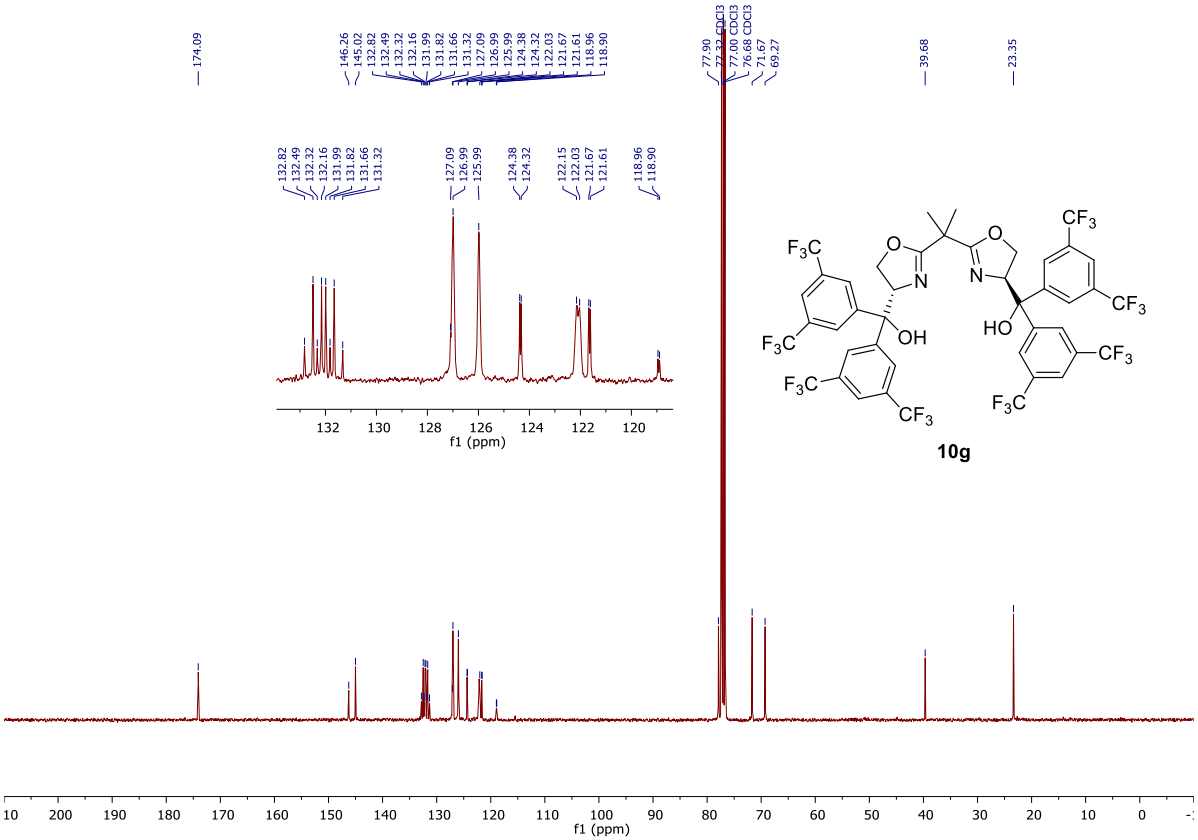
10f

((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(bis(3,5-bis(trifluoromethyl)phenyl)methanol) (10g)

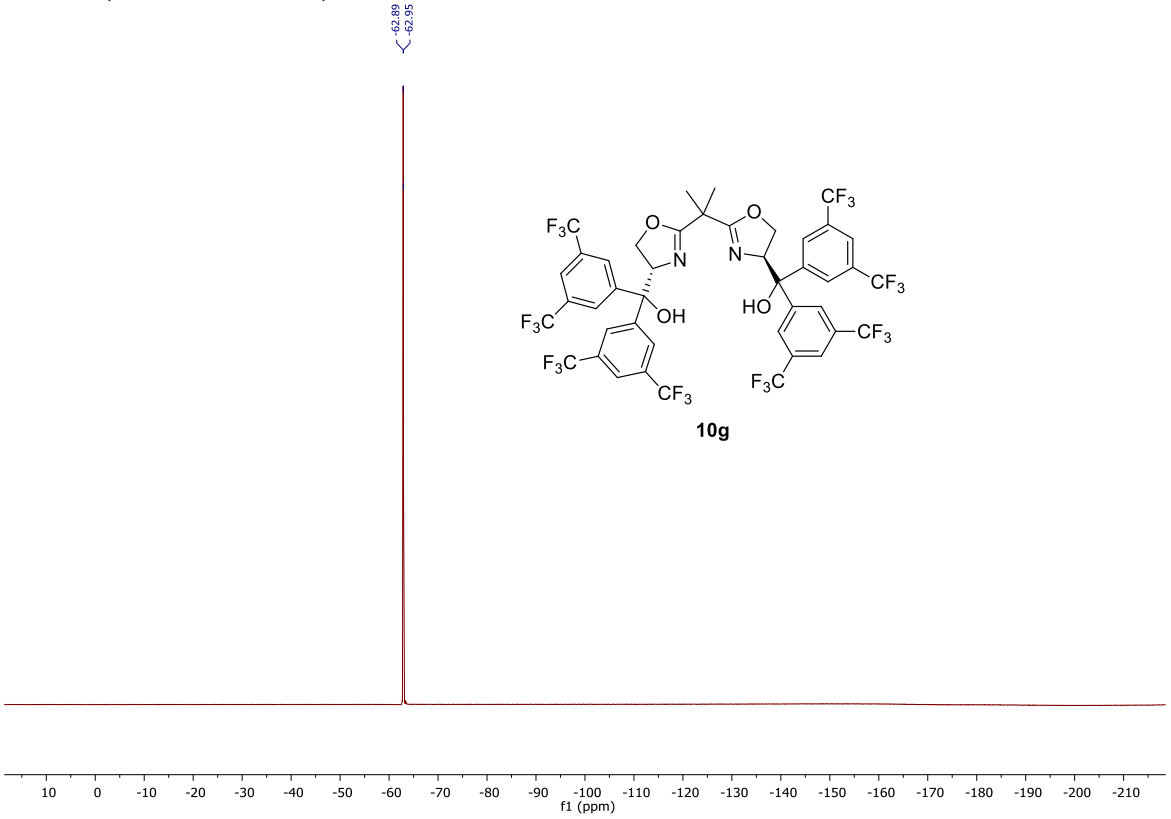
^{1}H-NMR (400 MHz, $CDCl_3$)



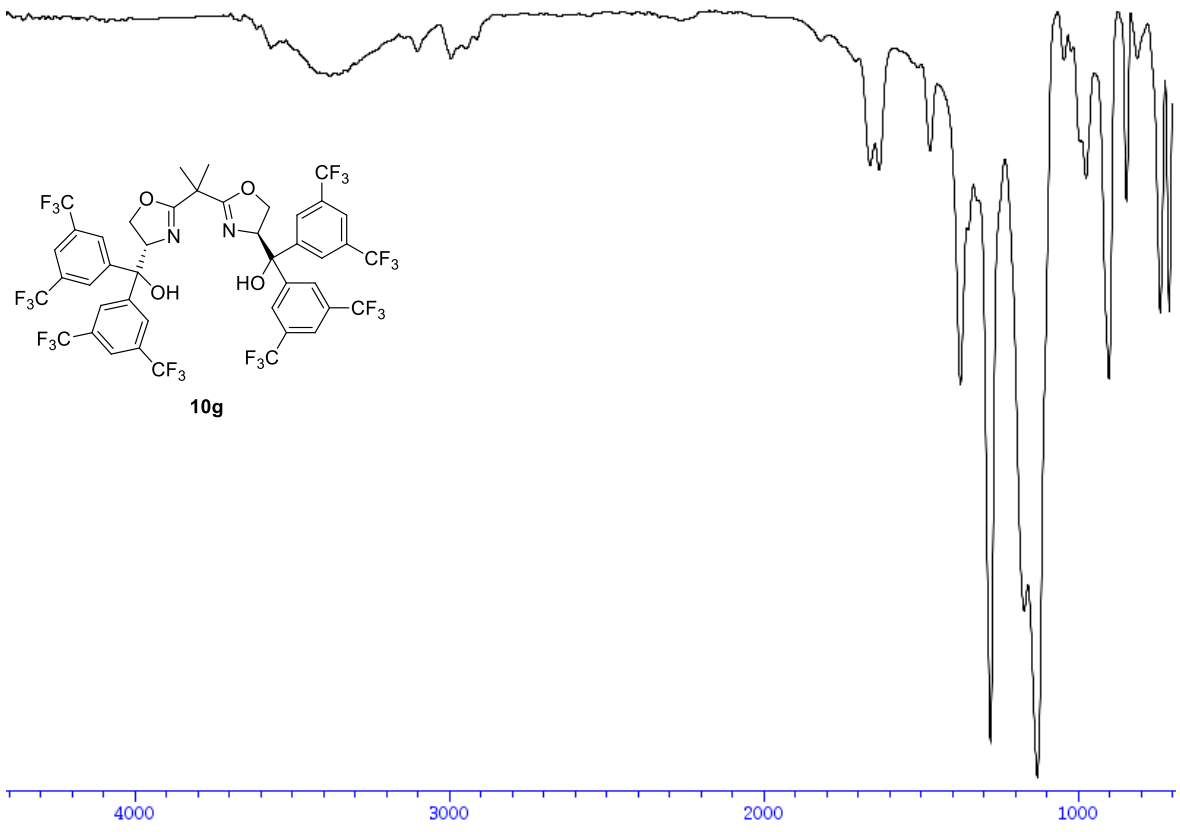
^{13}C-NMR (101 MHz, $CDCl_3$)



^{19}F NMR (376 MHz, $CDCl_3$)

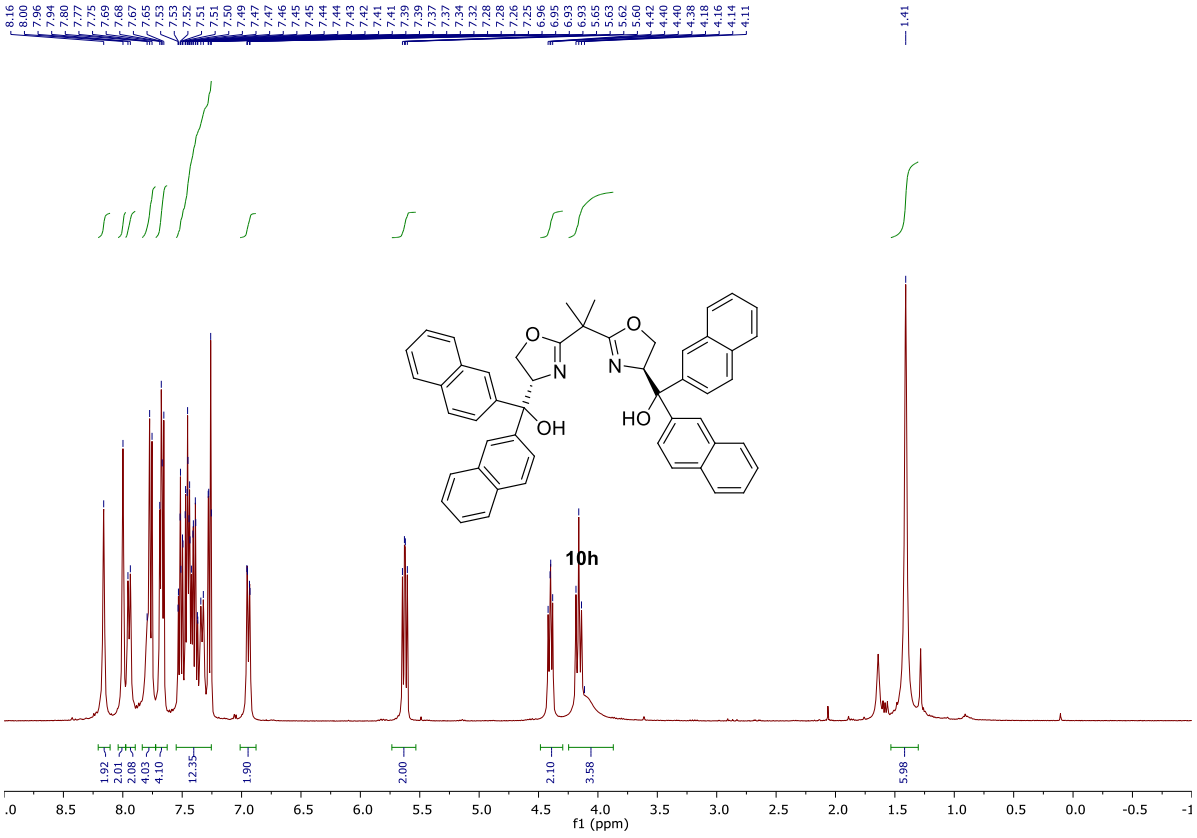


IR

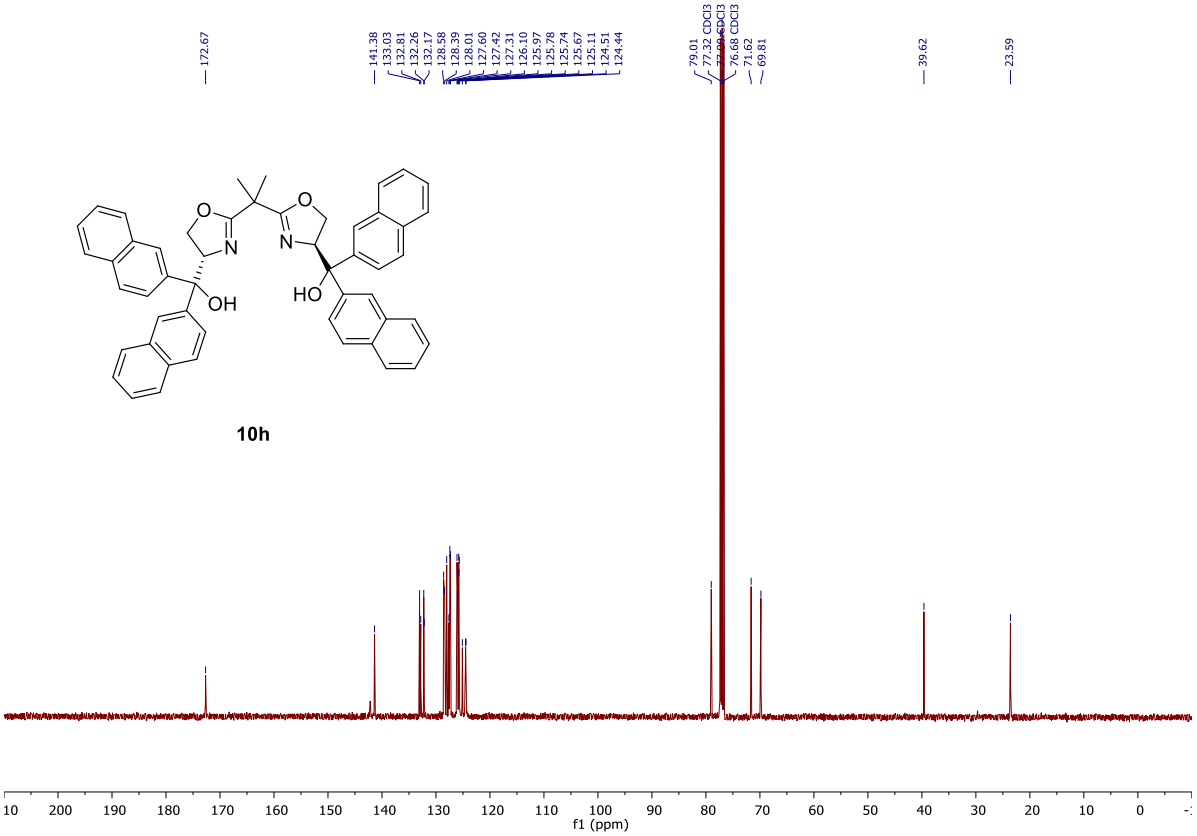


((4S,4'S)-2,2'-(propane-2,2-diyl)bis(4,5-dihydrooxazole-4,2-diyl))bis(di(naphthalen-2-yl)methanol) (10h)

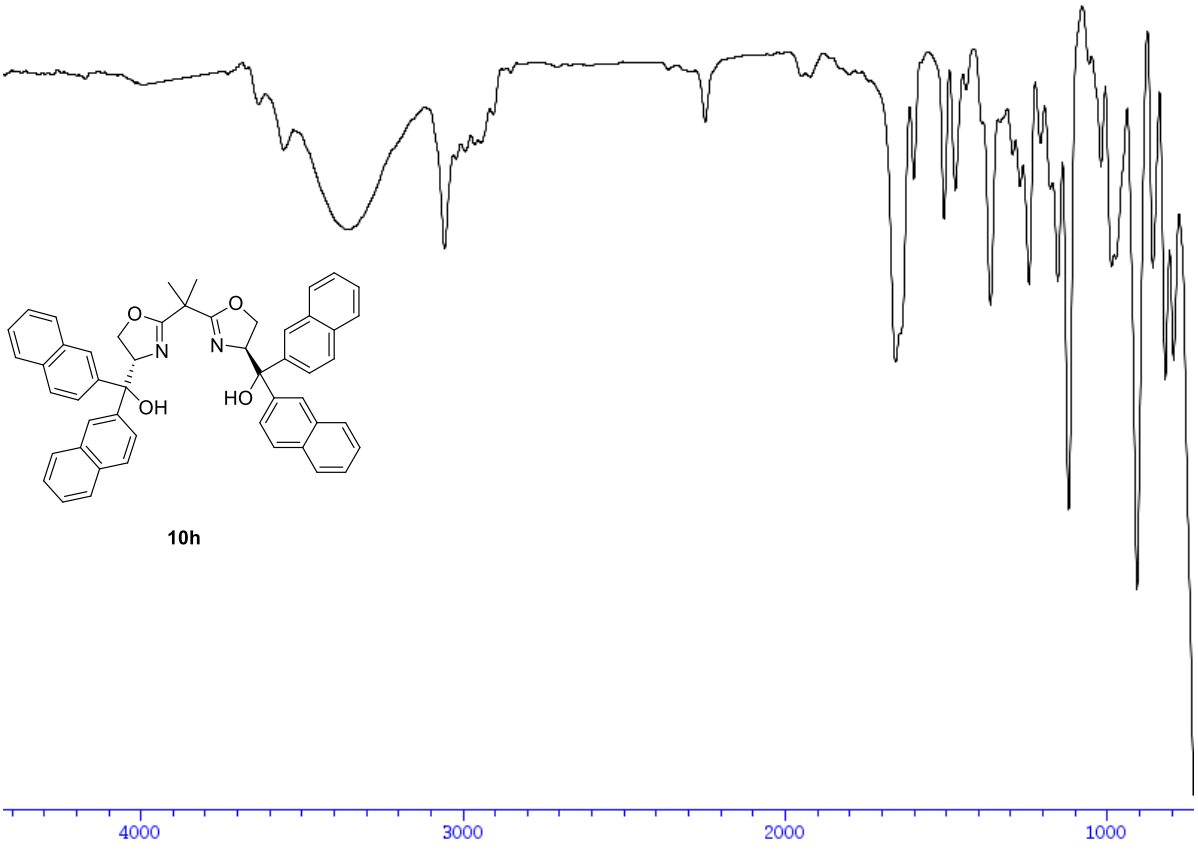
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



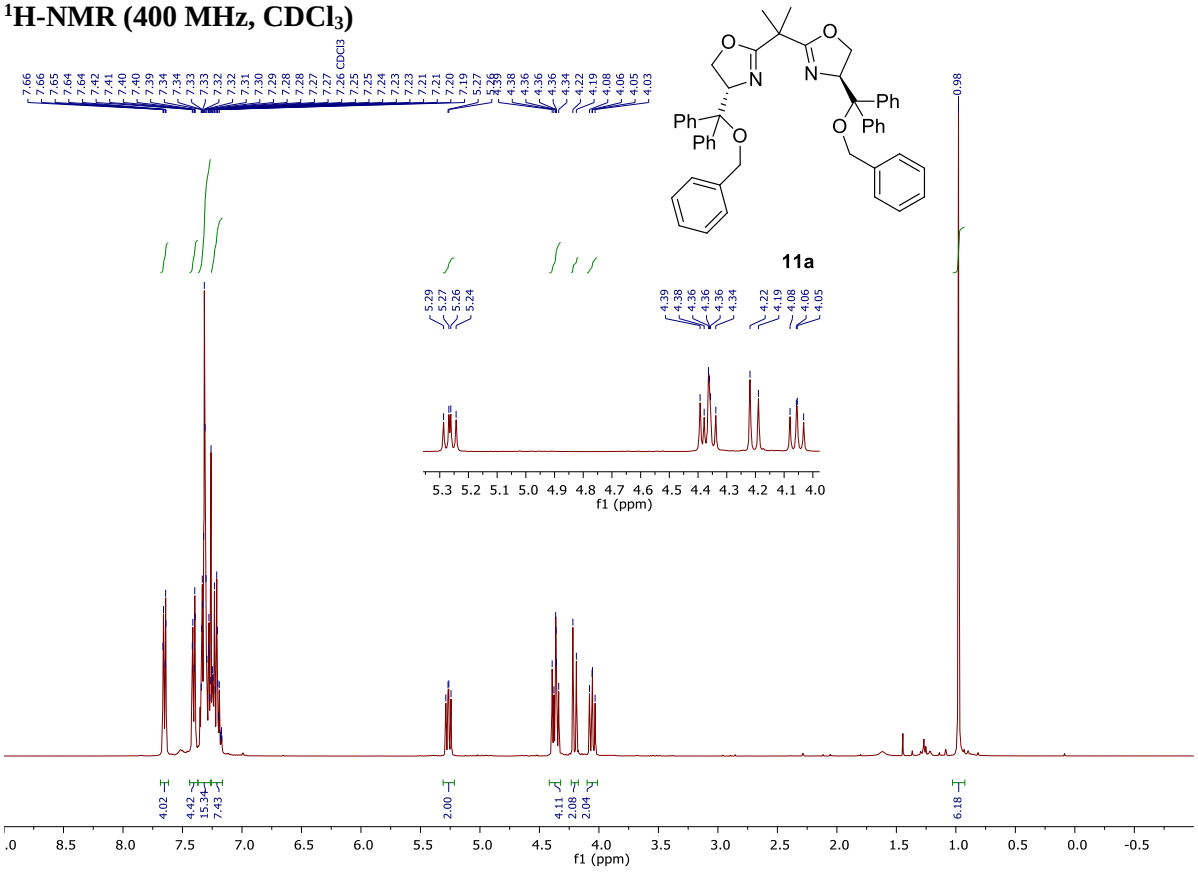
IR



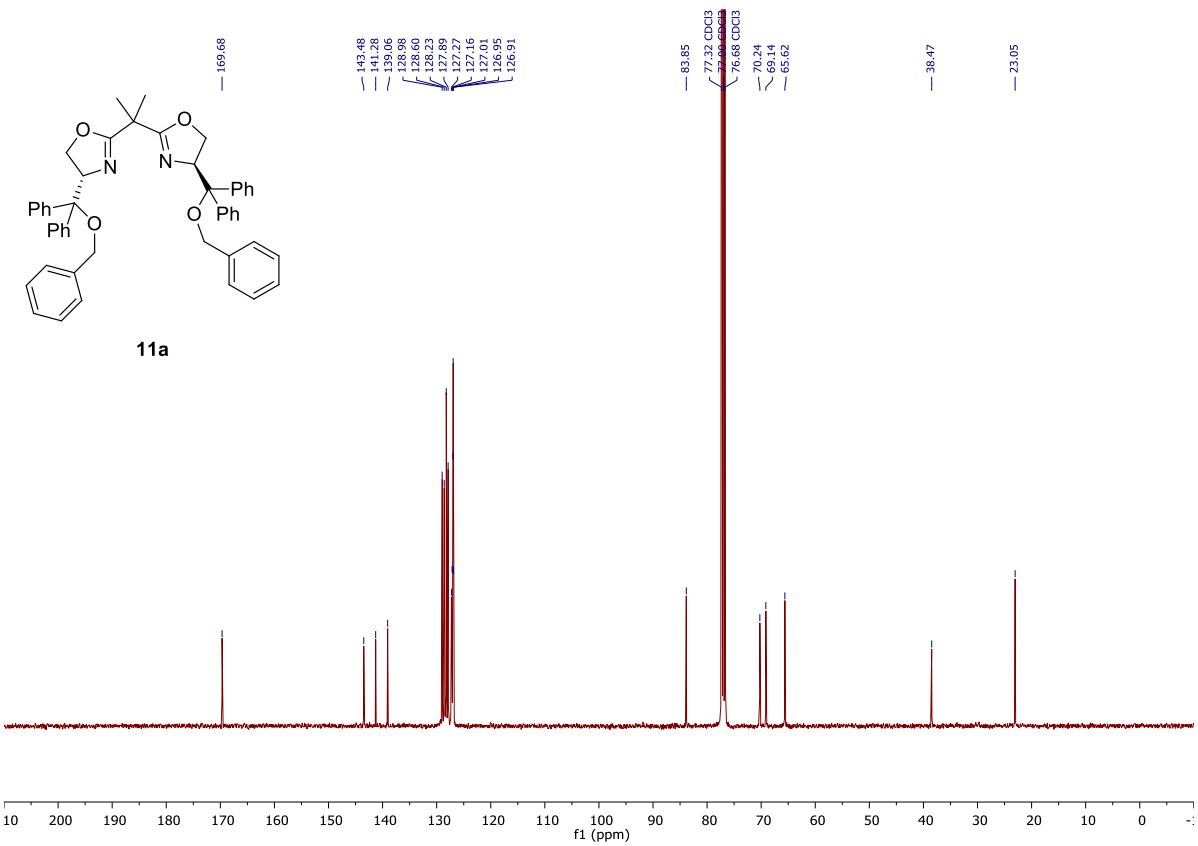
10h

(4S,4'S)-2,2'-(propane-2,2-diyl)bis(4-((benzyloxy)diphenylmethyl)-4,5-dihydrooxazole) (11a)

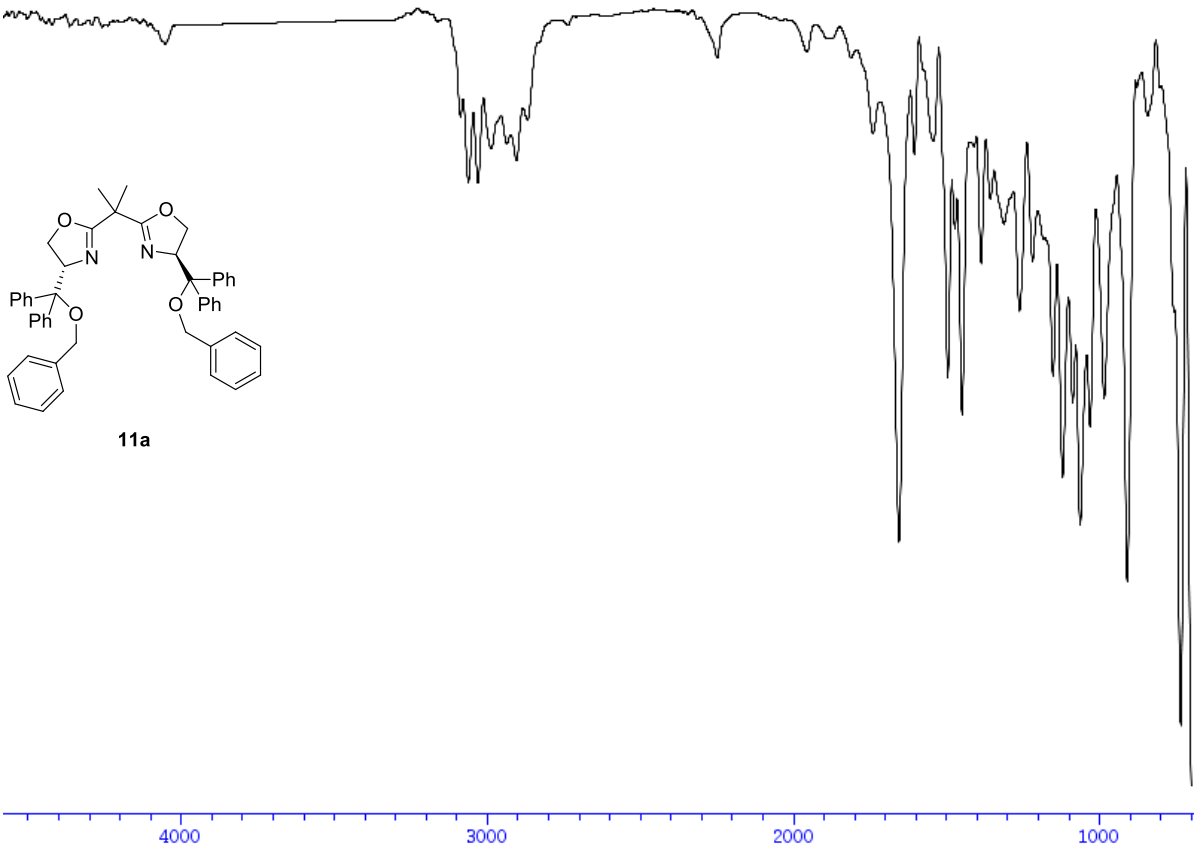
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



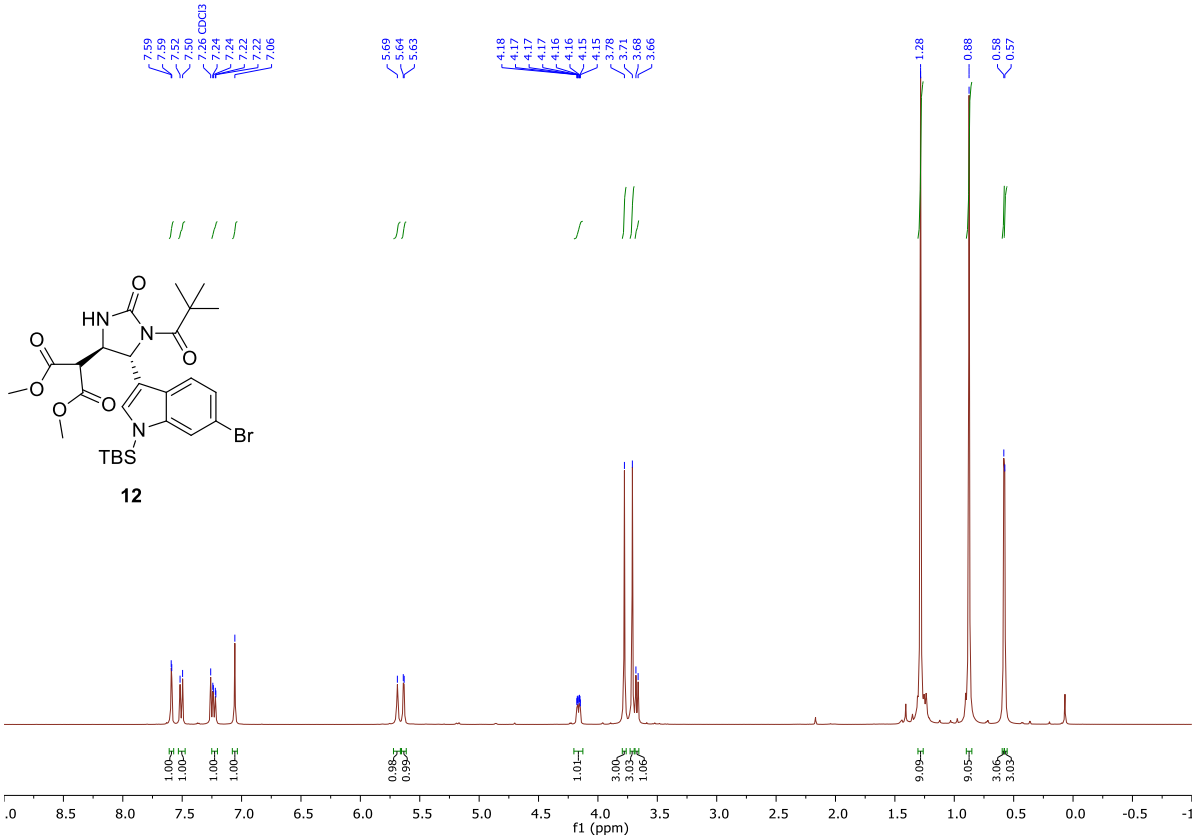
IR

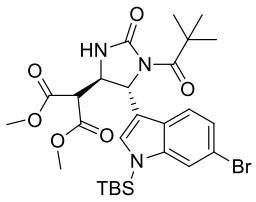


11a

Dimethyl 2-(5-(6-bromo-1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxo-1-pivaloylimidazolidin-4-yl)malonate (12)

^{1}H-NMR (400 MHz, $CDCl_3$)



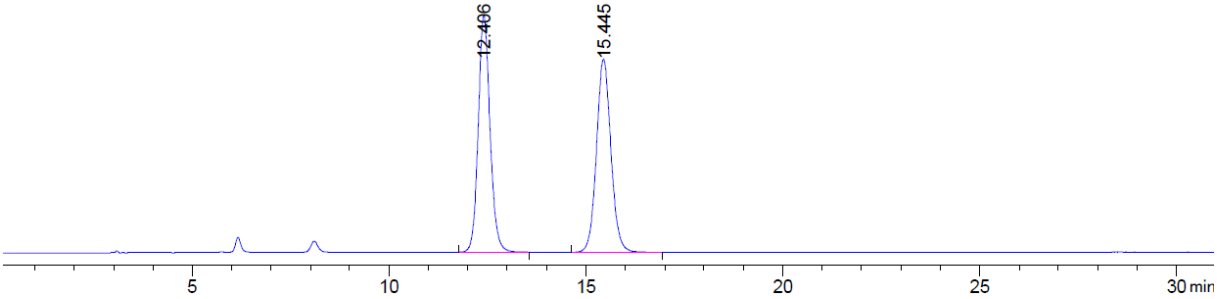


12

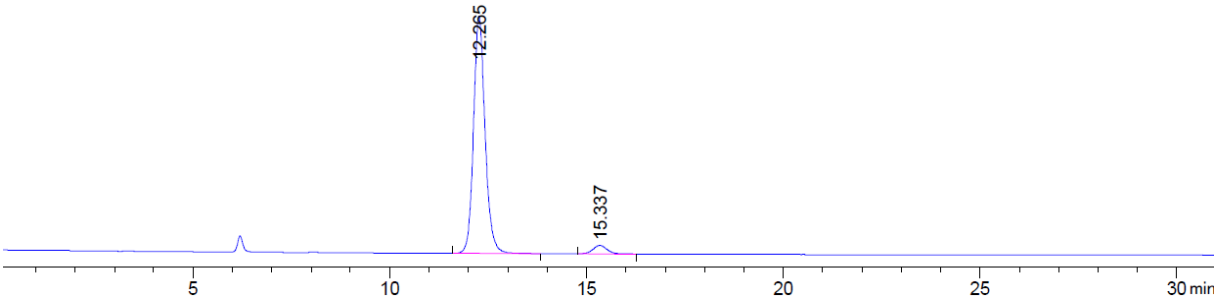
^{13}C-NMR (101 MHz, $CDCl_3$)

12

HPLC

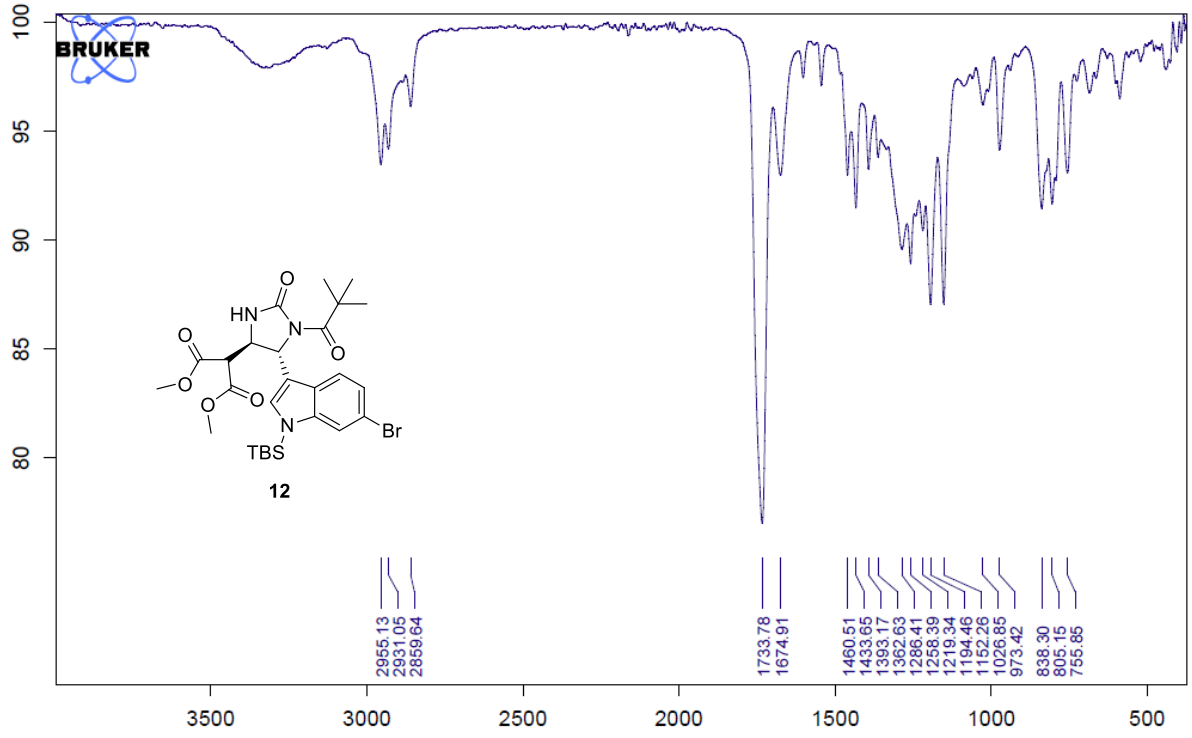


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.406	BB	0.3190	499.85181	23.99638	49.9896
2	15.445	BB	0.3949	500.05972	19.52072	50.0104



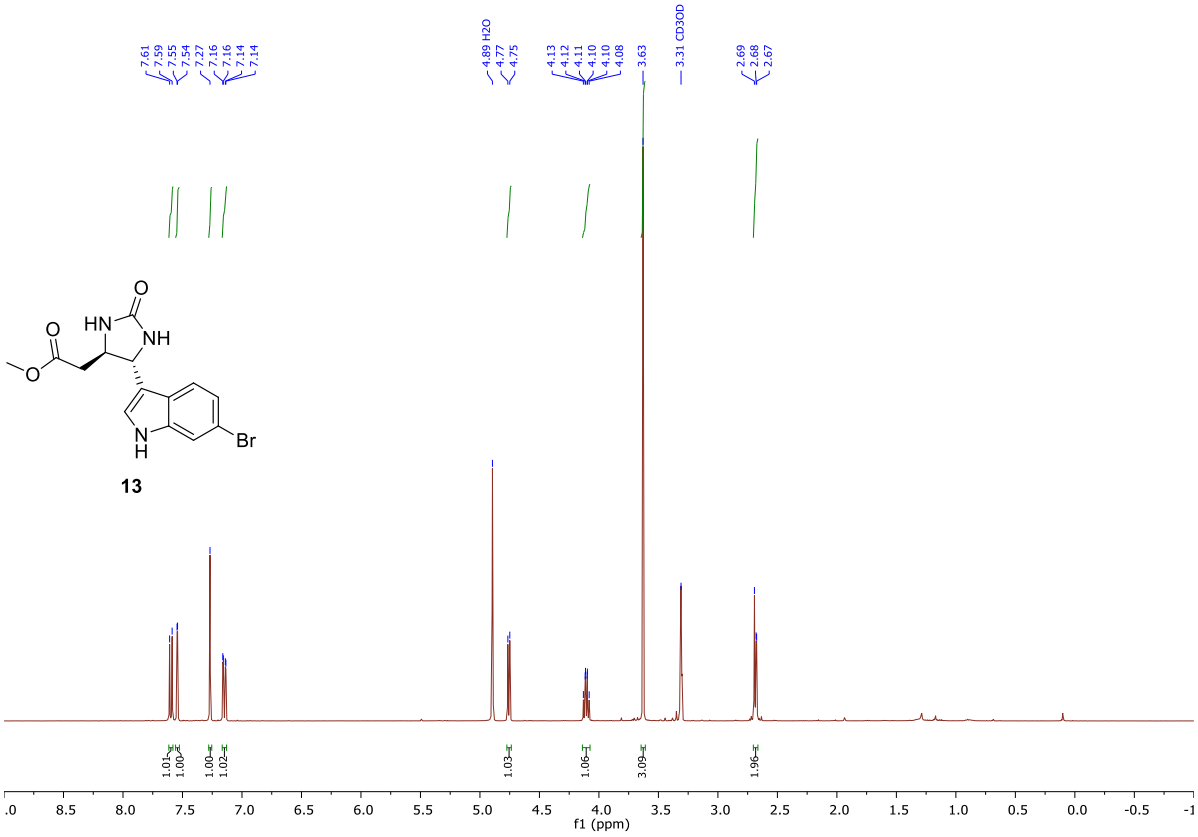
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.265	BB	0.3099	1376.40649	67.48692	95.8382
2	15.337	BB	0.3851	59.77117	2.39564	4.1618

IR


BRUKER
100
95
90
85
80
3500
3000
2500
2000
1500
1000
500
2955.13
2931.05
2859.64
1733.78
1674.91
1460.51
1433.65
1393.17
1362.63
1286.41
1258.39
1219.34
1194.46
1152.26
1026.85
973.42
838.30
805.15
755.85
HN
N
O
O
O
O
O
O
N
TBS
Br
12

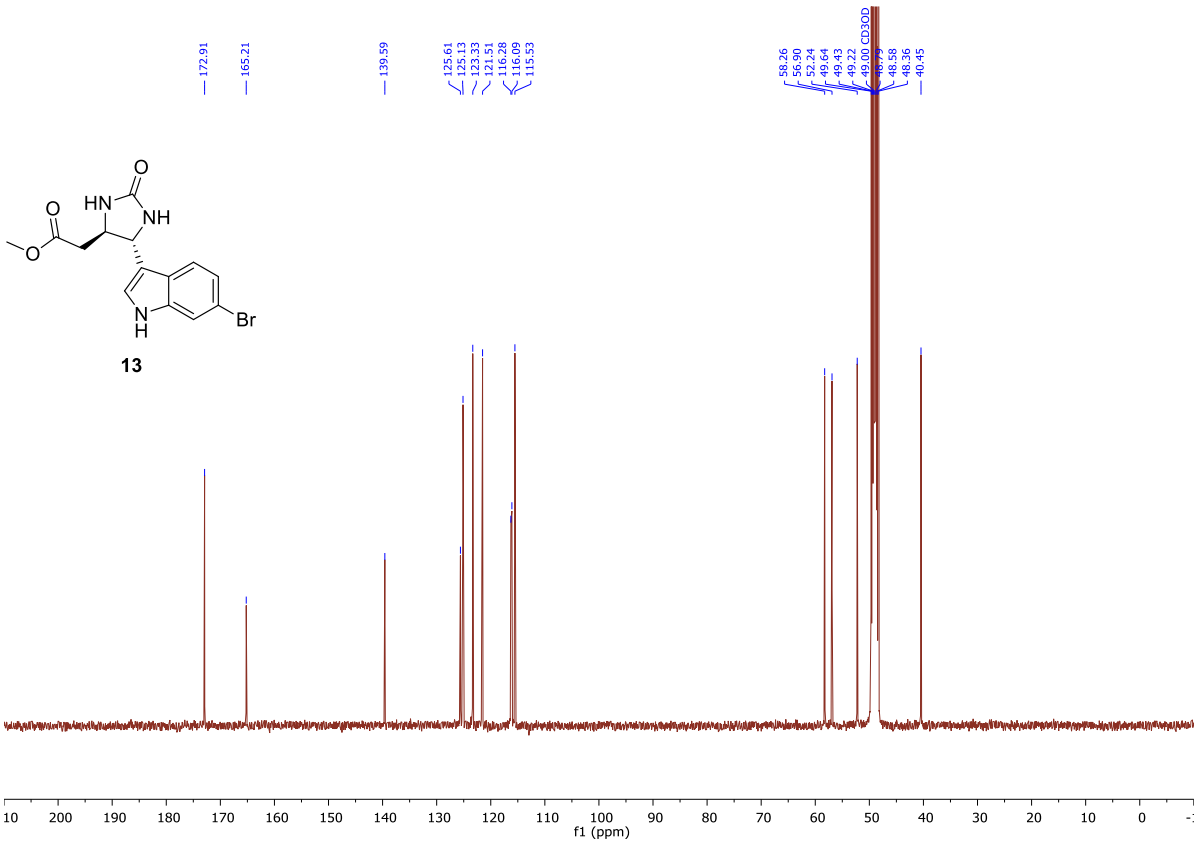
Methyl 2-(5-(6-bromo-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)acetate (13)

^{1}H-NMR (400 MHz, CD_3OD)



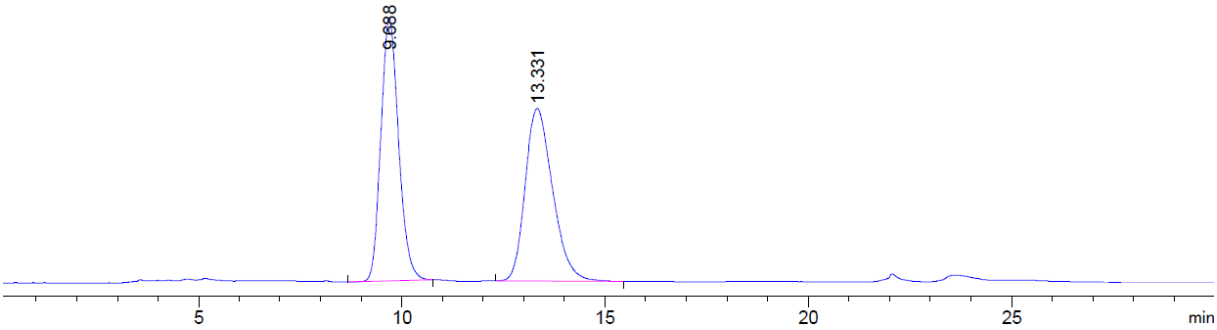
13

^{13}C-NMR (101 MHz, CD_3OD)

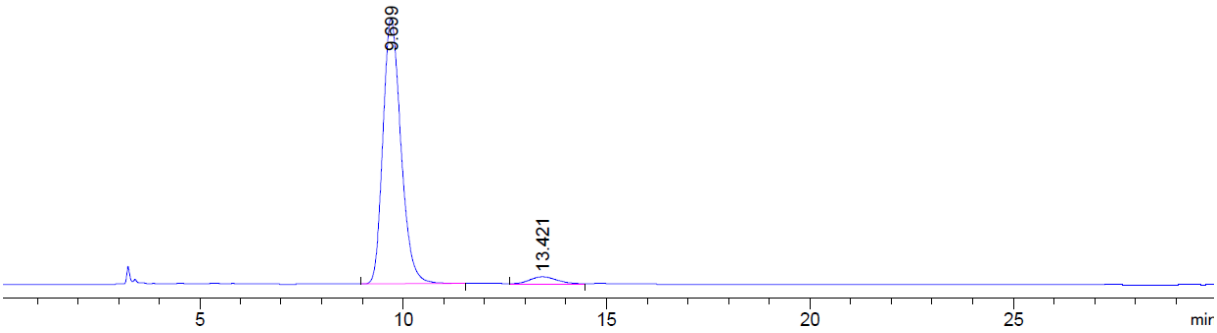


13

HPLC

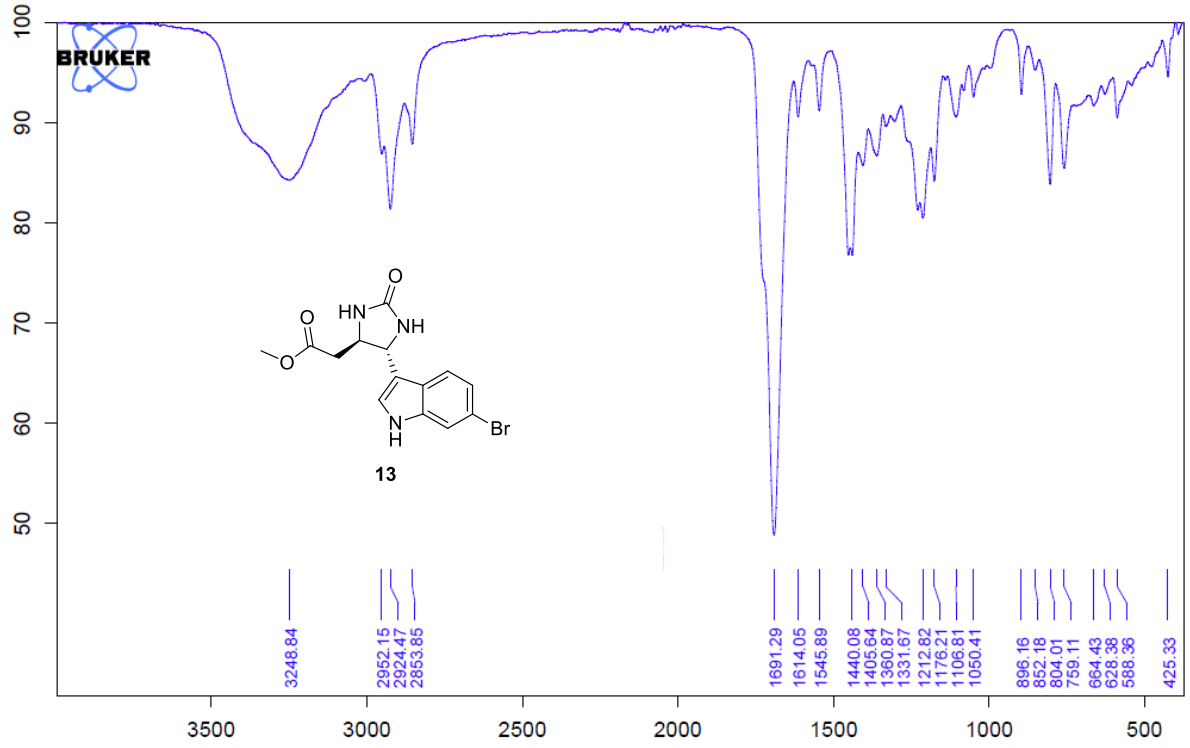


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.688	BB	0.4616	1951.05151	64.38180	49.5707
2	13.331	BB	0.7122	1984.84839	42.24086	50.4293



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.699	BB	0.4781	3.11224e4	1008.40546	96.3021
2	13.421	BB	0.7020	1195.05774	26.40552	3.6979

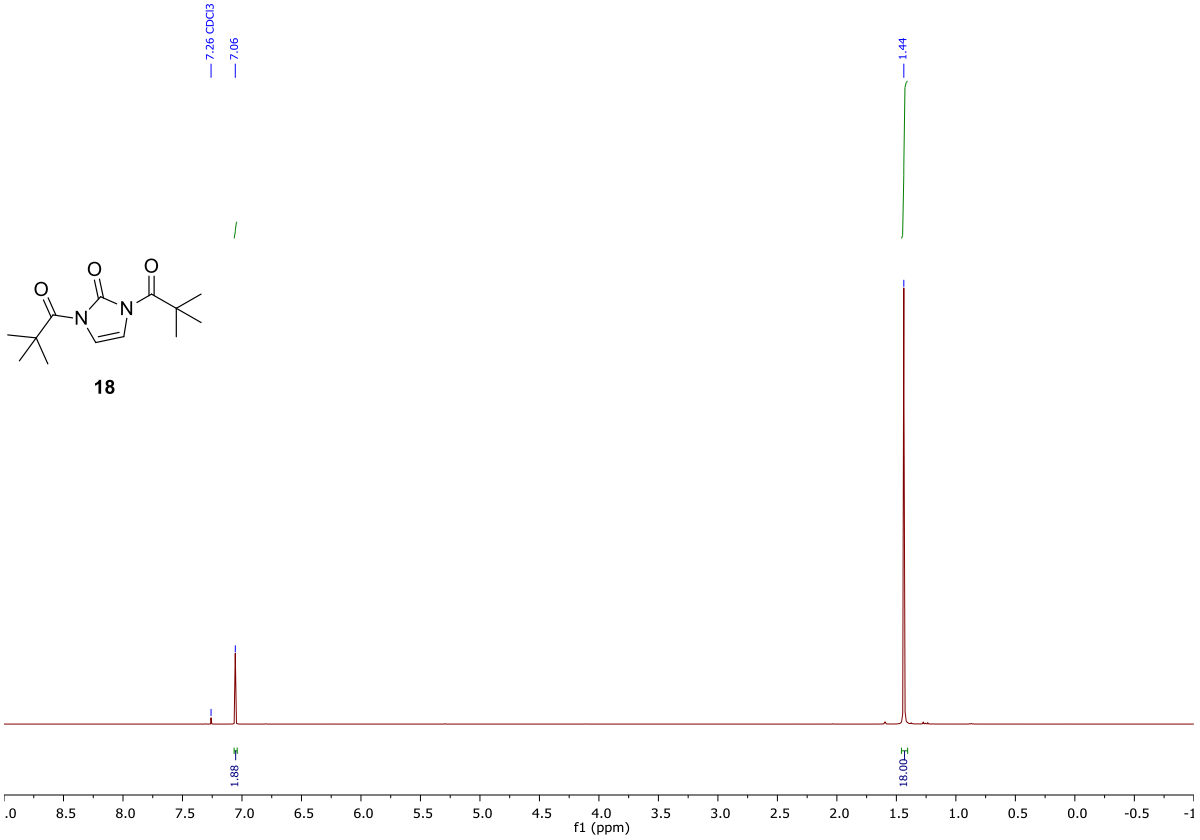
IR


BRUKER
100
90
80
70
60
50
3500
3000
2500
2000
1500
1000
500
3248.84
2952.15
2924.47
2853.85
1691.29
1614.05
1545.89
1440.08
1405.64
1360.87
1331.67
1212.82
1176.21
1106.81
1050.41
896.16
852.18
804.01
759.11
664.43
628.38
588.36
425.33
HN
NH
O
O
N
H
Br

13

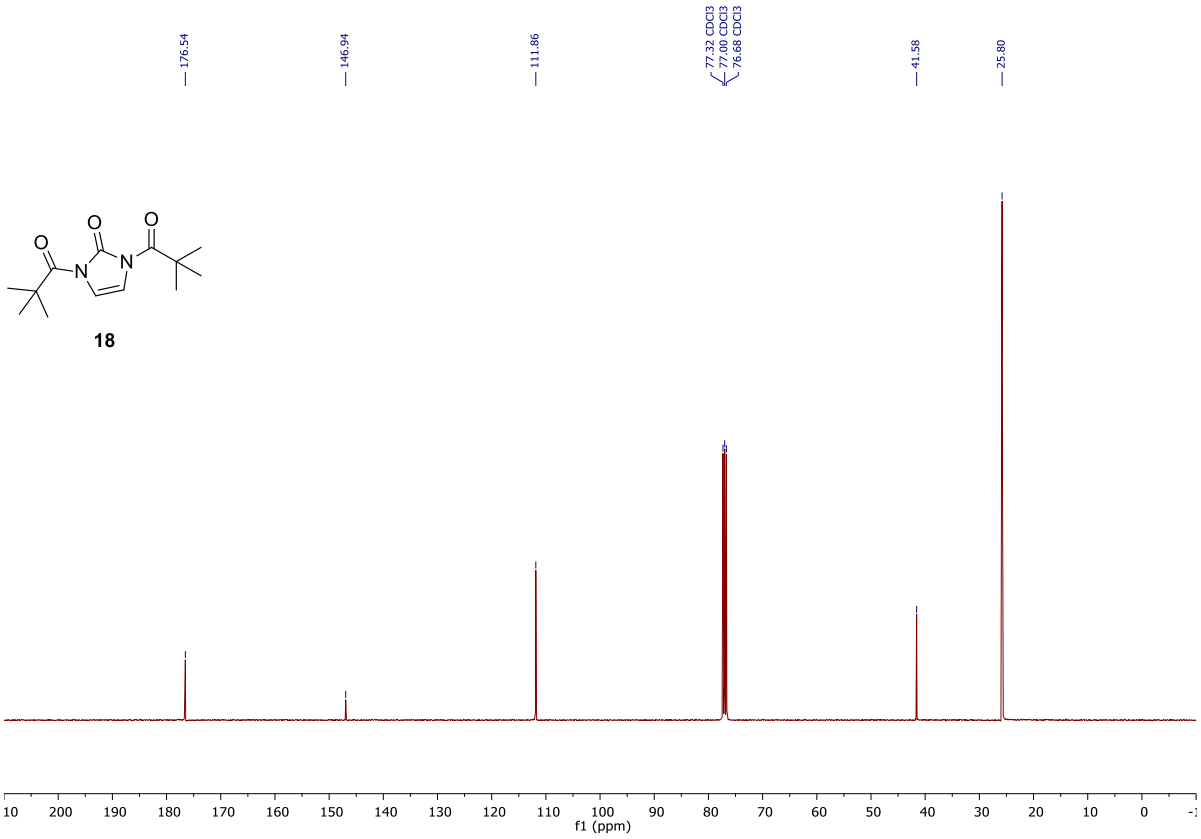
1,1'-(2-oxo-1H-imidazole-1,3(2H)-diyl)bis(2,2-dimethylpropan-1-one) (18)

^{1}H-NMR (400 MHz, $CDCl_3$)



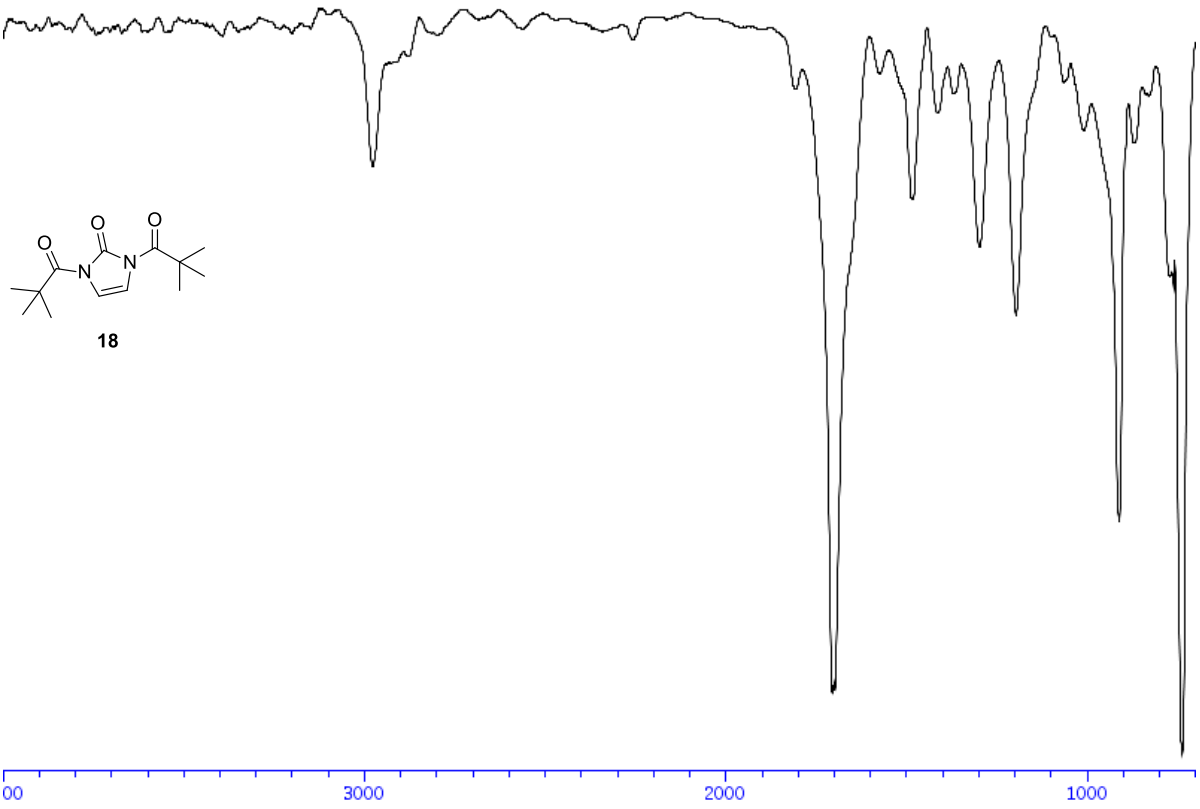
18

^{13}C-NMR (101 MHz, $CDCl_3$)



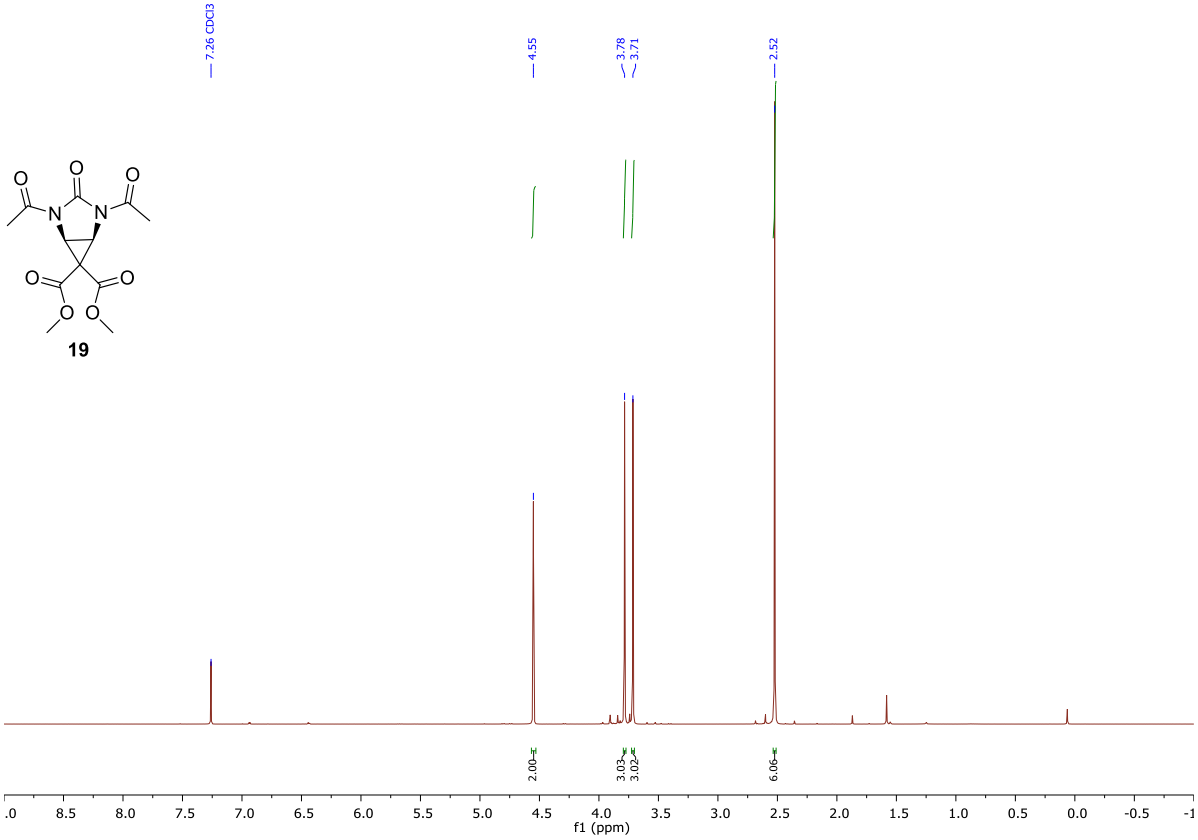
18

IR

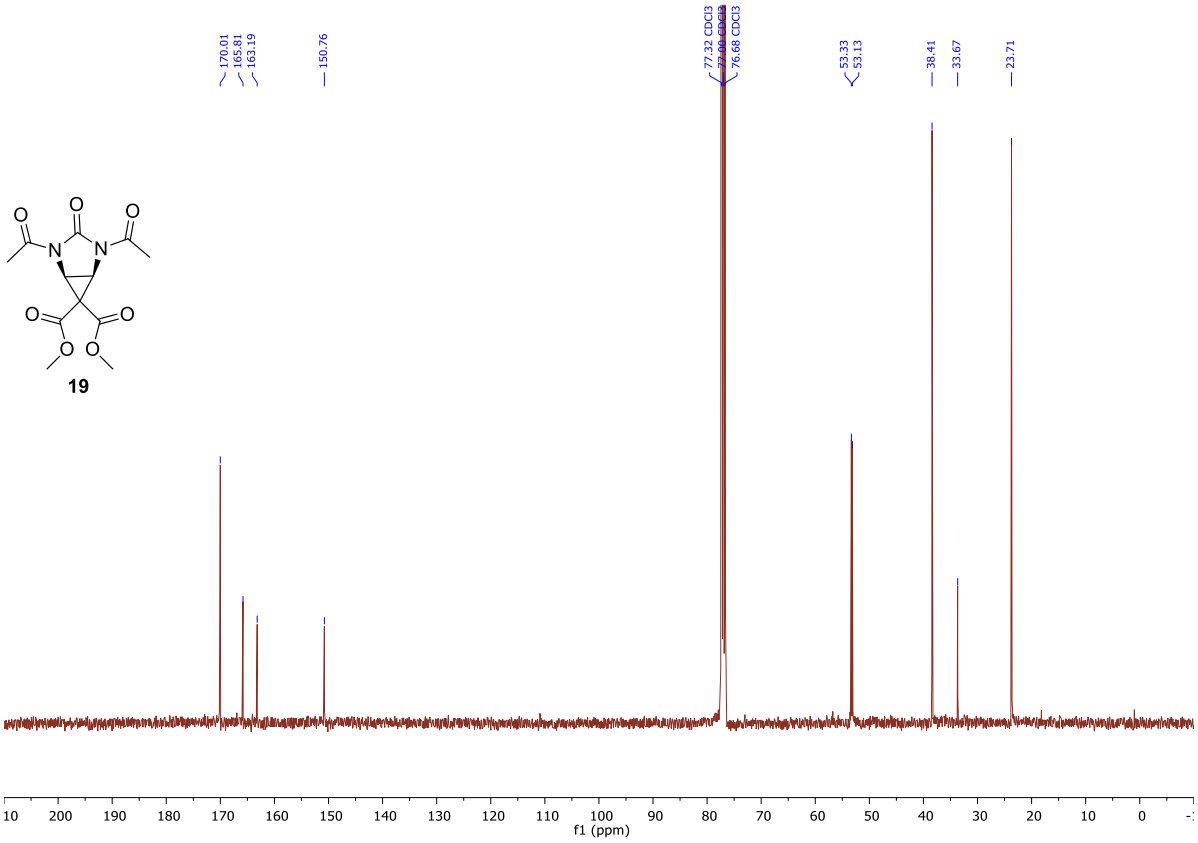


Dimethyl 2,4-diacetyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (19)

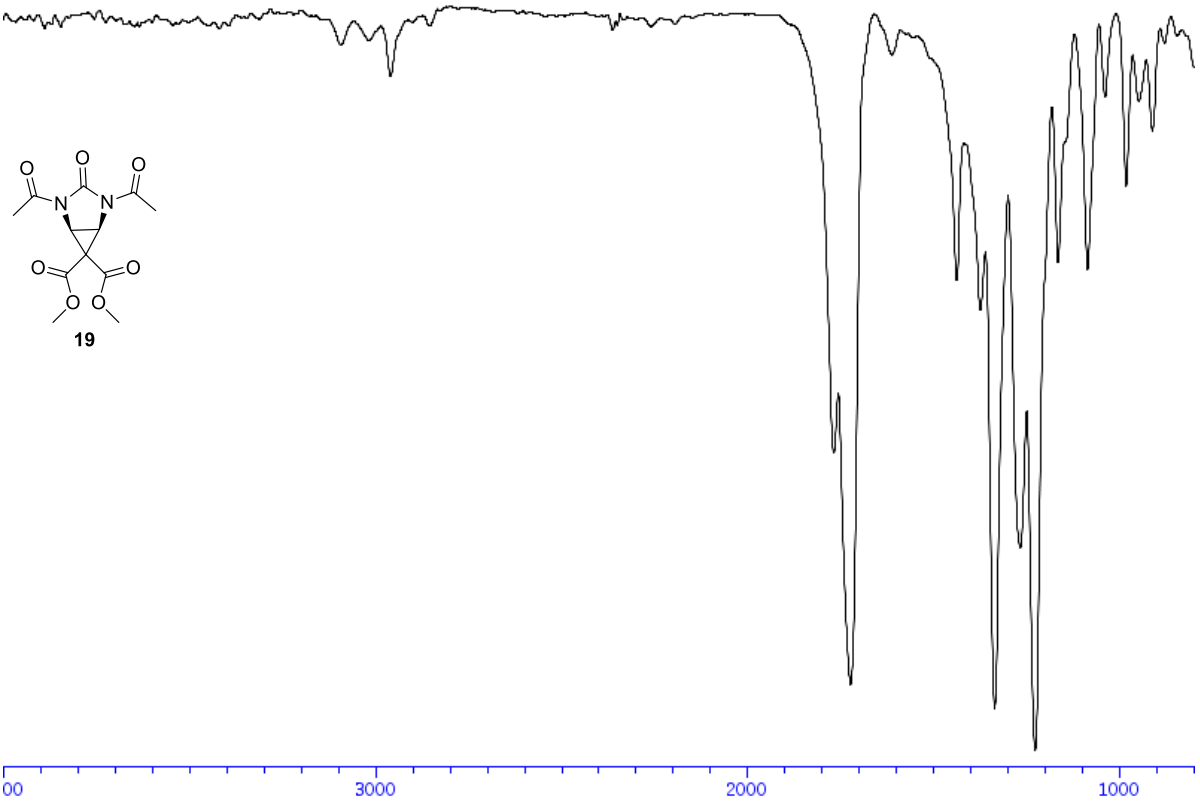
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)

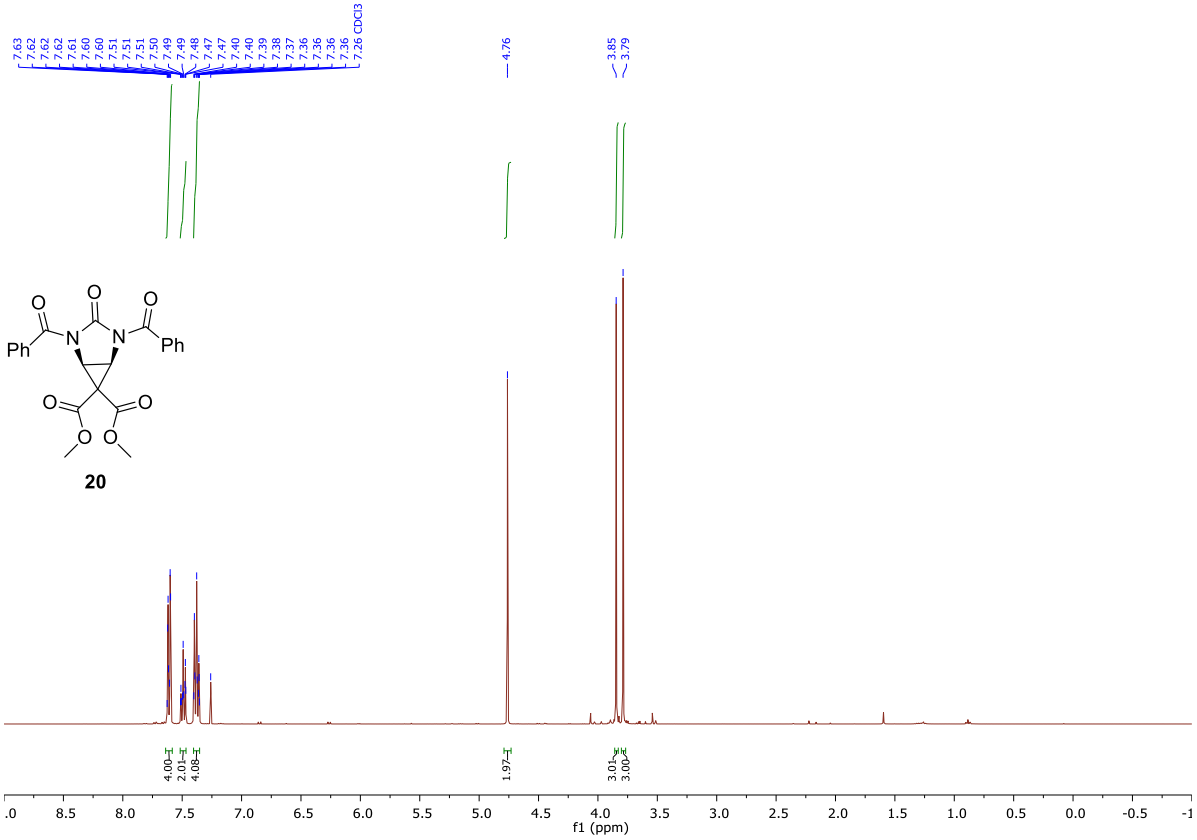


IR

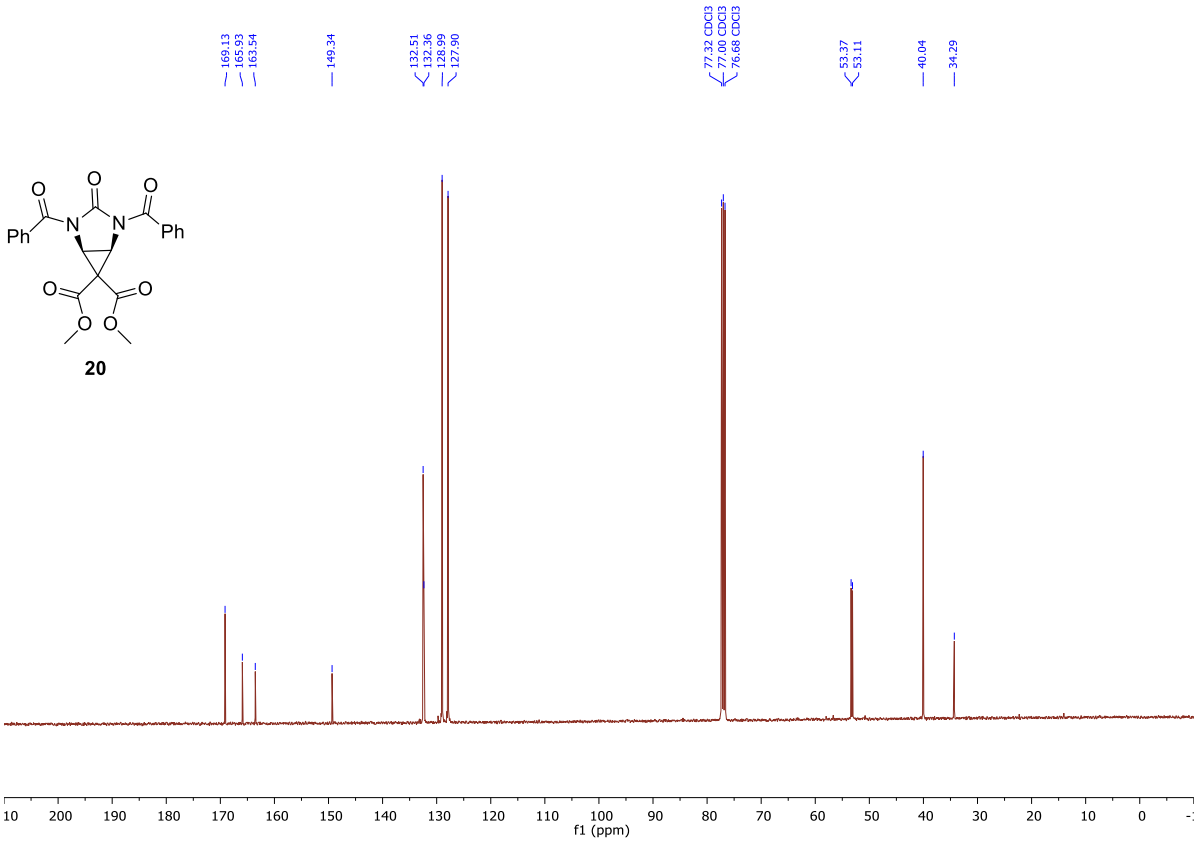


Dimethyl 2,4-dibenzoyl-3-oxo-2,4-diazabicyclo[3.1.0]hexane-6,6-dicarboxylate (20)

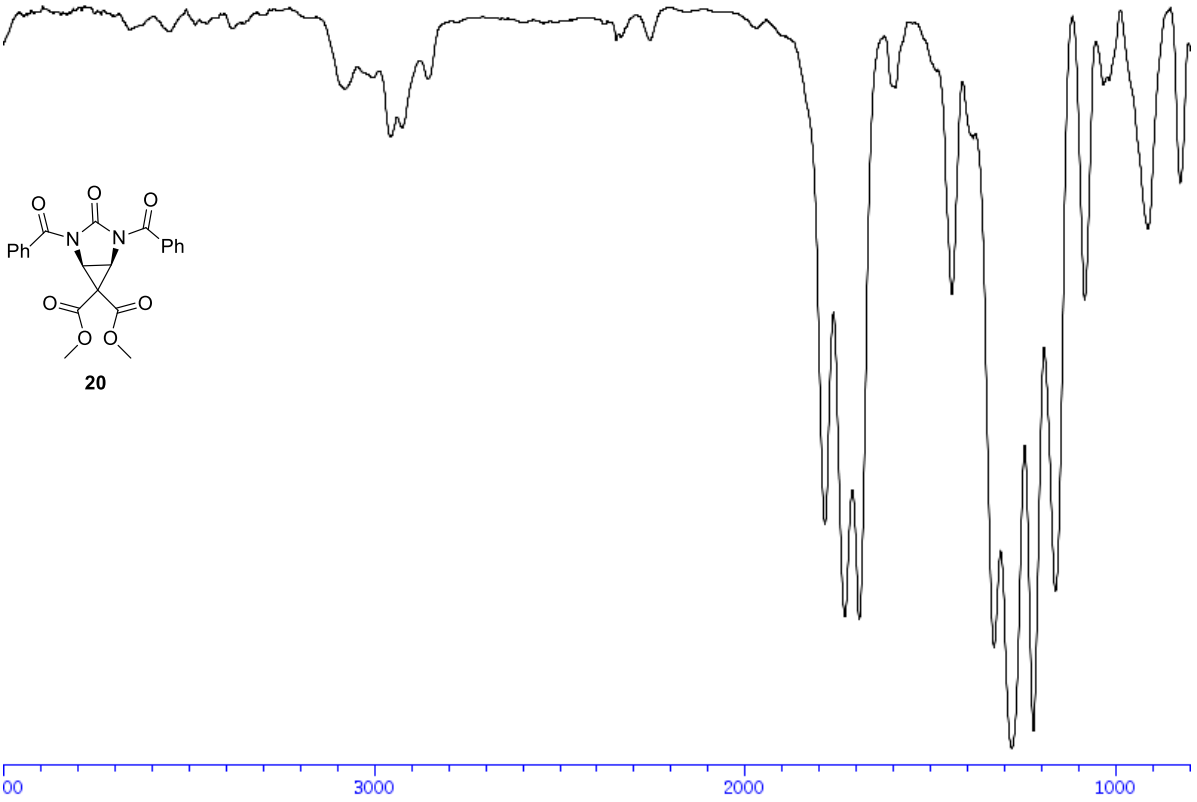
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)



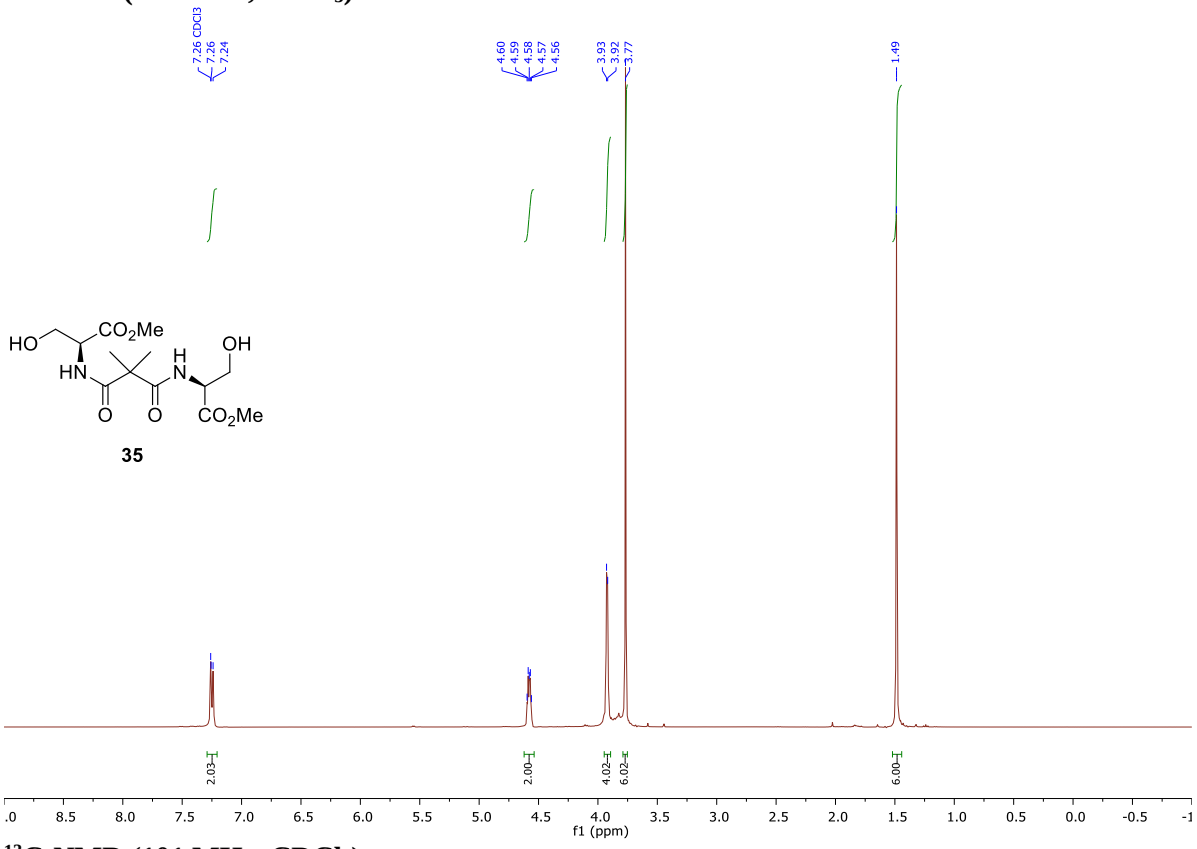
IR



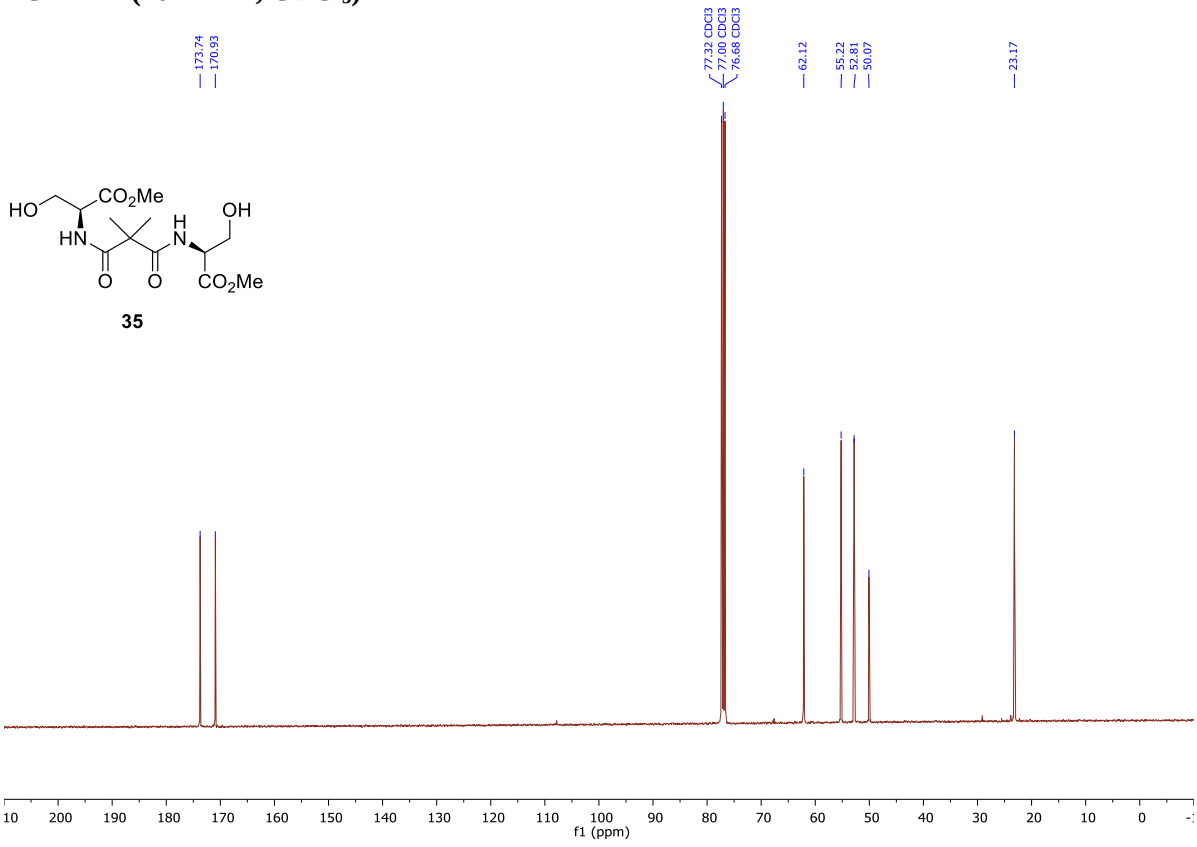
20

(2S,2'S)-dimethyl 2,2'-((2,2-dimethylmalonyl)bis(azanediyl))bis(3-hydroxypropanoate) (35)

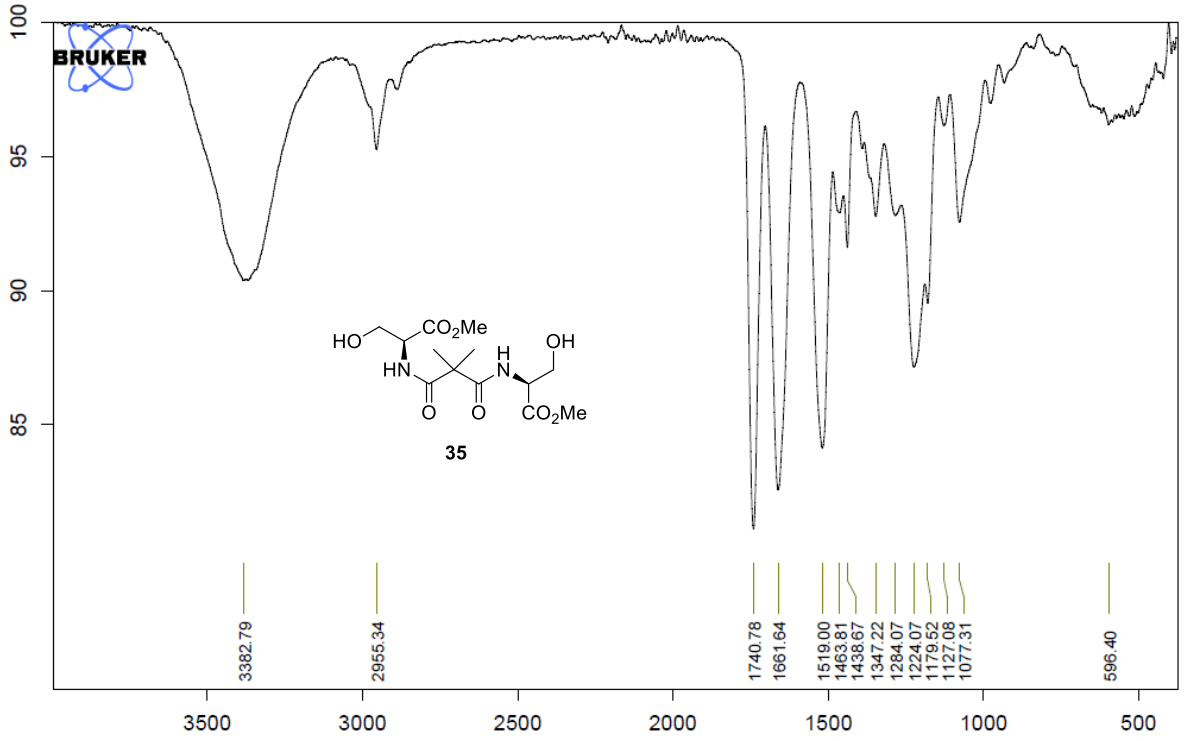
^{1}H-NMR (400 MHz, $CDCl_3$)



^{13}C-NMR (101 MHz, $CDCl_3$)

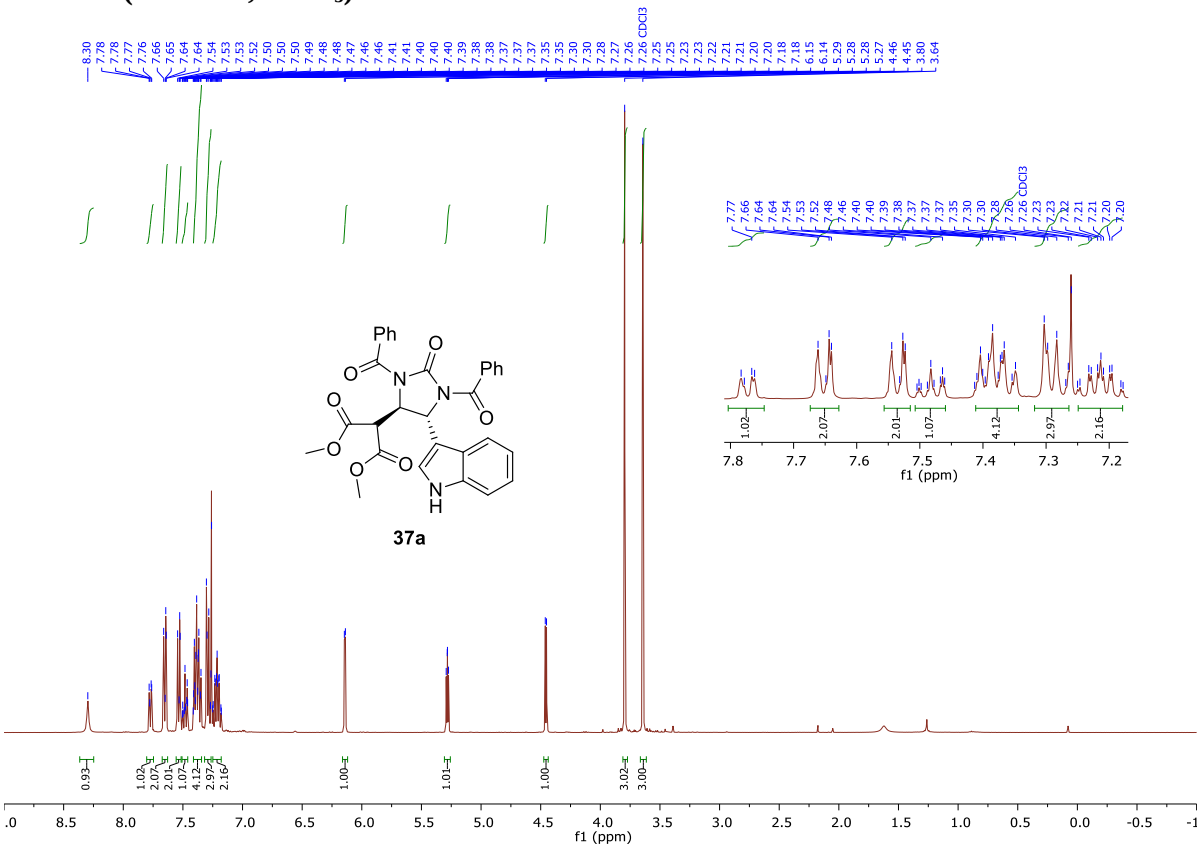


IR

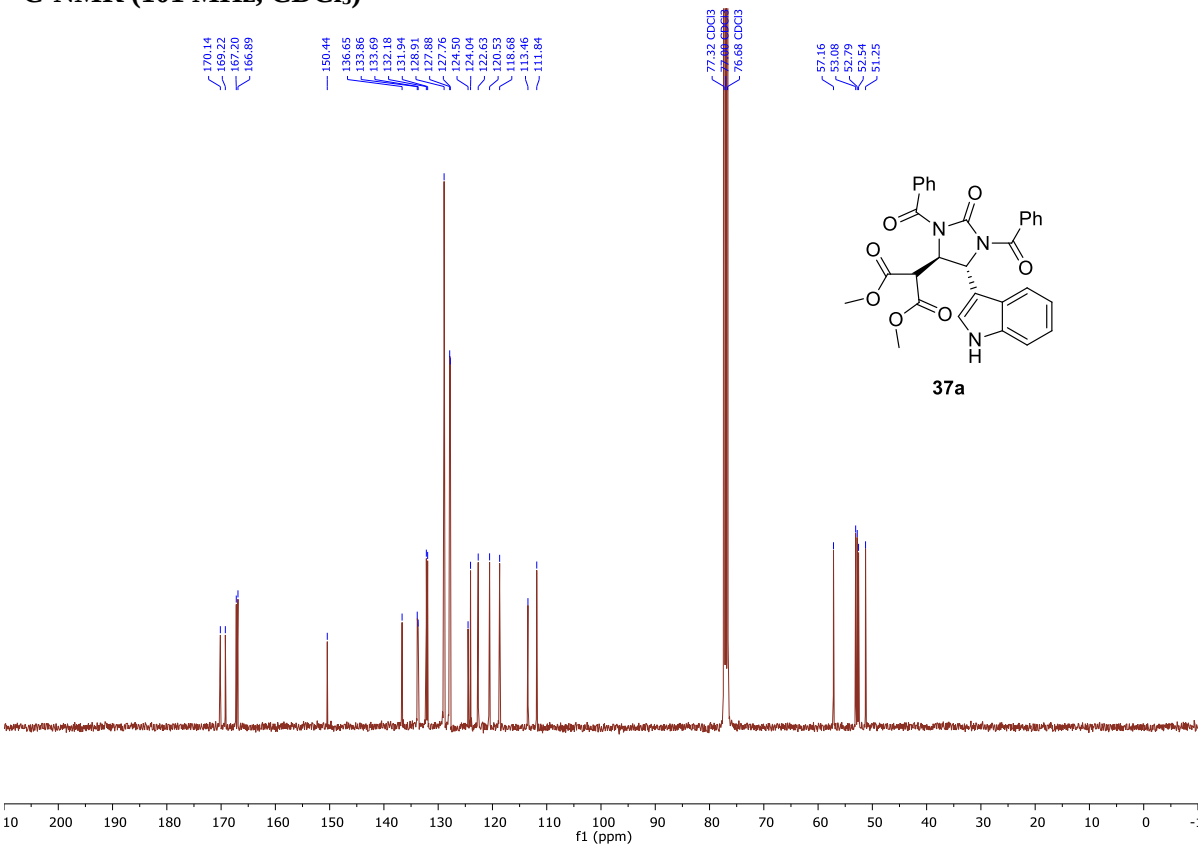

100
95
90
85
BRUKER
HO
CO2Me
HN
H
N
OH
O
O
CO2Me
35
3382.79
2955.34
1740.78
1661.64
1519.00
1463.81
1438.67
1347.22
1284.07
1224.07
1179.52
1127.08
1077.31
596.40
3500
3000
2500
2000
1500
1000
500

Dimethyl 2-(1,3-dibenzoyl-5-(1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (37a)

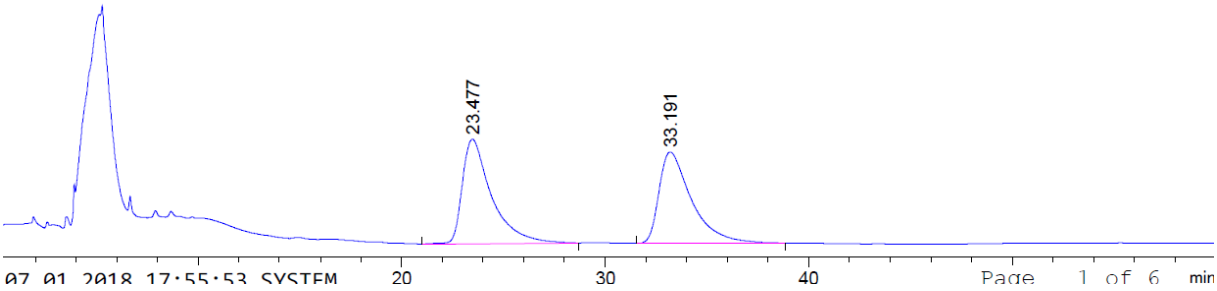
^{1}H-NMR (400 MHz, $CDCl_3$)



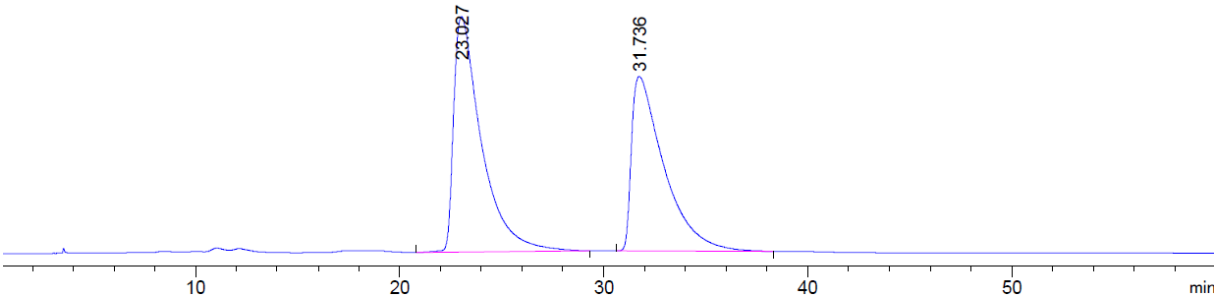
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

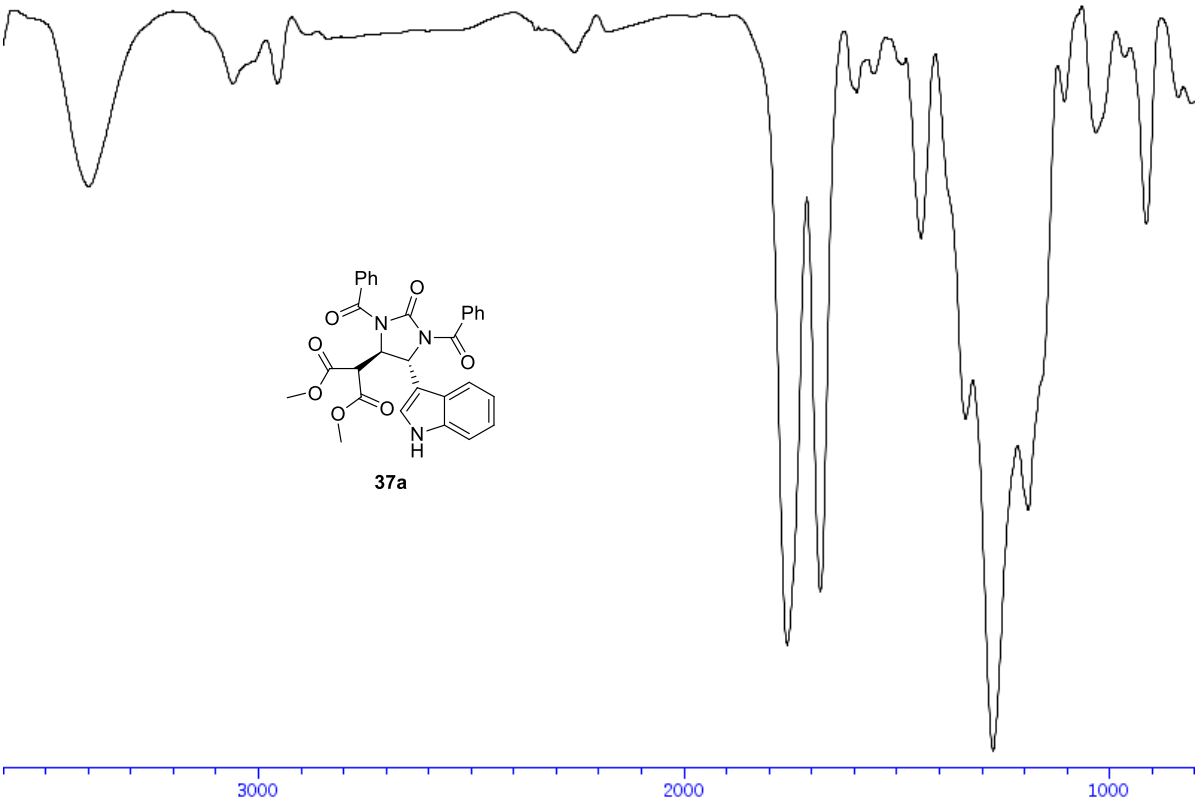


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.477	BB	1.4360	2106.84277	20.97338	50.8853
2	33.191	BB	1.5470	2033.53027	18.32022	49.1147



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.027	BB	1.3877	2.37098e4	249.72836	53.6806
2	31.736	BB	1.5937	2.04584e4	185.07137	46.3194

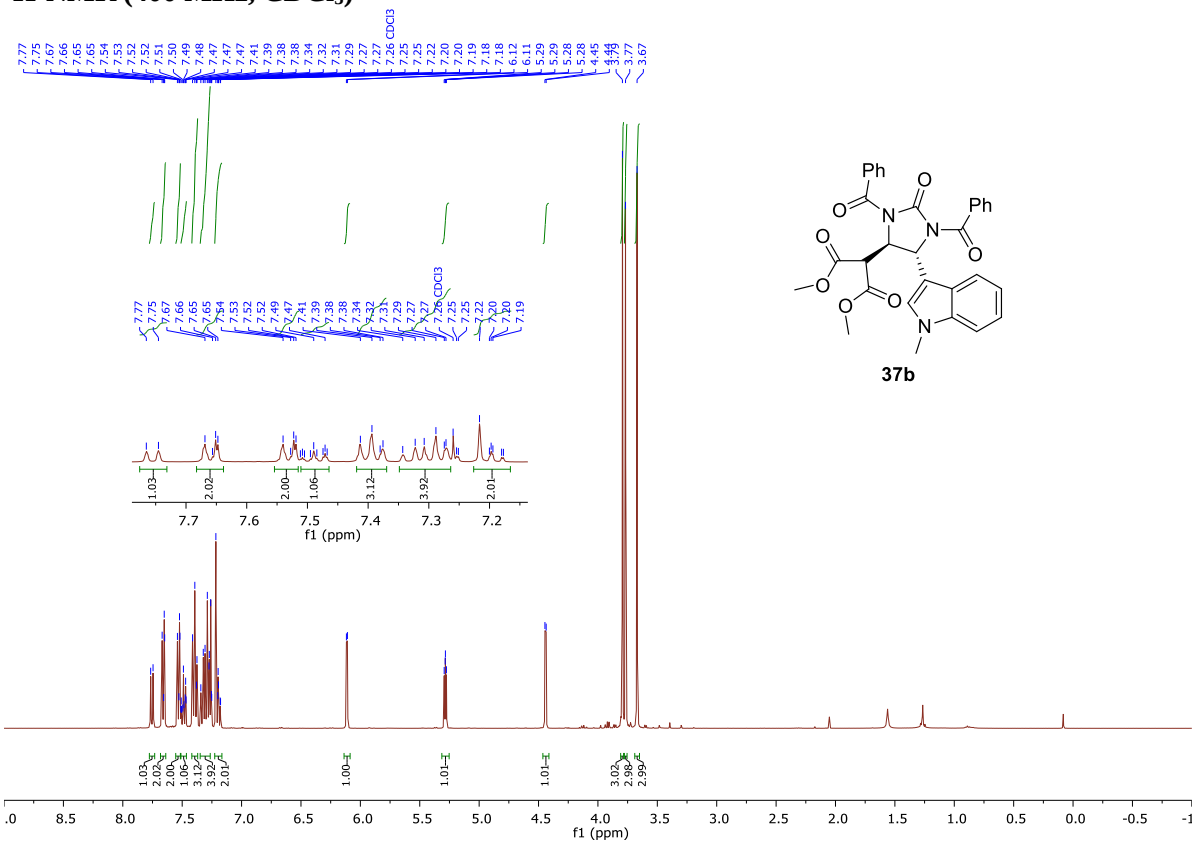
IR



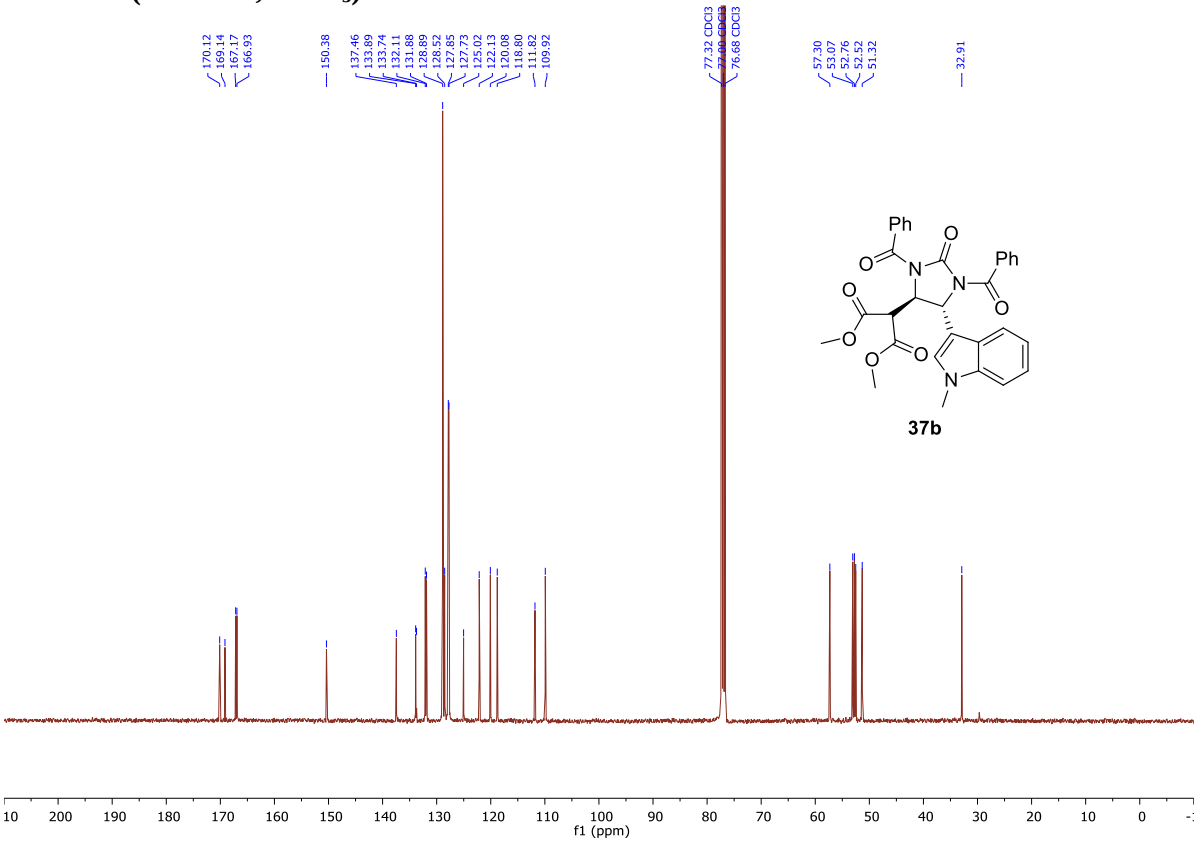
37a

Dimethyl 2-(1,3-dibenzoyl-5-(1-methyl-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (37b)

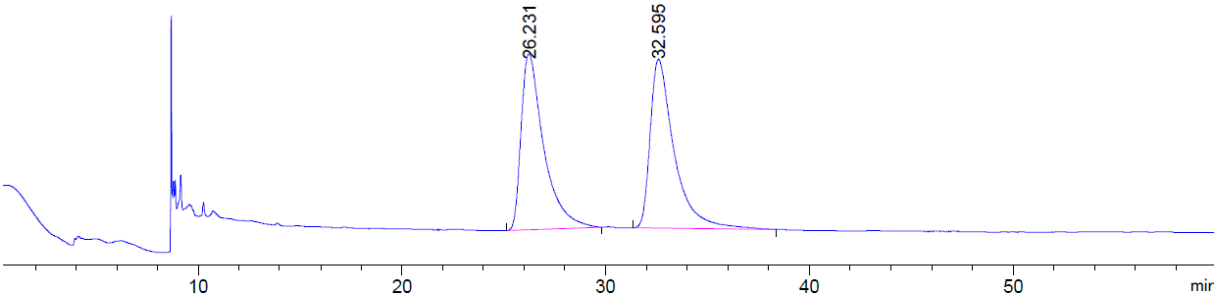
^{1}H-NMR (400 MHz, $CDCl_3$)



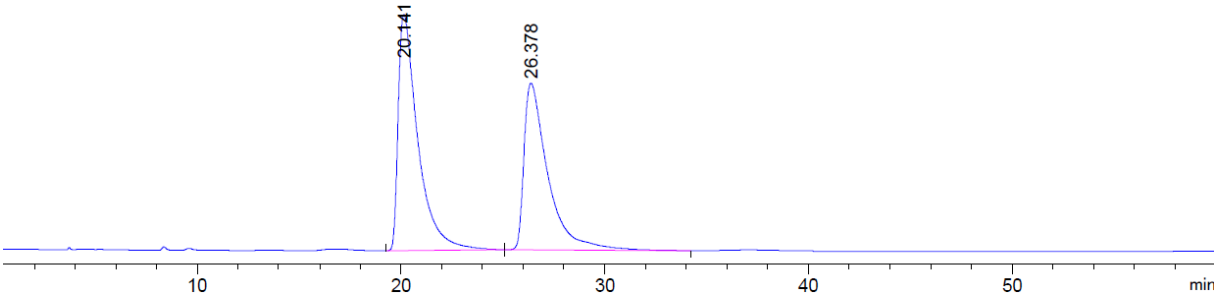
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

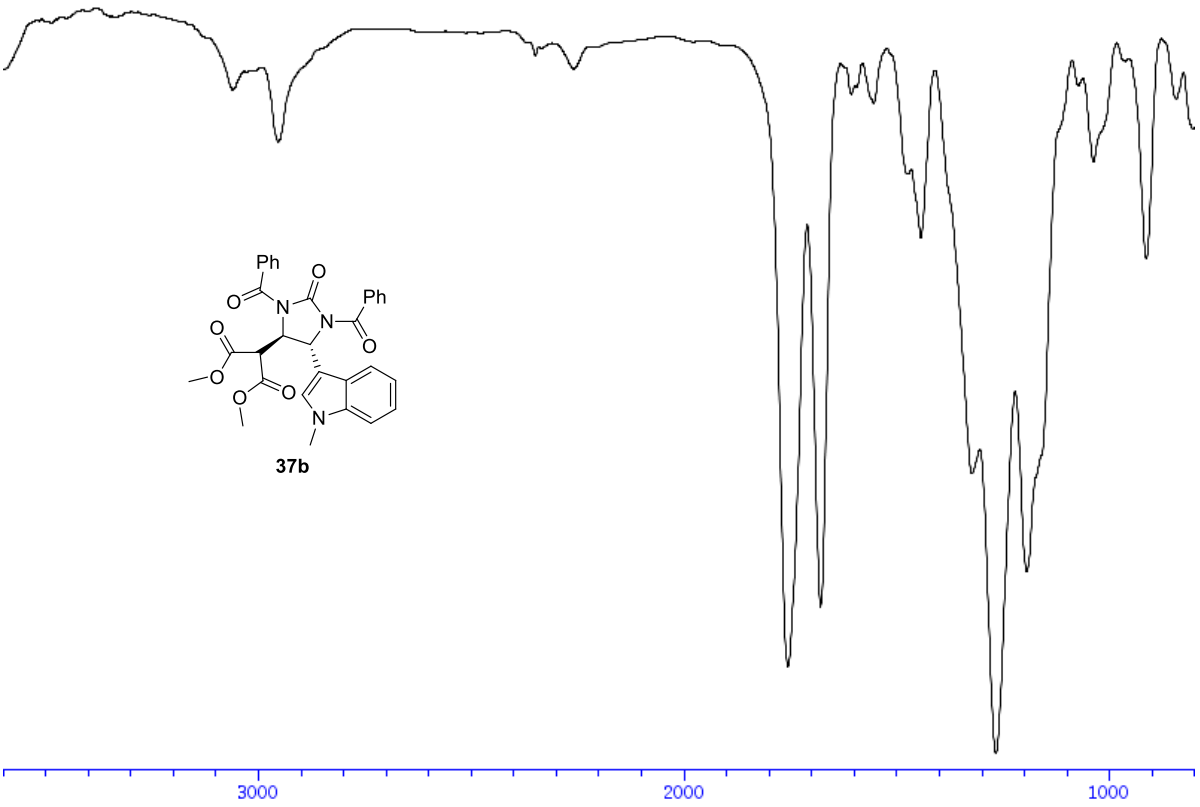


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	26.231	BB	1.1351	1276.38037	16.52586	49.5286
2	32.595	BB	1.1962	1300.67651	15.83574	50.4714



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.141	BB	0.9875	1.15441e4	171.90218	53.8875
2	26.378	BB	1.1885	9878.47363	121.24817	46.1125

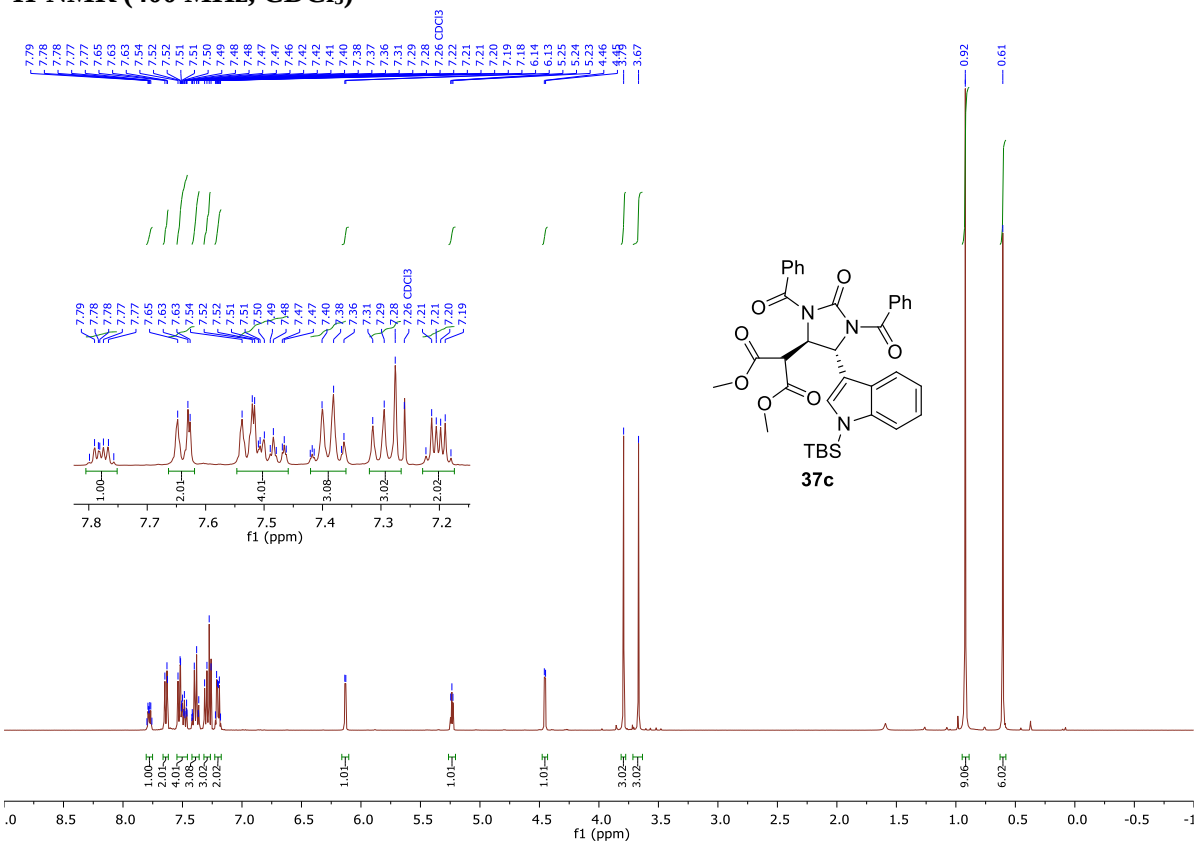
IR



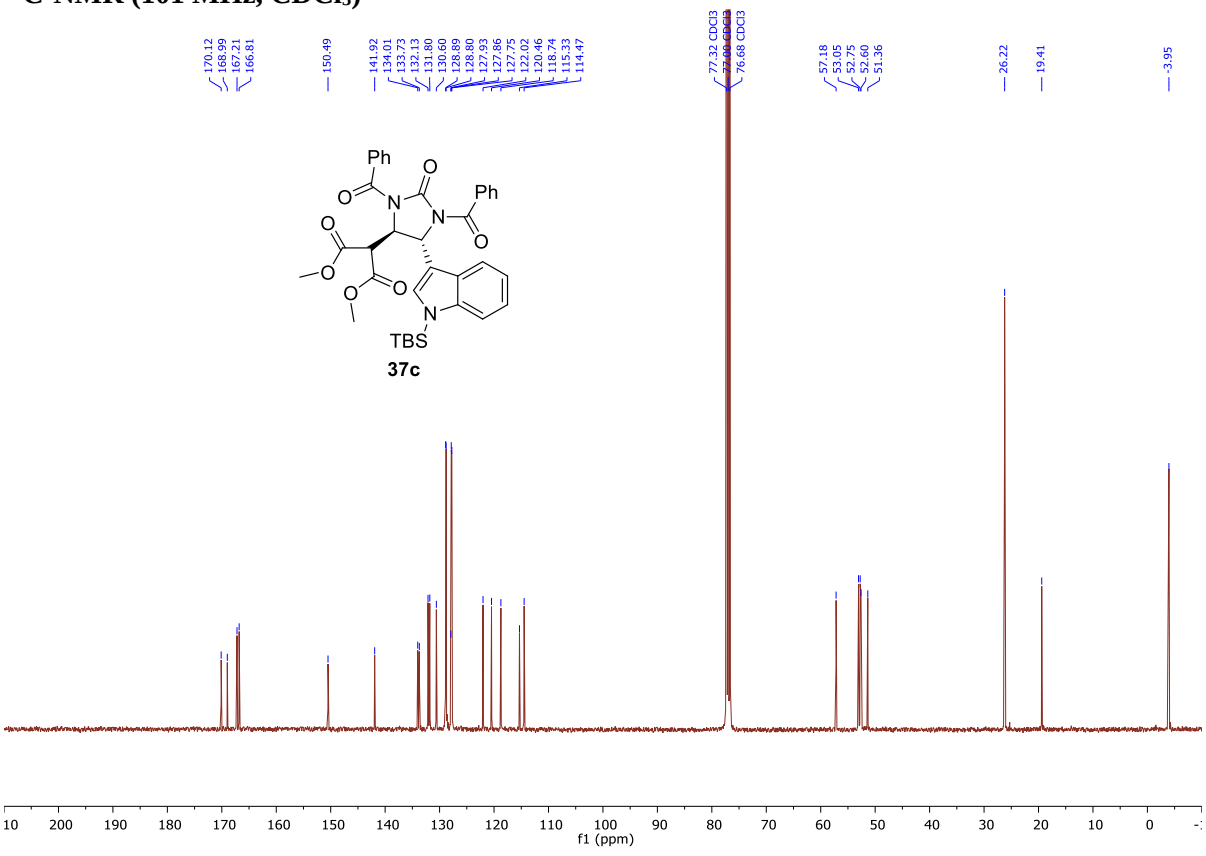
37b

Dimethyl 2-(1,3-dibenzoyl-5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (37c)

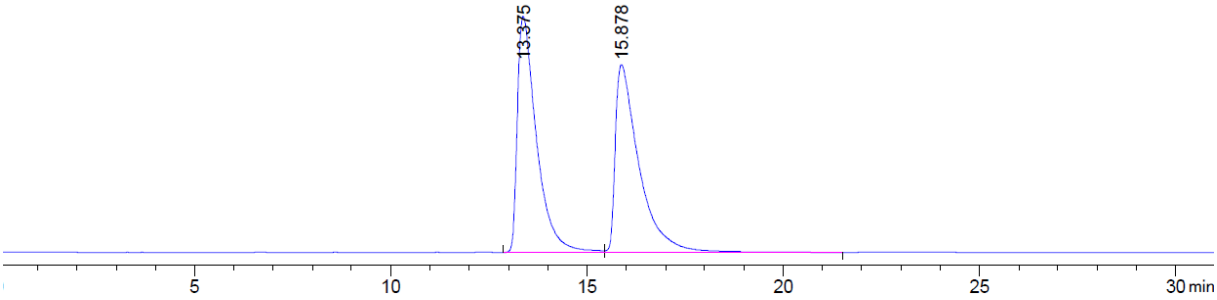
^{1}H-NMR (400 MHz, $CDCl_3$)



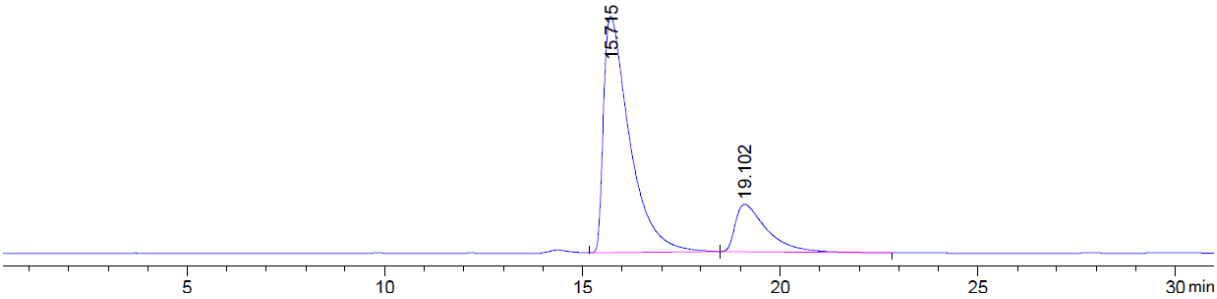
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC

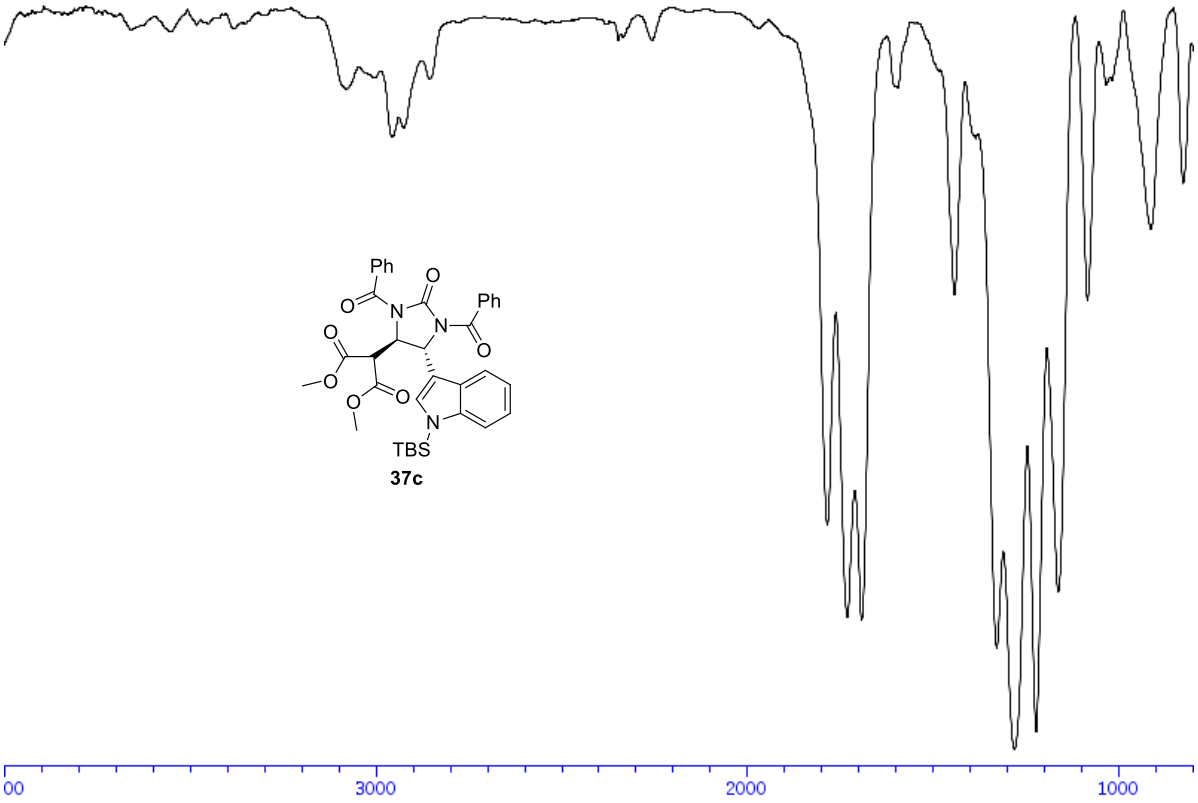


Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.375	BV	0.5039	1.03140e4	303.93405	50.3354
2	15.878	VB	0.6115	1.01766e4	241.56946	49.6646



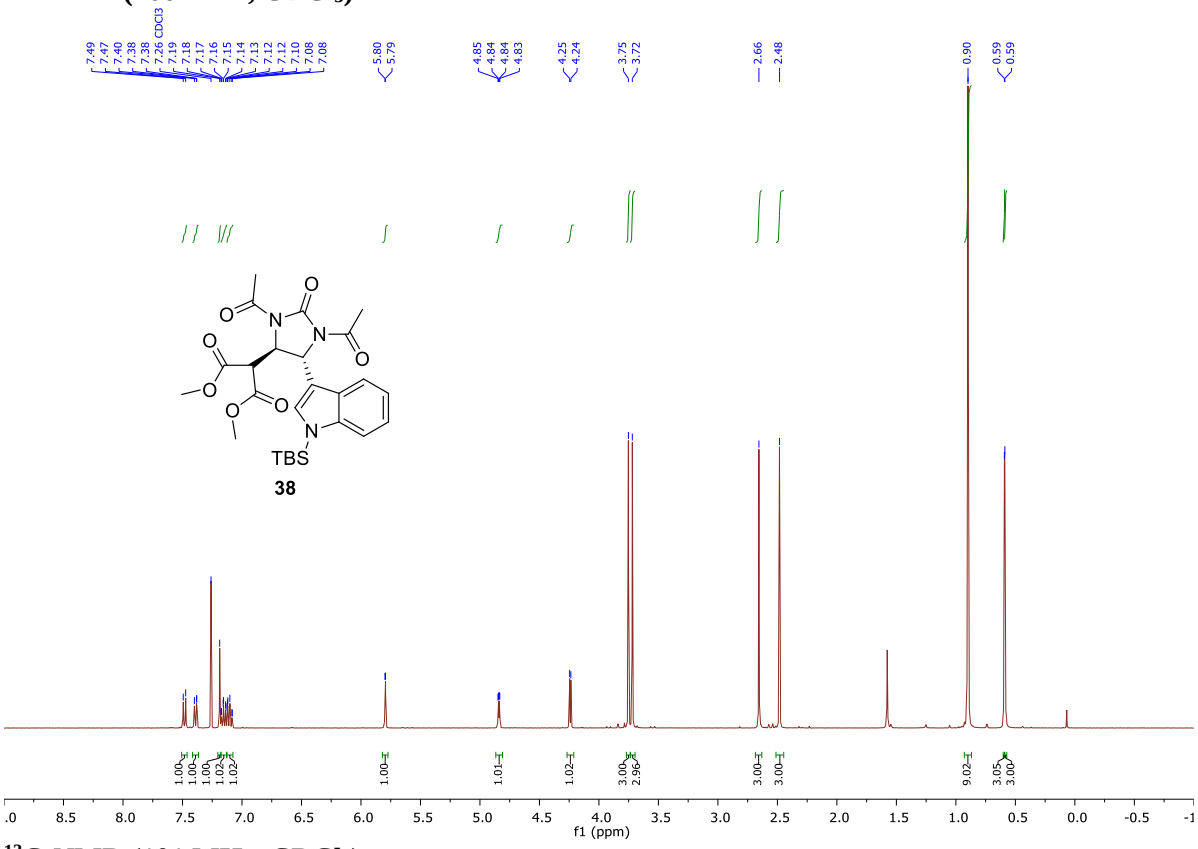
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.715	BB	0.6740	1.80448e4	394.22021	80.5650
2	19.102	BB	0.8102	4353.02441	78.83581	19.4350

IR

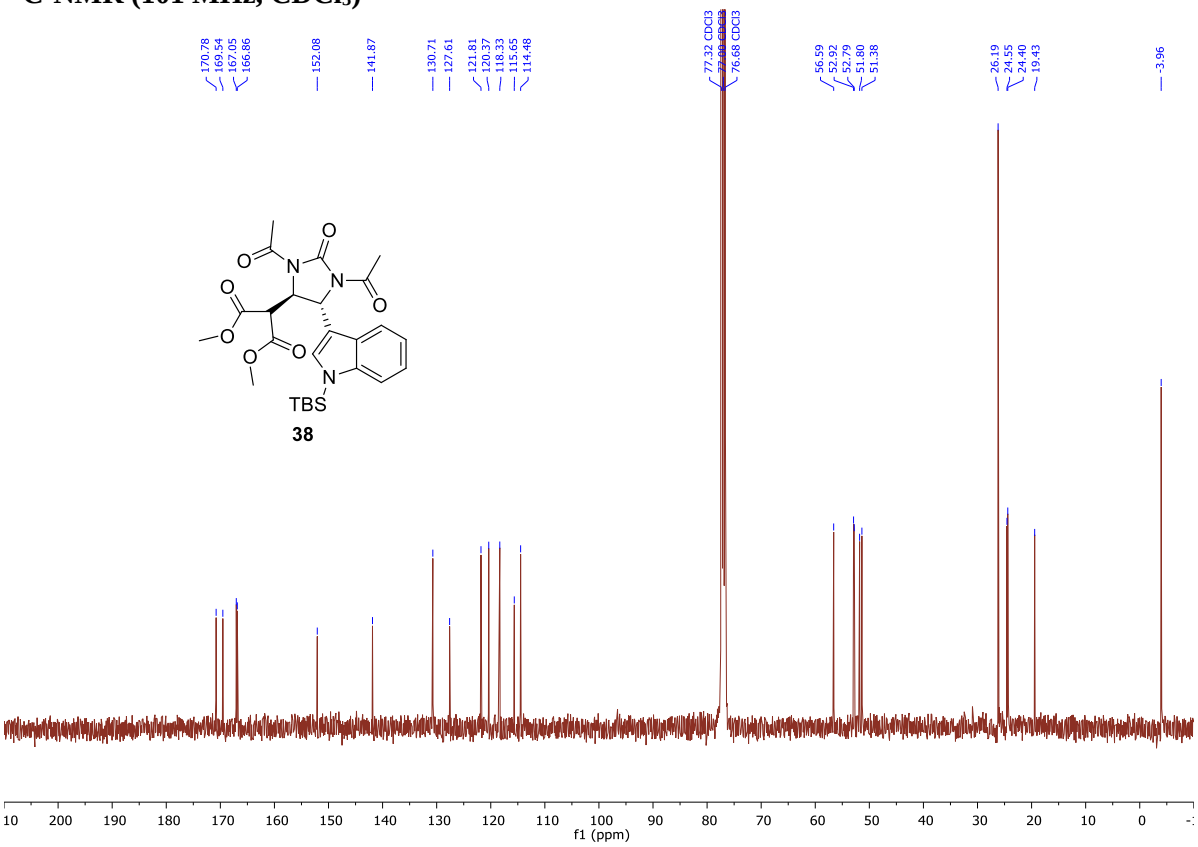


Dimethyl 2-(1,3-diacetyl-5-(1-(tert-butyldimethylsilyl)-1H-indol-3-yl)-2-oxoimidazolidin-4-yl)malonate (38)

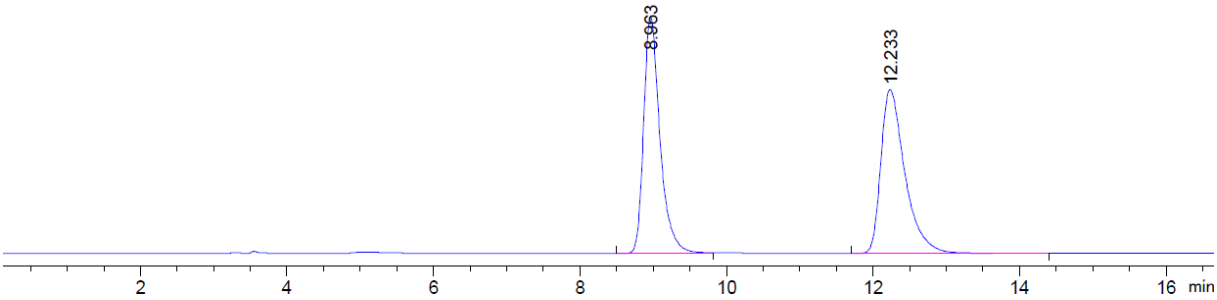
^{1}H-NMR (400 MHz, $CDCl_3$)



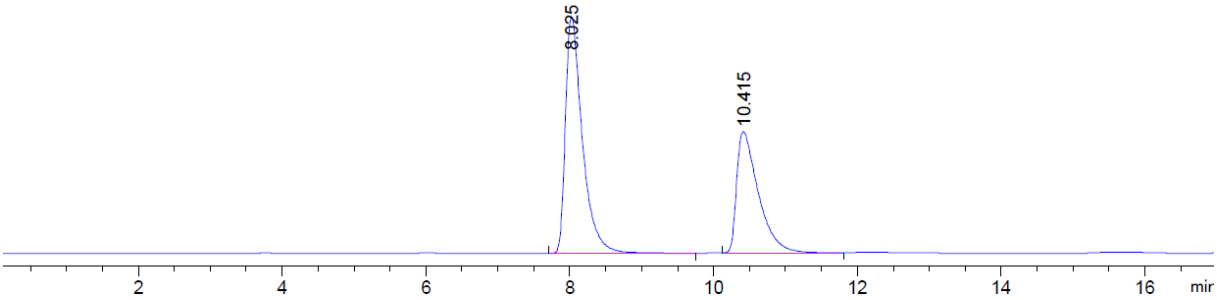
^{13}C-NMR (101 MHz, $CDCl_3$)



HPLC



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.963	BV	0.2342	2.80832e4	1818.24341	49.4899
2	12.233	BB	0.3440	2.86622e4	1257.33997	50.5101



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.025	BB	0.2452	4161.33301	253.93781	60.5109
2	10.415	BB	0.3101	2715.66553	129.78133	39.4891

IR