SUPPORTING INFORMATION

Synthesis of spiro-oxoindoles through Pd-catalyzed remote C–H alkylation using α-diazocarbonyl compounds

Marta Pérez-Gómez,^a Sergio Hernández-Ponte, ^a Delia Bautista^b and José-Antonio García-López^{a,*}

^aGrupo de Química Organometálica. Dpto. Química Inorgánica Universidad de Murcia Campus de Espinardo, 30100, Murcia, Spain E-mail: joangalo@um.es ^bSAI, Universidad de Murcia, Apartado 4021, 30071, Murcia, Spain

•	General Remarks	S2
•	Chart of starting materials	S2
•	Optimization table	S3
•	Synthetic procedures and characterization of the products 3 .	S4-18
•	References	S19
•	Crystallographic data of compound 3b	S19
•	¹ H- and ¹³ C-NMR spectra of the compounds	S20–51
•	NOESY spectra of compound 3k	S52

General Remarks

Infrared spectra were recorded on a Perkin-Elmer spectrum 100 spectrophotometer. High-resolution ESI mass spectra were recorded on an Agilent 6220 Accurate Mass TOF LC/MS spectrometer. Melting points were determined using a Reichert apparatus and are uncorrected. Nuclear Magnetic Resonance (NMR) spectra were recorded on a 300 or 400 MHz Bruker NMR spectrometers in CDCl₃ at 298 K (unless stated otherwise). All chemical shift values are reported in parts per million (ppm) with coupling constant (*J*) values reported in Hz. All spectra were referenced to TMS for ¹H NMR and the CDCl₃ solvent peak for ¹³C{¹H} NMR. Anhydrous MeCN was purchased from commercial sources and used as received. TLC tests were run on TLC Alugram® Sil G plates and visualized under UV light at 254 nm. Chromatography: Separations were carried out on silica gel.



Chart of starting materials

Synthesis of the starting materials

The acrylamide substrates **1** were prepared from the corresponding anilines and 2phenylacrilic acid as reported previously.^[1] The α -diazocarbonyl compounds **2** were synthesized from commercially available 2-arylacetic acids following the procedures described in the literature.^[2, 3]

Optimization of the cascade reaction



Entry ^[a]	Pd source (mol%)	Ligand (mol%)	base (equiv)	solvent	yield ^[b] (%)	dr
1	Pd(OAc) ₂ (10)	PPh₃ (20)	Cs ₂ CO ₃ (1 equiv)	MeCN	96	2.2:1
1	Pd(OAc) ₂ (10)	PPh₃ (20)	Cs ₂ CO ₃ (1 equiv)	1,4- dioxane	33	2.2:1
2	Pd(OAc) ₂ (10)	PPh₃ (20)	Cs ₂ CO ₃ (1 equiv)	MeCN	85 ^[c]	2.0:1
3	Pd(OAc) ₂ (5)	PPh₃ (10)	Cs ₂ CO ₃ (1 equiv)	MeCN	96 (95) ^[d]	2.2:1
4	Pd(OAc) ₂ (2.5)	PPh₃ (5)	Cs ₂ CO ₃ (1 equiv)	MeCN	30	2.2:1
5	Pd(OAc) ₂ (5)	R-BINAP (5)	Cs ₂ CO ₃ (1 equiv)	MeCN	traces	-
7	Pd(OAc) ₂ (10)	dppe (20)	Cs ₂ CO ₃ (1 equiv)	MeCN	97	2.0:1
8	Pd(OAc) ₂ (10)	dppf (20)	Cs ₂ CO ₃ (1 equiv)	MeCN	86	2.0:1
11	-	-	Cs ₂ CO ₃ (1 equiv)	MeCN	0	-

[a] The reactions were carried out using 0.3 mmol of substrate **1a**, 0.3 mmol (1 equiv) of Cs_2CO_3 , 0.45 mmol (1.5 equiv) of the diazocompond **2a**, in 3 mL of dry solvent under nitrogen atmosphere at 100 °C in a Carius tube for 16 h. [b] NMR yields using trimethyl benzene-1,3,5-tricarboxylate as standard. [c] Starting form the iodoarene instead of the bromoarene substrate **1a**. [d] Isolated yield.



Representative procedure A: A Carius tube was charged with the corresponding substrate **1** (0.3 mmol), $Pd(OAc)_2$ (3.5 mg, 0.015 mmol, 5 mol%), PPh_3 (8 mg, 0.03 mmol, 10 mol%), dry Cs_2CO_3 (100 mg, 0.3 mmol, 1 eq) and a magnetic stirrer. The tube was rapidly set under nitrogen atmosphere and 3 mL of dry MeCN were added while stirring. The corresponding α -diazocarbonyl compound **2** (0.45 mmol, 1.5 eq) was added to the reaction mixture and the tube was sealed and stirred in a pre-heated oil bath at 100 °C for 16 h. After cooling the tube, the crude was diluted with CH_2Cl_2 (50 mL) and filtered through a Celite pad. The filtrate was concentrated and the crude was purified by column chromatography or preparative TLC in silica gel to afford the cascade products **3**.

Compound 3a. Prepared according to the procedure A from substrates 1a and 2a.



The reaction produced a mixture of diastereomers **3a** and **3a'** in a ratio of 2.2:1 (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3a** and **3a'** were purified by column chromatography (silica gel, petroleum ether/EtOAc gradient from 12 to 16% EtOAc). Data for compound **3a** (major diastereomer): pale yellow solid (77 mg, 0.200 mmol, 67%). M. p.:

68 °C. IR (cm⁻¹): ν(CO) 1720 (s),1611 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.58-7.55 (m, 1 H), 7.36-7.20 (m, 8 H), 6.91-6.86 (m, 2 H), 6.70-6.60 (m, 2 H), 3.86 (d, *J* = 14.0 Hz, 1 H), 3.82 (s, 3 H), 3.24 (s, 3 H), 2.70 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (100.81 MHz, CDCl₃): δ = 178.7 (s, C_q), 173.6 (s, C_q), 144.7 (s, C_q), 144.4 (s, C_q), 144.3 (s, C_q), 143.9 (s, C_q), 133.5 (s, C_q), 128.7 (s, CH), 128.6 (s, CH), 128.3 (s, CH), 128.1 (s, CH), 127.1 (s, CH), 126.9 (s, CH), 123.8 (s, CH), 123.3 (s, CH), 122.8 (s, CH), 107.9 (s, CH), 64.1 (s, C_q), 58.9 (s, C_q), 52.9 (s, CH₃), 50.3 (s, CH₂), 26.5 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) *m/z* calcd for C₂₅H₂₂NO₃ [M+H]⁺ 384.1594, found 384.1606. Data for compound 3a' (minor diastereomer): pale yellow oil (34 mg, 0.088 mmol,



29%). IR (cm⁻¹): ν (CO) 1720 (s), 1611 (s). ¹H-NMR (400 MHz, CDCI₃) δ = 7.52-7.50 (m, 1 H), 7.36-7.20 (m, 8 H), 7.06-7.01 (m, 2 H), 6.90 (d, *J* = 7.6 Hz, 1 H), 6.73-6.71 (m, 1 H), 3.83 (s, 3 H), 3.68 (d, *J* = 14.0 Hz, 1 H), 3.26 (s, 3 H), 2.89 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (100.81 MHz, CDCI₃): δ = 179.4 (s, C_q), 175.0 (s, C_q), 145.1

^{MeO₂C Ph (s, C_q), 144.9 (s, C_q), 143.9 (s, C_q), 143.2 (s, C_q), 135.0 (s, C_q), 129.2 (s, CH), 128.4 (s, CH), 128.3 (s, CH), 128.2 (s, CH), 127.9 (s, CH), 126.9 (s, CH), 126.8 (s, CH), 124.3 (s, CH), 123.5 (s, CH), 123.1 (s, CH), 107.9 (s, CH), 65.3 (s, C_q), 59.6 (s, C_q), 52.9 (s, CH₃), 49.1 (s, CH₂), 26.6 (s, CH₃) . HR-MS (+ESI) *m/z* calcd for $C_{25}H_{22}NO_3$ [M+H]⁺ 384.1594, found 384.1605.}

Compound 3b. Prepared according to the procedure A from substrates 1a and 2b.



The reaction produced a mixture of diastereomers **3b** and **3b'** in a 2.1:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3b** and **3b'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (6:1). Data for compound **3b** (major diastereomer): white solid (76 mg, 0.191 mmol, 64%). M.p.: 115 °C. IR (cm⁻¹): v(CO) 1720 (s),

1610 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.63-7.60 (m, 1 H), 7.36-7.21 (m, 8 H), 6.88-6.83 (m, 2 H), 6.70-6.67 (m, 1 H), 6.57 (dd, *J* = 7.8, 1.2 Hz, 1 H), 4.29 (q, *J* = 14.4, 7.2 Hz, 2 H), 3.89 (d, *J* = 14.0 Hz, 1 H), 3.24 (s, 3 H), 2.69 (d, *J* = 14.0 Hz, 1 H), 1.26 (t, *J* = 14.4, 7.2 Hz, 3 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.8 (s, C_q), 173.9 (s, C_q), 146.0 (s, C_q), 145.6 (s, C_q), 145.3 (s, C_q), 144.8 (s, C_q), 134.7 (s, C_q), 129.73 (s, CH), 129.70 (s, CH), 129.6 (s, CH), 129.3 (s, CH), 129.1 (s, CH), 128.1 (s, CH), 127.9 (s, CH), 124.9 (s, CH), 124.4 (s, CH), 123.8 (s, CH), 108.9 (s, CH), 65.1 (s, C_q), 62.7 (s, CH₂), 59.9 (s, C_q), 51.2 (s, CH₂), 27.5 (s, CH₃), 15.1 (s, CH₃). HR-MS (+ESI) *m/z* calcd for C₂₆H₂₄NO₃ [M+H]⁺ 398.1751, found 398.1756.

Data for compound **3b'** (minor diastereomer): pale yellow oil (36 mg, 0.09 mmol, 30%).



IR (cm⁻¹): ν (CO) 1720 (s), 1610 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.51-7.50 (m, 1 H), 7.36-7.19 (m, 8 H), 7.10-7.02 (m, 2 H), 6.90 (d, J = 7.8 Hz, 1 H), 6.73-6.69 (m, 1 H), 4.30 (qd, J = 7.2, 0.9 Hz, 2 H), 3.67 (d, J = 14.0, 1 H), 3.24 (s, 3 H), 2.89 (d, J = 14.0 Hz, 1 H), 1.27 (t, J = 14.4, 7.2 Hz, 3 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.5 (s, C_q), 179.4 (s, C_q), 145.3 (s, C_q), 144.9 (s, C_q), 145.2 (s, C_q),

143.2 (s, C_q), 135.1 (s, C_q), 129.5 (s, CH), 128.4 (s, CH), 128.20 (s, CH), 128.17 (s, CH), 127.9 (s, CH), 126.9 (s, CH), 124.3 (s, CH), 123.4 (s, CH), 123.1 (s, CH), 107.9

(s, CH), 65.3 (s, C_q), 61.8 (s, CH₂), 59.6 (s, C_q), 49.0 (s, CH₂), 26.6 (s, CH₃), 14.1 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) m/z calcd for C₂₆H₂₄NO₃ [M+H]⁺ 398.1751, found 398.1756.

Compound 3c. Prepared according to the procedure A from substrates 1a and 2c.



The reaction produced a mixture of diastereomers **3c** and **3c'** in a 1.6:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3c** and **3c'** were purified and partially separated by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (5:1). A first fraction of the chromatography corresponding to the pure diasteromer **3c** could be isolated. Data

for compound **3c** (major diastereomer). Pale yellow oil (50 mg, 0.109 mmol, 36%). IR (cm⁻¹): ν (CO) 1716 (s), 1612 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.58-7.56 (m, 1 H), 7.34-7.22 (m, 13 H), 6.87 (d, *J* = 7.5 Hz, 2 H), 6.71-6.87 (m, 1 H), 6.62 (dd, *J* = 8, 1.5 Hz, 1 H), 5.28 (m, 2 H), 3.90 (d, *J* = 14.0 Hz, 1 H), 3.26 (s, 3 H), 2.72 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 178.7 (s, C_q), 172.8 (s, C_q), 144.6 (s, C_q), 144.5 (s, C_q), 144.2 (s, C_q), 143.8 (s, C_q), 135.9 (s, C_q), 133.5 (s, C_q), 128.8 (s, CH), 128.7 (s, CH), 128.6 (s, CH), 128.3 (s, CH), 128.1 (s, CH), 128.0 (s, CH), 127.9 (s, CH), 127.1 (s, CH), 126.9 (s, CH), 123.8 (s, CH), 123.3 (s, CH), 122.8 (s, CH), 107.9 (s, CH), 67.3 (s, CH₂), 64.1 (s, C_q), 58.9 (s, C_q), 50.2 (s, CH₂), 26.5 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) *m/z* calcd for C₃₁H₂₆NO₃ [M+H]⁺ 460.1907, found 460.1912.

Data for compound 3c' (minor diastereomer). A second fraction of the chromatography



corresponded to a mixture of diasteromers **3c** and **3c'** in a 1:0.7 ratio (52 mg, 0.113 mmol, 38%). Selected NMR signals of **3c'** exctracted from the mixture of isomers **3c** and **3c'**: ¹H-NMR (300 MHz, CDCl₃) δ = 7.51-7.48 (m, 1 H), 5.35-5.20 (m, 2 H), 3.65 (d, *J* = 14.0 Hz, 1 H), 3.24 (s, 3 H), 2.93 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.4 (s, C_q), 174.2 (s, C_q), 144.9 (s, C_q),

143.9 (s, C_q), 143.1 (s, C_q), 135.5 (s, C_q), 134.9 (s, C_q), 124.3 (s, CH), 123.4 (s, CH), 123.1 (s, CH), 67.4 (s, CH₂), 65.3 (s, C_q), 59.6 (s, C_q), 49.1 (s, CH₂), 26.5 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) *m/z* calcd for $C_{31}H_{26}NO_3$ [M+H]⁺ 460.1907, found 460.1911.

Compound 3d. Prepared according to the procedure A from substrates 1a and 2d.



The reaction produced a mixture of diastereomers **3d** and **3d'** in a 2:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3d** and **3d'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (6:1). The minor diasteromer **3d'** was further repurified by preparative TLC chromatography (silica gel, toluene/EtOAc (6:1)). Data for compound **3d** (major

diastereomer): pale yellow oil (75 mg, 0.188 mmol, 63%). IR (cm⁻¹): ν (CO) 1714 (s), 1602 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.49-7.47 (m, 1 H), 7.25 (td, *J* = 7.2, 1.2 Hz, 1 H), 7.20-7.11 (m, 3 H), 7.02-6.97 (m, 3 H), 6.83-6.78 (m, 2 H), 6.61-6.58 (m, 2 H), 3.78 (d, *J* = 14.0 Hz, 1 H), 3.74 (s, 3 H), 3.17 (s, 3 H), 2.62 (d, *J* = 14.0 Hz, 1 H), 2.25 (s, 3 H). ¹³C-NMR (100.81 MHz, CDCl₃): δ = 178.6 (s, C_q), 173.5 (s, C_q), 144.6 (s, C_q), 144.4 (s, C_q), 144.3 (s, C_q), 143.8 (s, C_q), 138.2 (s, C_q), 133.5 (s, C_q), 128.6 (s, CH), 128.4 (s, CH), 128.3 (s, CH), 128.1 (s, CH), 127.9 (s, CH), 127.4 (s, CH), 123.9 (s, CH), 123.8 (s, CH), 123.2 (s, CH), 122.8 (s, CH), 107.9 (s, CH), 64.1 (s, C_q), 58.9 (s, C_q), 52.8 (s, CH₃), 50.3 (s, CH₂), 26.5 (s, CH₃), 21.6 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) *m/z* calcd for C₂₆H₂₄NO₃ [M+H]⁺ 398.1752, found 398.1751.

Data for compound 3d' (minor diastereomer): pale yellow oil (26 mg, 0.065 mmol,



22%). IR (cm⁻¹): ν (CO) 1714 (s), 1602 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.52-7.49 (m, 1 H), 7.34-7.19 (m, 5 H), 7.09-7.01 (m, 4 H), 6.90 (d, *J* = 7.8 Hz, 1 H), 6.73-6.70 (m, 1 H), 3.82 (s, 3 H), 3.65 (d, *J* = 14.0 Hz, 1 H), 3.26 (s, 3 H), 2.90 (d, *J* = 14.0 Hz, 1 H), 2.33 (s, 3 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.5 (s, C_q), 175.0 (s, C_q), 145.0 (s, C_q), 144.9 (s, C_q), 143.9 (s, C_q), 143.2 (s, C_q), 138.1 (s, C_q), 135.1 (s, C_q), 129.1 (s, CH), 128.3

(s, CH), 128.2 (s, CH), 128.1 (s, CH), 128.0 (s, CH), 127.8 (s, CH), 127.3 (s, CH), 124.3 (s, CH), 123.9 (s, CH), 123.5 (s, CH), 123.1 (s, CH), 107.9 (s, CH), 65.3 (s, C_q), 59.6 (s, C_q), 52.8 (s, CH₃), 49.1 (s, CH₂), 26.6 (s, CH₃), 21.6 (s, CH₃). HR-MS (+ESI) m/z calcd for C₂₆H₂₄NO₃ [M+H]⁺ 398.1752, found 398.1754.

Compound 3e. Prepared according to the procedure A from substrates 1a and 2e but



using a 10 mol% of Pd(OAc)₂ and a 20 mol% of PPh₃. The reaction produced a mixture of diastereomers **3e** and **3e'** in a 2.5:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3e** and **3e'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (2:1). Data for compound **3e** (major diastereomer): pale yellow oil (66 mg, 0.139 mmol, 46%). IR

(cm⁻¹): ν (CO) 1716 (s), 1611 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.68 (d, *J* = 7.6 Hz, 1 H), 7.36 (td, *J* = 7.2, 1.2 Hz, 1 H), 7.27-7.21 (m, 2 H), 7.69-7.87 (m, 2 H), 6.69 (d, *J* = 7.6 Hz, 1 H), 6.59 (dd, *J* = 8.0, 1.2 Hz, 1 H), 6.52 (s, 2 H), 3.88 (d partially obscured, *J* = 14.4 Hz, 1 H), 3.85 (s, 3 H), 3.82 (s, 3 H), 3.77 (s, 6 H), 3.26 (s, 3 H), 2.68 (d, *J* = 14.4 Hz, 1 H). ¹³C-NMR (100.81 MHz, CDCl₃): δ = 178.6 (s, C_q), 173.4 (s, C_q), 153.0 (s, C_q), 144.5 (s, C_q), 143.7 (s, C_q), 143.4 (s, C_q), 140.2 (s, C_q), 137.1 (s, C_q), 133.5 (s, C_q), 128.9 (s, CH), 128.5 (s, CH), 128.3 (s, CH), 127.9 (s, CH), 123.7 (s, CH), 123.4 (s, C_q), 158.8 (s, C_q), 56.1 (s, CH₃), 52.9 (s, CH₃), 49.9 (s, CH₂), 26.5 (s, CH₃). HR-MS (+ESI) *m/z* calcd for C₂₈H₂₈NO₆ [M+H]⁺474.1911, found 474.1925.

Data for compound **3e'** (minor diastereomer) pale yellow oil (25 mg, 0.052 mmol, 18%).



IR (cm⁻¹): v(CO) 1715 (s), 1611 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.56-7.54 (m, 1 H), 7.32-7.29 (m, 2 H), 7.22 (td, J = 7.5, 1.5 Hz, 1 H), 7.04-7.02 (m, 2 H), 6.90 (d, J = 7.8 Hz, 1 H), 6.73-6.70 (m, 1 H), 6.48 (s, 2 H), 3.84 (s, 3 H), 3.83 (s, 3 H), 3.79 (s, 6 H), 3.66 (d, J = 14.4 Hz, 1 H), 3.26 (s, 3 H), 2.91 (d, J = 14.4 Hz, 1 H).¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.6 (s, C_q), 174.9 (s, C_q), 153.1 (s, C_q), 145.0 (s, C_q), 143.8 (s, C_q), 143.1 (s, C_q), 140.8 (s, C_q), 135.2 (s, C_q), 129.3 (s, CH), 128.7

(s, CH), 128.2 (s, CH), 128.0 (s, CH), 127.3 (s, C_q), 124.2 (s, CH), 123.5 (s, CH), 123.1 (s, CH), 108.0 (s, CH), 104.2 (s, CH), 65.5 (s, C_q), 60.8 (s, CH₃), 59.6 (s, C_q), 56.1 (s, CH₃), 52.8 (s, CH₃), 48.9 (s, CH₂), 26.6 (s, CH₃). HR-MS (+ESI) m/z calcd for C₂₈H₂₈NO₆ [M+H]⁺ 474.1911, found 474.1920.

Compound 3f. Prepared according to the procedure A from substrates 1a and 2f. The



reaction produced a mixture of diastereomers **3f** and **3f'** in a 2.0:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3f** and **3f'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (5:1). Data for compound **3f** (major diastereomer): pale yellow solid (47 mg, 0.110 mmol, 37%). M.p.: 165 °C. IR (cm⁻¹): ν (CO) 1715 (s), 1611 (s). ¹H-NMR (300 MHz, CDCl₃) δ =

7.59-7.57 (br d, J = 7.5 Hz, 1 H), 7.35-7.31 (td, J = 7.8, 0.9 Hz, 1 H), 7.25-7.20 (m, 3 H), 6.94-6.86 (m, 2 H), 6.79-6.75 (m, 3 H), 6.67 (br d, 1 H), 5.95 (s, 2 H), 3.86 (d partially overlapped, J = 13.8 Hz, 1 H), 3.81 (s, 3 H), 3.24 (s, 3 H), 2.65 (d, J = 13.8 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): $\delta = 178.7$ (s, Cq), 173.6 (s, Cq), 147.9 (s, Cq), 146.6 (s, Cq), 144.4 (s, Cq), 144.1 (s, Cq), 143.8 (s, Cq), 138.7 (s, Cq), 133.5 (s, Cq), 128.8 (s, CH), 128.6 (s, CH), 128.3 (s, CH), 128.1 (s, CH), 123.8 (s, CH), 123.3 (s, CH), 122.9 (s, CH), 120.2 (s, CH), 108.0 (s, CH), 107.9 (s, CH), 107.7 (s, CH), 101.2 (s, CH₂), 63.8 (s, Cq), 58.8 (s, Cq), 52.9 (s, CH₃), 50.3 (s, CH₂), 26.5 (s, CH₃). HR-MS (+ESI) *m/z* calcd for C₂₆H₂₂NO₅ [M+H]⁺ 428.1492, found 428.1484.

Data for compound 3f' (minor diastereomer): pale yellow solid (19 mg, 0.044 mmol,



15%). M.p.: 170 °C. IR (cm⁻¹): ν (CO) 1715 (s), 1611 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.54-7.52 (br d, J = 7.5 Hz, 1 H), 7.32-7.31-7.21 (m, 3 H), 7.03-7.01 (m, 2 H), 6.90 (br d, J = 7.8 Hz, 1 H), 6.78-6.67 (m, 4 H), 5.92 (s, 2 H), 3.82 (s, 3 H), 3.66 (d, J = 14.0 Hz, 1 H), 3.25 (s, 3 H), 2.85 (d, J = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.4 (s, C_q), 174.9 (s, C_q), 147.8 (s, C_q), 146.5 (s, C_q), 144.9 (s, C_q), 143.8 (s, C_q), 143.2 (s, C_q), 139.1 (s, C_q), 135.0 (s, C_q), 129.2 (s, CH), 128.3 (s, CH), 128.2

(s, CH), 127.9 (s, CH), 124.3 (s, CH), 123.6 (s, CH), 123.1 (s, CH), 120.1 (s, CH), 108.0 (s, CH), 107.9 (s, CH), 107.7 (s, CH), 101.1 (s, CH₂), 64.9 (s, C_q), 59.5 (s, C_q), 52.9 (s, CH₃), 49.1 (s, CH₂), 26.6 (s, CH₃). HR-MS (+ESI) m/z calcd for C₂₆H₂₂NO₅ [M+H]⁺ 428.1492, found 428.1484.

Compound 3g. Prepared according to the procedure A from substrates 1a and 2g.



The reaction produced a mixture of diastereomers **3g** and **3g'** in a 2.2:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3g** and **3g'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (4:1). The minor diastereomer **3g'** was repurified by preparative TLC (silica gel, toluene/EtOAc (9:1)). Data for compound **3g** (major diastereomer): pale yellow solid (67 mg,

0.167 mmol, 56%). M. p.: 140 °C. IR (cm⁻¹): ν (CO) 1718 (s), 1611 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.56-7.54 (d, *J* = 7.5 Hz, 1 H), 7.37 (td, *J* = 7.8, 3.3 Hz, 1 H), 7.35-7.16 (m, 4 H), 7.04-6.99 (m, 2 H), 6.90-6.87 (m, 2 H), 6.69 (d, *J* = 7.8 Hz, 1 H), 6.60 (d, *J* = 7.8 Hz, 1 H), 3.86 (d, *J* = 13.8 Hz, 1 H), 3.82 (s, 3 H), 3.25 (s, 3 H), 2.66 (d, *J* = 13.8 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 178.6 (s, C_q), 173.4 (s, C_q), 161.7 (d, *J*_{CF} = 246.0 Hz, C_q), 144.4 (s, C_q), 143.9 (s, C_q), 143.8 (s, C_q), 140.3 (d, *J*_{CF} = 3.1 Hz, C_q), 133.3 (s, C_q), 128.8 (s, CH), 128.6 (s, CH), 128.5 (s, CH), 128.4 (s, CH), 128.3 (s, CH), 128.2 (s, CH), 63.5 (s, C_q), 58.8 (s, C_q), 52.9 (s, CH₃), 50.4 (s, CH₂), 26.5 (s, CH₃). ¹⁹F-NMR (300 MHz, CDCl₃) δ = -115.0 (s). HR-MS (+ESI) *m*/z calcd for C₂₅H₂₁FNO₃ [M+H]⁺ 402.1500, found 402.1505.

Data for compound 3g' (minor diastereomer): pale yellow solid (18 mg, 0.045 mmol,



15%). M. p.: 140 °C. IR (cm⁻¹): ν(CO) 1718 (s), 1611 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.51-7.49 (m, 1 H), 7.34-7.19 (m, 5 H), 7.06-6.99 (m, 4 H), 6.90-6.88 (m, 1 H), 6.70-6.68 (m, 1 H), 3.83 (s, 3 H), 3.67 (d, *J* = 14.2 Hz, 1 H), 3.24 (s, 3 H), 2.83 (d, *J* = 14.2 Hz, 1 H). ¹³C-NMR (100.81 MHz, CDCl₃): δ = 179.4 (s, C_q), 173.8 (s, C_q), 161.6 (d, *J*_{CF} = 184.0 Hz, C_q), 144.9 (s, C_q), 143.7 (s, C_q), 143.3 (s, C_q), 140.9 (d, *J*_{CF} = 3.0 Hz, C_q), 134.8 (s, C_q), 129.3 (s, CH), 128.6 (s, CH), 128.4 (d, *J*_{CF} = 24.3 Hz, CH), 128.3 (s, CH), 127.7 (s, CH),

124.2 (s, CH), 123.7 (s, CH), 123.2 (s, CH), 115.3 (d, J_{CF} = 16.0 Hz, CH), 107.9 (s, CH), 64.6 (s, C_q), 59.6 (s, C_q), 52.9 (s, CH₃), 49.1 (s, CH₂), 26.6 (s, CH₃). ¹⁹F-NMR (300 MHz, CDCl₃) δ = -115.5 (s). HR-MS (+ESI) *m/z* calcd for C₂₅H₂₁FNO₃ [M+H]⁺ 402.1500, found 402.1505.

Compound 3h. Prepared according to the procedure A from substrates 1a and 2h but



using a 10 mol% of Pd(OAc)₂ and a 20 mol% of PPh₃. The reaction produced a mixture of diastereomers **3h** and **3h'** in a 1.8:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3h** and **3h'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (7:1). The minor diastereomer **3h'** was repurified by preparative TLC (silica gel, toluene/EtOAc (6:1)).

Data for compound **3h** (major diastereomer): pale yellow oil (64 mg, 0.142 mmol, 47%). IR (cm⁻¹): ν (CO) 1718 (s), 1615 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.60 (br d, *J* = 8.1 Hz, 2 H), 7.52-7.49 (m, 1 H), 7.43 (br d, *J* = 8.1 Hz, 2 H), 7.36 (td, *J* = 7.2, 1.2 Hz, 1 H), 7.28 (td, *J* = 7.5, 1.2 Hz, 1 H), 7.24 (td, *J* = 7.5, 1.2 Hz, 1 H), 6.95-6.88 (m, 2 H), 6.71-6.65 (m, 2 H), 3.89 (d, *J* = 14.0 Hz, 1 H), 3.84 (s, 3 H), 3.24 (s, 3 H), (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 178.4 (s, C_q), 173.0 (s, C_q), 148.7 (s, C_q), 144.6 (s, C_q), 144.0 (s, C_q), 143.6 (s, C_q), 133.1 (s, C_q), 129.1 (s, CH), 128.6 (s, CH), 128.5 (s, CH), 128.4 (s, CH), 127.3 (s, CH), 125.6 (q, *J*_{C-F} = 3.5 Hz, CH), 123.6 (s, CH), 123.5 (s, CH), 122.9 (s, CH), 108.1 (s, CH), 64.1 (s, C_q), 58.9 (s, C_q), 53.0 (s, CH₃), 50.4 (s, CH₂), 26.5 (s, CH₃). Two C_q signals are not observed. ¹⁹F-NMR (282.40 MHz): -62.2 (s). HR-MS (+ESI) *m/z* calcd for C₂₆H₂₁F₃NO₃ [M+H]⁺ 452.1468, found 452.1469.

Data for compound 3h' (minor diastereomer): Pale yellow oil (11 mg, 0.024 mmol, 8%).



IR (cm⁻¹): ν (CO) 1718 (s), 1613 (s). ¹H-NMR (300 MHz, CDCl₃) $\delta = 7.58$ (br d, J = 8.4 Hz, 2 H), 7.52-7.49 (m, 1 H), 7.35 (br d, J = 8.4 Hz, 2 H), 7.31-7.23 (m, 3 H), 7.10-7.04 (m, 2 H), 6.90 (d, J = 7.8 Hz, 1 H), 6.74-6.71 (m, 1 H), 3.84 (s, 3 H), 3.74 (d, J = 14.4 Hz, 1 H), 3.24 (s, 3 H), 2.83 (d, J = 14.4 Hz, 1 H).¹³C-NMR (75.45 MHz, CDCl₃): $\delta = 179.3$ (s, C_q), 174.4 (s, C_q), 149.0 (br s, C_q), 145.1 (s, C_q), 143.3 (s, C_q), 143.0 (s, C_q), 134.7 (s, C_q), 129.5 (s, CH), 128.5 (s, CH), 128.4 (s, CH), 127.6 (s, CH), 127.4

(s, CH), 125.5 (q, J_{C-F} = 3.7 Hz, CH), 123.3 (s, CH), 123.8 (s, CH), 123.2 (s, CH), 108.0 (s, CH), 65.1 (s, C_q), 59.6 (s, C_q), 53.1 (s, CH₃), 48.7 (s, CH₂), 26.6 (s, CH₃). Two C_q signals are not observed. ¹⁹F-NMR (282.40 MHz): – 62.1 (s). HR-MS (+ESI) *m/z* calcd for C₂₆H₂₁F₃NO₃ [M+H]⁺ 452.1468, found 452.1470.

Compound 3i. Prepared according to the procedure A from substrates 1a and 2i. The



reaction produced a mixture of diastereomers **3i** and **3i'** in a 1.9:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3i** and **3i'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (3:1). Data for compound **3i** (major diastereomer): pale yellow solid (63 mg, 0.145 mmol, 48%). M. p.: 83 °C. IR (cm⁻¹): ν (CO) 1721 (s),1644 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.75-7.69 (m, 3 H), 7.63 (d, *J* = 1.8

Hz, 1 H), 7.52-7.49 (m, 1 H), 7.42-7.37 (m, 2 H), 7.32-7.25 (m, 2 H), 7.19-7.14 (m, 3 H), 6.80-6.74 (m, 2 H), 6.64-6.61 (m, 1 H), 3.87 (d, J = 14.0 Hz, 1 H), 3.78 (s, 3 H), 3.17 (s, 3 H), 2.72 (d, J = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): $\delta = 178.7$ (s, C_q), 173.6 (s, C_q), 144.5 (s, C_q), 144.2 (s, C_q), 143.8 (s, C_q), 141.9 (s, C_q), 133.5 (s, C_q), 132.9 (s, C_q), 132.3 (s, C_q), 128.8 (s, CH), 128.7 (s, CH), 128.6 (s, CH), 128.3 (s, CH), 128.2 (s, CH), 127.4 (s, CH), 126.3 (s, CH), 107.9 (s, CH), 64.4 (s, C_q), 58.9 (s, C_q), 52.9 (s, CH₃), 50.1 (s, CH₂), 26.5 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) *m/z* calcd for C₂₉H₂₄NO₃ [M+H]⁺ 434.1751, found 434.1754.

Data for compound 3i' (minor diastereomer): pale yellow solid (23 mg, 0.053 mmol,



18%). M. p.: 81 °C. IR (cm⁻¹): v(CO) 1719 (s), 1610 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.76-7.68 (m, 3 H), 7.60-7.59 (m, 1 H), 7.48-7.46 (m, 1 H), 7.39-7.33 (m, 2 H), 7.32-7.18 (m, 4 H), 7.04-6.94 (m, 2 H), 6.84-6.82 (m, 1 H), 6.70-6.67 (m, 1 H), 3.78 (s, 3 H), 3.69 (d, J = 14.0 Hz, 1 H), 3.18 (s, 3 H), 2.92 (d, J = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.4 (s, C_q), 179.9 (s, C_q), 145.0 (s, C_q), 143.8 (s, C_q), 142.3 (s, C_q), 135.0 (s, C_q), 133.1 (s, C_q), 132.3 (s, C_q), 129.3 (s, CH), 128.5 (s, CH), 128.4 (s, CH),

128.2 (s, CH), 128.0 (s, CH), 127.5 (s, CH), 126.1 (s, CH), 125.9 (s, CH), 125.3 (s, CH), 124.3 (s, CH), 123.6 (s, CH), 123.1 (s, CH), 107.9 (s, CH), 65.4 (s, C_q), 59.6 (s, C_q), 52.9 (s, CH₃), 48.9 (s, CH₂), 26.6 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) m/z calcd for C₂₉H₂₄NO₃ [M+H]⁺ 434.1751, found 434.1746.

Compound 3j. Prepared according to procedure **A** from substrates **1a** and **2j**. The reaction produced a mixture of diasteroisomers **3j** and **3j**' in a ratio of 1.1:1 (determined from the ¹H-NMR spectrum of the crude reaction mixture) in a 45% NMR yield. We could only purify the major diasteroisomer **3j** after column chromatography (silica gel, toluene/EtOAc 12% EtOAc). The minor diasteroisomer **3j**' was obtained along with some unidentified impurities.

Data for compound 3j (major diasteroisomer): pale yellow oil (24 mg, 0.07 mmol, 23%). IR



(cm⁻¹): ν (CO) 1718 (s), 1612 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.51 (d, J = 7.6 Hz, 1 H), 7.27-7.23 (m, 2 H), 7.05 (td, J = 7.6, 0.8 Hz, 1 H), 6.98-6.96 (m, 2 H), 6.82 (d, J = 7.6 Hz, 1 H), 6.48 (d, J = 8.0 Hz, 1 H), 4.20-4.10 (m, 2 H), 3.32 (d, J = 13.6 Hz, 1 H), 3.14 (s, 3 H), 2.27 (d, J = 13.6 Hz, 1 H), 2.24-2.19 (m, 1 H), 1.91-1.86 (m, 1 H), 1.22 (t, J = 7.2 Hz, 3 H), 0.91 (t, J = 7.6 Hz, 3 H). ¹³C-NMR

(75.45 MHz, CDCl₃): δ = 178.9 (s, C_q), 174.3 (s, C_q), 145.7 (s, C_q), 144.3 (s, C_q), 143.3 (s, C_q), 134.1 (s, C_q), 128.4 (s, CH), 128.2 (s, CH), 128.0 (s, CH), 126.4 (s, CH), 123.5 (s, CH), 123.2 (s, CH), 122.8 (s, CH), 107.9 (s, CH), 61.1 (s, CH₂), 59.1(s, C_q), 58.6 (s, C_q), 44.4 (s, CH₂), 34.24(s, CH₂), 26.4 (s, CH₃), 14.2 (s, CH₃), 9.5 (s, CH₃). HR-MS (+ESI) *m/z* calcd for C₂₂H₂₄NO₃ [M+H]⁺ 350.1751, found 350.1758.

Representative ¹H-NMR data for compound **3j**' (minor diasteroisomer) extracted from the mixture obtained from the chromatography column: ¹H-NMR (300 MHz, CDCl₃) δ = 7.48 (d, *J* = 7.8 Hz, 1 H), 6.84 (d, *J* = 7.5 Hz, 1 H), 6.57 (d, *J* = 7.8 Hz, 1 H), 4.18-4.12 (m, 2 H), 3.12 (d, *J* = 14.1 Hz, 1 H), 2.56 (d, *J* = 14.1 Hz, 1 H), 2.33-2.29 (m, 1 H), 2.12-2.05 (m, 1 H), 0.92 (t, *J* = 7.5 Hz, 3 H), 0.58 (t, *J* = 7.2 Hz, 3 H).

Compound 3k. Prepared according to the procedure A from substrates 1b and 2a.



The reaction produced a mixture of diastereomers **3k** and **3k'** in a 2.1:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3k** and **3k'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (5:1). Data for compound **3k** (major diastereomer): pale yellow oil (78 mg, 0.196 mmol, 65%). IR

(cm⁻¹): v(CO) 1714 (s), 1620 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.58 (d, J = 7.6 Hz, 1 H), 7.37-7.29 (m, 6 H), 7.22 (td, J = 7.6, 1.2 Hz, 1 H), 7.05-7.02 (m, 1 H), 6.75 (d, J = 8.0 Hz, 1 H), 6.70 (br d, J = 7.6 Hz, 1 H), 6.36 (br s, 1 H), 3.86 (d partially overlapped, J = 14.0 Hz, 1 H), 3.83 (s, 3 H), 3.23 (s, 3 H), 2.70 (d, J = 14.0 Hz, 1 H), 2.10 (s, 3 H).

¹³C-NMR (100.81 MHz, CDCl₃): $\delta = 178.7$ (s, C_q), 173.6 (s, C_q), 144.7 (s, C_q), 144.6 (s, C_q), 144.2 (s, C_q), 141.4 (s, C_q), 133.5 (s, C_q), 132.3 (s, C_q), 128.7 (s, CH), 128.6 (s, CH), 128.4 (s, CH), 128.0 (s, CH), 127.1 (s, CH), 127.0 (s, CH), 124.7 (s, CH), 123.4 (s, CH), 107.6 (s, CH), 64.1 (s, C_q), 58.9 (s, C_q), 52.8 (s, CH₃), 50.3 (s, CH₂), 26.5 (s, CH₃), 20.9 (s, CH₃). One of the aromatic CH signal is overlapped. HR-MS (+ESI) *m/z* calcd for C₂₆H₂₄NO₃ [M+H]⁺ 398.1751, found 398.1751.

Data for compound 3k' (minor diastereomer): pale yellow oil (27 mg, 0.068 mmol,



22%). IR (cm⁻¹): ν (CO) 1714 (s), 1620 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.52-7.50 (m, 1 H), 7.36-7.20 (m, 6 H) 7.09 (m, 2 H), 6.84 (br d, *J* = 1.2 Hz, 1 H), 6.78 (d, *J* = 7.8 Hz, 1 H), 6.73-6.71 (m, 1 H), 3.83 (s, 3 H), 3.67 (d, *J* = 14.0 Hz, 1 H), 3.23 (s, 3 H), 2.90 (d, *J* = 14.0 Hz, 1 H), 2.27 (s, 3 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.3 (s, C_a), 175.0 (s, C_a), 145.1 (s, C_a),

143.9 (s, C_q), 140.8 (s, C_q), 135.0 (s, C_q), 132.6 (s, C_q), 129.1 (s, CH), 128.4 (s, CH), 128.2 (s, CH), 127.9 (s, CH), 126.92 (s, CH), 126.88 (s, CH), 125.0 (s, CH), 123.6 (s, CH), 107.7 (s, CH), 65.2 (s, C_q), 59.7 (s, C_q), 52.8 (s, CH₃), 49.2 (s, CH₂), 26.6 (s, CH₃), 21.2 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) *m/z* calcd for $C_{26}H_{24}NO_3$ [M+H]⁺ 398.1751, found 398.1751.

Compound 3I. Prepared according to the procedure A from substrates 1c and 2a. The



reaction produced a mixture of diastereomers **3I** and **3I'** in a 2.0:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3I** and **3I'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (5:1). The minor diasteromer **3I'** was

further repurified by preparative TLC chromatography (silica gel, petroleum ether /EtOAc (3:1)). Data for compound **3I** (major diastereomer): pale yellow oil (69 mg, 0.167 mmol, 56%). IR (cm⁻¹): ν (CO) 1717 (s), 1611 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.65-7.63 (m, 1 H), 7.39-7.21 (m, 8 H), 6.75-6.71 (m, 2 H), 6.08-6.07 (m, 1 H), 3.90 (d, J = 14.0 Hz, 1 H), 3.81 (s, 3 H), 3.46 (s, 3 H), 3.23 (s, 3 H), 2.72 (d, J = 14.0 Hz, 1 H). ¹³C-NMR (100.81 MHz, CDCl₃): δ = 178.6 (s, C_q), 173.6 (s, C_q), 156.1 (s, C_q), 144.7 (s, C_q), 144.6 (s, C_q), 143.7 (s, C_q), 137.0 (s, C_q), 134.9 (s, C_q), 128.9 (s, CH), 128.6 (s, CH), 128.5 (s, CH), 128.1 (s, CH), 127.2 (s, CH), 127.1 (s, CH), 123.5 (s, CH), 113.4 (s, CH), 110.6 (s, CH), 108.3 (s, CH), 64.0 (s, C_q), 59.4 (s, C_q), 55.6 (s, CH₃), 52.8 (s, CH₂), 50.1 (s, CH₃), 26.6 (s, CH₃). HR-MS (+ESI) *m*/*z* calcd for C₂₆H₂₄NO₄ [M+H]⁺ 414.1700, found 414.1694.

Data for compound **3I'** (minor diastereomer): pale yellow oil (31 mg, 0.075 mmol, 25%).



IR (cm⁻¹): ν (CO) 1717 (s), 1611 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.52-7.49 (m, 1 H), 7.36-7.27 (m, 5 H), 7.25-7.08 (m, 2 H), 6.84-6.79 (m, 2 H), 6.73 (d, *J* = 7.5 Hz, 1 H), 6.70-6.69 (m, 1 H), 3.82 (s, 3 H), 3.74 (s, 3 H), 3.65 (d, *J* = 14.0 Hz, 1 H), 3.23 (s, 3 H), 2.90 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.1 (s, C_q), 175.0 (s, C_q), 156.3 (s,

C_q), 145.1 (s, C_q), 144.9 (s, C_q), 143.9 (s, C_q), 136.7 (s, C_q), 136.3 (s, C_q), 129.2 (s, CH), 128.4 (s, CH), 128.3 (s, CH), 127.9 (s, CH), 126.9 (s, CH), 126.8 (s, CH), 123.6 (s, CH), 112.7 (s, CH), 111.6 (s, CH), 108.2 (s, CH), 65.3 (s, C_q), 60.0 (s, C_q), 55.7 (s, CH₃), 52.9 (s, CH₂), 49.1 (s, CH₃), 26.7 (s, CH₃). HR-MS (+ESI) *m/z* calcd for $C_{26}H_{24}NO_4 [M+H]^+ 414.1700$, found 414.1695.

Compound 3m. Prepared according to the procedure A from substrates 1d and 2a.



The reaction produced a mixture of diastereomers **3m** and **3m'** in a 2.1:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3m** and **3m'** were purified by preparative TLC chromatography (silica gel, toluene/EtOAc (6:1)). Data for compound **3m** (major diastereomer): pale yellow oil (62 mg, 0.148 mmol, 49%). IR

(cm⁻¹): v(CO) 1722 (s), 1609 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.58 (br d, *J* = 8.0 Hz, 1 H), 7.38-7.20 (m, 8 H), 6.78 (d, *J* = 8.4 Hz, 1 H), 6.70-6.67 (m, 1 H), 6.50 (d, *J* = 2.4 Hz, 1 H), 3.86 (d, *J* = 14.0 Hz, 1 H), 3.82 (s, 3 H), 3.23 (s, 3 H), 2.68 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (100.81 MHz, CDCl₃): 178.2 (s, C_q), 173.4 (s, C_q), 144.3 (s, C_q), 144.2 (s, C_q), 143.7 (s, C_q), 142.3 (s, C_q), 135.0 (s, C_q), 128.9 (s, CH), 128.7 (s, CH), 128.4 (s, CH), 128.2 (s, CH), 128.1 (s, C_q), 127.4 (s, CH), 126.9 (s, CH), 124.4 (s, CH), 123.3 (s, CH), 108.8 (s, CH), 64.0 (s, C_q), 59.0 (s, C_q), 52.9 (s, CH₃), 50.3 (s, CH₂), 26.6 (s, CH₃). Some signals are overlapped. HR-MS (+ESI) *m/z* calcd for C₂₅H₂₁CINO₃ [M+H]⁺ 418.1205, found 418.1198.

Data for compound 3m' (minor diastereomer): pale yellow oil (24 mg, 0.057 mmol,



19%). IR (cm⁻¹): ν (CO) 1722 (s), 1609 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.53-7.51 (m, 1 H), 7.36-7.32 (m, 3 H), 7.28-7.21 (m, 5 H), 7.03 (d, *J* = 2.4 Hz, 1 H), 6.82 (d, *J* = 8.4 Hz, 1 H), 6.71 (m, 1 H), 3.84 (s, 3 H), 3.65 (d, *J* = 14.0 Hz, 1 H), 3.24 (s, 3 H), 2.88 (d, *J* = 14.0 Hz, 1 H).¹³C-NMR (100.81 MHz, CDCl₃): 178.9

(s, C_q), 174.8 (s, C_q), 144.8 (s, C_q), 144.2 (s, C_q), 143.9 (s, C_q), 141.8 (s, C_q), 136.5 (s, C_q), 129.3 (s, CH), 128.6 (s, CH), 128.5 (s, CH), 128.3 (s, C_q), 128.2 (s, CH), 128.0 (s,

CH), 127.0 (s, CH), 126.8 (s, CH), 124.9 (s, CH), 123.5 (s, CH), 108.9 (s, CH), 65.3 (s, C_q), 59.7 (s, C_q), 53.0 (s, CH₃), 49.1 (s, CH₂), 26.7 (s, CH₃). HR-MS (+ESI) *m/z* calcd for $C_{25}H_{21}CINO_3$ [M+H]⁺ 418.1205, found 418.1198.

Compound 3n. Prepared according to the procedure A from substrates 1e and 2a.



The reaction produced a mixture of diastereomers **3n** and **3n'** in a 2.1:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3n** and **3n'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (6:1). The minor diasteromer **3n'** was further repurified by preparative TLC chromatography (silica gel

toluene/EtOAc (7:1)). Data for compound **3n** (major diastereomer): pale yellow oil (74 mg, 0.184 mmol, 61%). IR (cm⁻¹): ν (CO) 1716 (s), 1620 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.59 (br d, *J* = 7.2 Hz, 1 H), 7.38-7.21 (m, 7 H), 6.93 (td, *J* = 2.7, 8.7 Hz, 1 H), 6.80-6.76 (m, 1 H), 6.71-6.68 (m, 1 H), 6.27 (dd, *J* = 8.1, 2.7 Hz, 1 H), 3.90 (d, *J* = 14.0 Hz, 1 H), 3.81 (s, 3 H), 3.23 (s, 3 H), 2.67 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 178.4 (s, Cq), 173.4 (s, Cq), 160.8 (d, *J*_{CF} = 240.8 Hz, Cq), 144.4 (s, Cq), 144.0 (s, Cq), 143.8 (s, Cq), 139.7 (d, *J*_{CF} = 1.5 Hz, Cq), 135.0 (d, *J*_{CF} = 8.0 Hz, Cq), 128.8 (s, CH), 128.7 (s, CH), 128.6 (s, CH), 128.3 (s, CH), 127.3 (s, CH), 126.8 (s, CH), 123.2 (s, CH), 114.5 (d, *J*_{CF} = 23.5 Hz, CH), 112.0 (d, *J*_{CF} = 25.2 Hz, CH), 108.4 (d, *J*_{CF} = 8.1 Hz, CH), 64.0 (s, Cq), 58.2 (s, Cq), 52.8 (s, CH₃), 50.2 (s, CH₂), 26.7 (s, CH₃). ¹⁹F-NMR (300 MHz, CDCl₃) δ = -119.7 (s). HR-MS (+ESI) *m*/z calcd for C₂₅H₂₁FNO₃ [M+H]⁺ 402.1500, found 402.1514.

Data for compound 3n' (minor diastereomer). This diastereomer was obtained along



with a non-identified impurity which signals have been marked with an asterisk in the spectra. Pale yellow oil (25 mg, 0.062 mmol, 21%). IR (cm⁻¹): v(CO) 1716 (s), 1620 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.52 (m, 1 H), 7.37-7.21 (m, 7 H), 6.84-6.80 (m, 2 H), 6.72-6.70 (m, 1 H), 6.66-6.64 (m, 1 H), 3.83 (s, 3 H), 3.65 (d, *J* = 14.0 Hz, 1 H), 3.24 (s, 3 H), 2.87 (d, *J* = 14.0 Hz, 1 H).

¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.0 (s, C_q), 174.9 (s, C_q), 160.8 (d, J_{CF} = 242.0 Hz, C_q), 144.9 (s, C_q), 144.5 (s, C_q), 144.4 (s, C_q), 143.9 (s, C_q), 136.0 (d, J_{CF} = 8.0 Hz, C_q), 128.8 (s, CH), 128.5 (s, CH), 127.2 (s, CH), 127.1 (s, CH), 127.0 (s, CH), 126.8 (s, CH), 123.5 (s, CH), 114.5 (d, J_{CF} = 24.0 Hz, CH), 112.6 (d, J_{CF} = 25.0 Hz, CH), 108.4 (d, J_{CF} = 8.0 Hz, CH), 65.3 (s, C_q), 59.9 (s, C_q), 52.9 (s, CH₃), 48.9 (s, CH₂), 26.5 (s, CH)

CH₃). ¹⁹F-NMR (300 MHz, CDCl₃) δ = -119.4 (s). HR-MS (+ESI) *m*/z calcd for C₂₅H₂₁FNO₃ [M+H]⁺ 402.1500, found 402.1514.

Compound 3o. Prepared according to the procedure A from substrates 1f and 2a. The



reaction produced a mixture of diastereomers **3o** and **3o'** in a 2.1:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3o** and **3o'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (5:1). Data for compound **3o** (major diastereomer): pale yellow oil (73 mg, 0.178 mmol, 59%). IR (cm⁻¹): v(CO)

1728 (s), 1614 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.65 (br d, *J* = 7.5 Hz, 1 H), 7.56 (dd, *J* = 8.1, 1.5 Hz, 1 H), 7.42-7.33 (m, 4 H), 7.28-7.23 (m, 3 H), 6.93 (d, *J* = 8.1 Hz, 1 H), 6.70 (d, *J* = 1.2 Hz, 1 H), 6.67 (d, *J* = 7.5 Hz, 1 H), 3.88 (d, *J* = 14.0 Hz, 1 H), 3.82 (s, 3 H), 3.28 (s, 3 H), 2.69 (d, *J* = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 178.3 (s, C_q), 173.2 (s, C_q), 147.5 (s, C_q), 144.1 (s, C_q), 143.9 (s, C_q), 142.9 (s, C_q), 134.5 (s, C_q), 133.5 (s, C_q), 129.0 (s, CH), 128.8 (s, CH), 128.7 (s, CH), 128.6 (s, CH), 127.4 (s, CH), 127.2 (s, CH), 126.8 (s, CH), 123.1 (d, CH), 118.7 (s, C_q), 108.4 (s, CH), 105.9 (s, CH), 64.0 (s, C_q), 58.4 (s, C_q), 52.9 (s, CH₃), 50.2 (s, CH₂), 26.7 (s, CH₃). One C_q signal is not observed. HR-MS (+ESI) *m*/*z* calcd for C₂₆H₂₁N₂O₃ [M+H]⁺ 409.1547, found 409.1557.

Data for compound 3o' (minor diastereomer). This diastereomer was obtained along



with a non-identified impurity which signals have been marked with an asterisk in the spectra. Pale yellow oil (20 mg, 0.049 mmol, 16%). IR (cm⁻¹): ν (CO) 1728 (s), 1614 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.67-7.62 (m, 2 H), 7.56-7.54 (br d, *J* = 8.0 Hz, 1 H), 7.39-7.24 (m, 5 H), 7.22-7.20 (m, 2 H), 6.97 (d, *J* =

8.0 Hz, 1 H), 6.68 (d, J = 7.6 Hz, 1 H), 3.84 (s, 3 H), 3.66 (d, J = 14.0 Hz, 1 H), 3.30 (s, 3 H), 2.84 (d, J = 14.0 Hz, 1 H). ¹³C-NMR (100.81 MHz, CDCI₃): $\delta = 179.1$ (s, C_q), 174.7 (s, C_q), 147.0 (s, C_q), 144.6 (s, C_q), 143.9 (s, C_q), 143.6 (s, C_q), 135.0 (s, C_q), 134.0 (s, CH), 133.6 (s, CH), 129.0 (s, CH), 128.9 (s, CH), 128.6 (s, CH), 128.5 (s, CH), 127.2 (s, CH), 127.1 (s, CH), 126.7 (s, CH), 119.1 (s, C_q), 108.4 (s, CH), 65.3 (s, C_q), 59.2 (s, C_q), 53.2 (s, CH₃), 49.0 (s, CH₂), 26.8 (s, CH₃). One C_q signal is not observed. HR-MS (+ESI) *m/z* calcd for C₂₆H₂₁N₂O₃ [M+H]⁺ 409.1547, found 409.1557.

Compound 3p. Prepared according to the procedure A from substrates 1g and 2a.



The reaction produced a mixture of diastereomers **3p** and **3p'** in a 2.0:1 ratio (determined from the ¹H-NMR spectrum of the crude reaction mixture). The diastereomers **3p** and **3p'** were purified by preparative TLC chromatography (silica gel, petroleum ether/EtOAc (5:1). The minor diasteromer **3p'** was further repurified by preparative TLC

chromatography (silica gel toluene/EtOAc (6:1)). Data for compound **3p** (major diastereomer): pale yellow solid (65 mg, 0.147 mmol, 49%). M. p.: 200 °C. IR (cm⁻¹): ν (CO) 1732 (s), 1710 (s), 1619 (s). ¹H-NMR (300 MHz, CDCl₃) δ = 7.54-7.50 (m, 2 H), 7.44 (br d, J = 1.2 Hz, 1 H), 7.31-7.12 (m, 7 H), 6.59-6.54 (m, 2 H), 3.82 (d partially overlapped, J = 14.0 Hz, 1 H), 3.83 (s, 3 H), 3.75 (s, 3 H), 3.22 (s, 3 H), 2.64 (d, J = 14.0 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 178.3 (s, C_q), 173.3 (s, C_q), 166.6 (s, C_q), 144.4 (s, C_q), 144.2 (s, C_q), 141.1 (s, C_q), 143.7 (s, C_q), 138.6 (s, C_q), 130.4 (s, C_q), 128.9 (s, CH), 128.7 (s, CH), 128.6 (s, CH), 128.4 (s, CH), 127.3 (s, CH), 127.0 (s, C_q), 52.9 (s, CH₃), 52.3 (s, CH₃), 50.2 (s, CH₂), 26.7 (s, CH₃). HR-MS (+ESI) *m/z* calcd for C₂₇H₂₄NO₅ [M+H]⁺ 442.1649, found 442.1652.

Data for compound 3p' (minor diastereomer): pale yellow solid (15 mg, 0.034 mmol,



11%). M. p.: 210 °C. IR (cm⁻¹): v(CO) 1733 (s), 1710 (s), 1620 (s). ¹H-NMR (400 MHz, CDCl₃) δ = 7.75 (dd, J = 8.0, 1.6 Hz, 1 H), 7.56 (d, J = 1.2 Hz, 1 H), 7.52 (br d, J = 7.6 Hz, 1 H), 7.39-7.20 (m, 7 H), 7.11 (d, J = 8.0 Hz, 1 H), 6.62 (d, J = 7.6 Hz, 1 H), 3.87 (m, 3 H), 3.76 (m, 3 H), 3.62 (d, J

= 14.4 Hz, 1 H), 3.23 (s, 3 H), 2.82 (d, J = 14.4 Hz, 1 H). ¹³C-NMR (75.45 MHz, CDCl₃): δ = 179.1 (s, C_q), 174.9 (s, C_q), 166.7 (s, C_q), 144.9 (s, C_q), 144.2 (s, C_q), 143.9 (s, C_q), 143.5 (s, C_q), 140.0 (s, C_q), 130.3 (s, C_q), 129.3 (s, CH), 128.5 (s, CH), 128.1 (s, CH), 127.2 (s, CH), 126.8 (s, CH), 124.9 (s, CH), 124.2 (s, CH), 123.5 (s, CH), 123.3 (s, CH), 108.7 (s, CH), 65.4 (s, C_q), 59.7 (s, C_q), 53.0 (s, CH₃), 52.3 (s, CH₃), 48.9 (s, CH₂), 26.8 (s, CH₃). HR-MS (+ESI) *m*/*z* calcd for C₂₇H₂₄NO₅ [M+H]⁺ 442.1649, found 442.1652.

References

[1] M. Pérez-Gómez and J. A. García-López, *Angew. Chem. Int. Ed.* 2016, **55**, 14389 - 14393.

[2] For the synthesis of α -diazocarbonylcompounds see for example: a) S. Muthusamy and M. Sivaguru, *Org.Lett.* 2014, **16**, 4248–4251; b) Z. Song, Y. Wu, T. Xin, C. Jin, X. Wen, H. Sun, and Q.-L. Xu, *Chem.Commun.*, 2016, **52**, 6079.

[3] L. Huang and W. D. Wulff, *J. Am. Chem. Soc.* 2011, **133**, 8892.

Crystal Data and Structure Refinement Details for Compound 3b

Empirical formula	$C_{26}H_{23}NO_3$			
Formula weight	397.45			
Temperature	100(2) K			
Wavelength	0.71073 Å			
Crystal system	Monoclinic			
Space group	P2 ₁ /c			
Unit cell dimensions	a = 10.1626(6) Å	<i>α</i> = 90°.		
	b = 8.6719(5) Å	$\beta = 92.173(2)^{\circ}.$		
	c = 22.3916(13) Å	$\gamma = 90^{\circ}.$		
Volume	1971.9(2) Å ³			
Z	4			
Density (calculated)	1.339 Mg/m ³			
Absorption coefficient	0.087 mm ⁻¹			
F(000)	840			
Crystal size	0.260 x 0.250 x 0.140 mm ³			
Theta range for data collection	1.820 to 28.280°.			
Index ranges	-13<=h<=13, -11<=k<=11, -29<=l<=29			
Reflections collected	178328			
Independent reflections	4898 [R(int) = 0.0618]			
Completeness to theta = 28.280°	100.0 %			
Absorption correction	Semi-empirical from equivalents			
Max. and min. transmission	0.7465 and 0.7128			
Refinement method	Full-matrix least-squares on F ²			
Data / restraints / parameters	4898 / 0 / 273			
Goodness-of-fit on F ²	1.057			
Final R indices [I>2sigma(I)]	R1 = 0.0427, wR2 = 0.1000			
R indices (all data)	R1 = 0.0525, wR2 = 0.1057			
Largest diff. peak and hole	0.357 and -0.233 e.Å ⁻³			



¹H- and ¹³C-NMR spectra of diastereoisomer **3a**.

21

¹H- and ¹³C-NMR spectra of diastereoisomer **3a'**.

22

¹H- and ¹³C-NMR spectra of diastereoisomer **3b**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3b'**.

 1 H- and 13 C-NMR spectra of diastereoisomer **3c**.

¹H- and ¹³C-NMR spectra of the mixture of diastereoisomers 3c and 3c'.

26

¹H- and ¹³C-NMR spectra of diastereoisomer **3d**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3d'**.

28

¹H- and ¹³C-NMR spectra of diastereoisomer **3e**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3e'**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3f**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3f**'.

¹H- and ¹³C-NMR spectra of diastereoisomer **3g'**.

190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

¹H- and ¹³C-NMR spectra of diastereoisomer **3h**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3h'**.

ppm

¹H- and ¹³C-NMR spectra of diastereoisomer **3i**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3**j.

¹H- and ¹³C-NMR spectra of diastereoisomer **3k'**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3**I.

¹H- and ¹³C-NMR spectra of diastereoisomer **3l**'.

¹H- and ¹³C-NMR spectra of diastereoisomer **3m**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3m'**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3n**.

¹H- and ¹³C-NMR spectra of diastereoisomer **3n'**. The signals marked with an asterisk correspond to non identified impurities which could not be removed.

47

¹H- and ¹³C-NMR spectra of diastereoisomer **30**.

¹H- and ¹³C-NMR spectra of diastereoisomer **30'**. The signals marked with an asterisk correspond to non identified impurities which could not be removed.

49

¹H- and ¹³C-NMR spectra of diastereoisomer **3p**.

NOESY spectrum of diasteromer 3k

