Supplementary Material (ESI) for Chemical Communications

Supporting Information

for

A new consecutive three-component oxazole synthesis by an amidation-coupling-cycloisomerization (ACCI) sequence

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SUPPORTING INFORMATION

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I. Experimental section

General Considerations. All reactions involving water-sensitive compounds were carried out in oven-dried Schlenk glassware under an argon atmosphere. The solvents were dried according to standard procedures[1] and were distilled prior to use. Column chromatography: silica gel 60 M (mesh 230-400) Macherey-Nagel. Thin layer chromatography (TLC): silica gel layered aluminium foil (60 F_{254} Merck, Darmstadt). Melting points (uncorrected): Reichert-Jung Thermovar and Büchi Melting Point B-540. Acid chlorides **3**, propargyl amine (**4**), *p*-iodo anisole (**7**), PTSA · H_2O, $PdCl_2(PPh_3)_2$, and CuI were purchased from ACROS, Aldrich Chemie GmbH, Fluka AG, Lancaster AG, or Merck KGaA and used without further purification. ^{1}H and ^{13}C NMR spectra: Bruker ARX250, Bruker DRX 300 with Aceton-d_6, $CDCl_3$ or DMSO-d_6 as solvents. The assignments of quaternary C, CH, CH_2 and CH_3 were made on the basis of DEPT spectra. IR: Bruker Vector 22 FT-IR. UV/Vis: Hewlett Packard HP8452 A. MS: Jeol JMS-700 und Finnigan TSQ 700. Elemental analyses were carried out in the microanalytical laboratory of the Department Chemie der Universität Heidelberg.

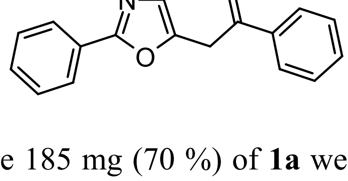
General procedure for the three-component synthesis of 1-(hetero)aryl-2-(2-(hetero)aryl-oxazol-5-yl) ethanones 1.

To a solution of 56 mg (1.00 mmol) of propargylamine (**4**) in 5 mL of dry degassed THF in a flame dried screw-cap vessel under argon were successively added 1.00 mmol of acid chloride **3** and 0.14 mL (1.00 mmol) of triethylamine at 0 °C (external cooling with ice/water) (for experimental details see Table 1). After stirring for 1 h at room temp a colorless to pale yellow precipitate had formed. Then, 14 mg (0.02 mmol) of $PdCl_2(PPh_3)_2$, 8 mg (0.04 mmol) of CuI, 1.00 mmol of acid chloride **3**, and 0.14 mL (1.00 mmol) of triethylamine were successively added to the reaction mixture and stirring was continued for 1 h at room temp. Then, to the brown reaction mixture 190 mg (1.00 mmol) of *p*-toluenesulfonic acid monohydrate and 1 mL of *tert*-butanol were added and stirring was continued for 1 h at 60 °C. After cooling to room temp 20 mL of saturated brine were added and the reaction mixture was extracted three times with dichloromethane (3 × 20 mL). The combined organic layers were dried with anhydrous sodium sulfate and after evaporation of the solvents the residue was chromatographed on silica gel (ethyl acetate/hexanes) to give the analytically pure 1-(hetero)aryl-2-(2-(hetero)aryl-oxazol-5-yl) ethanones **1**.

Table 1. Experimental details of the one-pot three-component synthesis of 1-(hetero)aryl-2-(2-(hetero)aryl-oxazol-5-yl) ethanones **1**.

Entry	Acid chloride **3** (substituent R^1)	Acid chloride **3'** (substituent R^2)	1-(hetero)aryl-2-(2-(hetero)aryl-oxazol-5-yl) ethanone **1** (yield)
1	141 mg (1.00 mmol) of **3a**	141 mg (1.00 mmol) of **3a**	185 mg (70 %) of **1a**
2	171 mg (1.00 mmol) of **3b**	158 mg (1.00 mmol) of **3c**	179 mg (58 %) of **1b**
3	177 mg (1.00 mmol) of **3d**	141 mg (1.00 mmol) of **3a**	225 mg (75 %) of **1c**
4	186 mg (1.00 mmol) of **3e**	158 mg (1.00 mmol) of **3c**	220 mg (68 %) of **1d**
5	141 mg (1.00 mmol) of **3a**	150 mg (1.00 mmol) of **3f**	143 mg (53 %) of **1e**
6	141 mg (1.00 mmol) of **3a**	170 mg (1.00 mmol) of **3g**	143 mg (49 %) of **1f**
7	150 mg (1.00 mmol) of **3f**	141 mg (1.00 mmol) of **3a**	190 mg (70 %) of **1g**
8	170 mg (1.00 mmol) of **3g**	158 mg (1.00 mmol) of **3c**	200 mg (66 %) of **1h**
9	145 mg (1.00 mmol) of **3h**	158 mg (1.00 mmol) of **3c**	161 mg (57 %) of **1i**

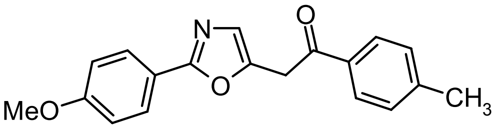
1-Phenyl-2-(2-phenyl-oxazol-5-yl) ethanone (1a)[2]



According to the general procedure 185 mg (70 %) of **1a** were obtained as an amorphous solid, Mp. 84–85 °C. ^{1}H NMR (CDCl$_3$, 300 MHz): δ 4.43 (s, 2 H), 7.14 (s, 1 H), 7.39–7.55 (m, 5 H), 7.57–7.65 (m, 1 H), 7.96–8.06 (m, 4 H). ^{13}C NMR (CDCl$_3$, 75 MHz): δ 36.0 (CH$_2$), 126.2 (CH), 126.9 (CH), 127.5 (C$_{quat}$), 128.5 (CH), 128.7 (CH), 128.8 (CH), 130.2 (CH), 133.7 (CH), 135.9

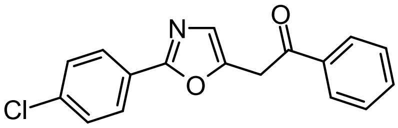
(C_{quat}), 145.5 (C_{quat}), 161.6 (C_{quat}), 193.7 (C_{quat}). EI MS (*m/z* (%)): 263 (M^+, 12), 158 (M^+ – C_6H_5CO, 16), 105 ($C_6H_5CO^+$, 100), 77 ($C_6H_5^+$, 30). IR (KBr): ṽ 1685 (s) cm^{-1}, 1598 (m), 1580 (w), 1549 (m), 1482 (m), 1448 (m), 1335 (m), 1230 (m), 1208 (w), 1123 (m), 1066 (w), 1001 (m), 980 (m), 778 (m), 754 (m), 713 (s), 691 (s), 646 (w). UV/Vis (CH_2Cl_2): λ_{max} (ε): 250 nm (18500), 274 (22100), 284 (20000).

2-[2-(4-Methoxyphenyl)-oxazol-5-yl]-1-*p*-tolyl ethanone (1b)



According to the general procedure and after crystallization from dichloromethane/pentane 179 mg (58 %) of **1b** were obtained as light yellow needles, Mp. 88 °C. ^1H NMR ($CDCl_3$, 300 MHz): δ 2.42 (s, 3 H), 3.84 (s, 3 H), 4.38 (s, 2 H), 6.94 (d, *J* = 8.8 Hz, 2 H), 7.06 (s, 1 H), 7.29 (d, *J* = 7.9 Hz, 2 H), 7.90–7.96 (m, 4 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 21.7 (CH_3), 35.9 (CH_2), 55.4 (CH_3), 114.1 (CH), 120.4 (C_{quat}), 126.5 (CH), 127.9 (CH), 128.6 (CH), 129.5 (CH), 133.5 (C_{quat}), 144.6 (C_{quat}), 145.1 (C_{quat}), 161.2 (C_{quat}), 161.6 (C_{quat}), 193.5 (C_{quat}). EI MS (*m/z* (%)): 307 (M^+, 61), 188 (M^+ – C_7H_7CO, 63), 162 (15), 160 (21), 134 (26), 120 (16), 119 ($C_7H_7CO^+$, 100), 113 (12), 91 ($C_7H_7^+$,45), 65 ($C_5H_5^+$, 12). HRMS calcd. for $C_{19}H_{17}NO_3$ 307.1208; Found. 307.1217. IR (KBr): ṽ 1685 (s) cm^{-1}, 1614 (s), 1585 (w), 1498 (s), 1443 (w), 1422 (w), 1326 (w), 1304 (m), 1255 (s), 1204 (m), 1173 (m), 1122 (w), 1105 (w), 1027 (m), 1009 (m), 978 (m), 838 (m), 811 (m), 743 (m). UV/Vis (CH_2Cl_2): λ_{max} (ε): 262 nm (23900), 280 (27200), 296 (20300). Anal. calcd. for $C_{19}H_{17}NO_3$ (307.4): C 74.25, H 5.58, N 4.56. Found: C 74.02, H 5.58, N 4.55.

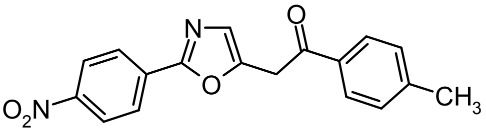
2-[2-(4-Chlorophenyl)-oxazol-5-yl]-1-phenyl ethanone (1c)



According to the general procedure and crystallization from dichloromethane/pentane 225 mg (75 %) of **1c** were obtained as colorless platelets, Mp. 128–129 °C. ^1H NMR ($CDCl_3$, 300 MHz): δ 4.44 (d, *J* = 0.7 Hz, 2 H), 7.14 (s, 1 H), 7.40 (d, *J* = 8.7 Hz, 2 H), 7.47–7.55 (m, 2 H), 7.62 (tt, *J* = 2.1, 7.3 Hz, 1 H), 7.93 (d, *J* = 8.7 Hz, 2 H), 8.00–8.06 (m, 2 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 35.9 (CH_2), 126.8 (C_{quat}), 127.5 (CH), 127.9 (CH), 128.1 (CH), 128.5 (CH), 128.8 (CH), 130.1 (C_{quat}), 133.8 (CH), 135.9 (C_{quat}), 145.0 (C_{quat}), 157.8 (C_{quat}), 193.6 (C_{quat}). EI MS (*m/z* (%)): 299

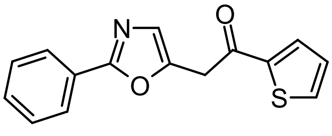
(^{37}Cl-M$^+$, 7), 297 (^{35}Cl-M$^+$, 16), 194 (^{37}Cl-M$^+$ – C_6H_5CO, 4), 192 (^{35}Cl-M$^+$ – C_6H_5CO, 13), 162 (12), 138 (13), 113 (11), 105 ($C_6H_5CO^+$, 100), 77 ($C_6H_5^+$, 38). HRMS (EI) *m/z* calcd. for $C_{17}H_{12}{}^{37}ClNO_2$: 299.0527; Found: 299.0519; HRMS calcd. for $C_{17}H_{12}{}^{35}ClNO_2$: 297.0557; Found: 297.0539. IR (KBr): $\tilde{\nu}$ 1692 (m) cm^{-1}, 1610 (w), 1580 (m), 1483 (m), 1333 (w), 1229 (w), 1208 (w), 1125 (w), 1093 (m), 1012 (w), 982 (w), 938 (w), 755 (w), 735 (w), 708 (s), 690 (w), 651 (w), 569 (w), 510 (w). UV/Vis (CH_2Cl_2): λ_{max} (ε): 250 nm (15600), 280 (24500), 290 (22300), 304 (11100). Anal. calcd. for $C_{17}H_{12}ClNO_2$ (297.7): C 68.58, H 4.06, N 4.70, Cl 11.91. Found: C 68.21, H 4.02, N 4.68, Cl 12.12.

2-[2-(4-Nitrophenyl)-oxazol-5-yl]-1-*p*-tolyl ethanone (1d)



According to the general procedure and after crystallization from dichloromethane/pentane 220 mg (68 %) of **1d** were obtained as a yellow solid, Mp. 190 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 2.44 (s, 3 H), 4.46 (s, 2 H), 7.23 (s, 1 H), 7.32 (d, J = 8.3 Hz, 2 H), 7.94 (d, J = 8.3 Hz, 2 H), 8.16 (d, J = 8.8 Hz, 2 H), 8.30 (d, J = 8.8 Hz, 2 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 21.8 (CH_3), 35.8 (CH_2), 124.2 (CH), 126.9 (CH), 127.9 (CH), 128.6 (CH), 129.6 (CH), 132.9 (C_{quat}), 133.3 (C_{quat}), 145.0 (C_{quat}), 147.6 (C_{quat}), 148.5 (C_{quat}), 159.5 (C_{quat}), 192.9 (C_{quat}). EI MS (*m/z* (%)): 322 (M$^+$, 3), 162 (13), 119 ($C_7H_7CO^+$, 100), 113 (12), 91 ($C_7H_7^+$, 45), 65 ($C_5H_5^+$, 13). HRMS calcd. for $C_{18}H_{14}N_2O_4$: 322.0954. Found: 322.0991. IR (KBr): $\tilde{\nu}$ 1693 (s) cm^{-1}, 1603 (s), 1547 (m), 1518 (s), 1358 (m), 1341 (s), 1236 (w), 1202 (w), 1181 (w), 1124 (w), 1110 (w), 994 (w), 978 (w), 857 (s), 816 (m), 714 (s), 588 (w), 571 (w). UV/Vis (CH_2Cl_2): λ_{max} (ε): 254 nm (17700), 330 (17700). Anal. calcd. for $C_{18}H_{14}N_2O_4$ (322.3): C 67.08, H 4.38, N 8.69. Found: C 66.69, H 4.35, N 8.66.

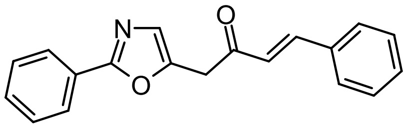
2-(2-Phenyl-oxazol-5-yl)-1-thiophen-2-yl ethanone (1e)



According to the general procedure and after crystallization from dichloromethane/pentane 143 mg (53 %) of **1e** were obtained as a yellow solid, Mp. 118 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 4.36 (d, J = 0.8 Hz, 2 H), 7.14 (s, 1 H), 7.17 (dd, J = 4.9 Hz, J = 3.8 Hz, 1 H), 7.40-7.46 (m, 3

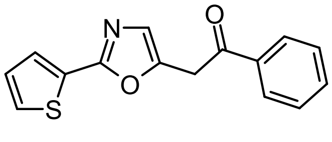
H), 7.70 (dd, *J* = 5.1 Hz, *J* = 1.1 Hz, 1 H), 7.83 (dd, *J* = 3.8 Hz, *J* = 1.1 Hz, 1 H), 7.97–8.03 (m, 2 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 36.7 (CH_2), 126.2 (CH), 126.9 (CH), 127.4 (C_{quat}), 128.4 (CH), 128.7 (CH), 130.2 (CH), 132.9 (CH), 134.8 (CH), 142.9 (C_{quat}), 145.1 (C_{quat}), 161.7 (C_{quat}), 186.4 (C_{quat}). EI MS (*m/z* (%)): 269 (M^+, 20), 162 (12), 158 ($M^+ - C_4H_3SCO$, 19), 151 (11), 111 ($C_4H_3SCO^+$, 100), 83 ($C_4H_3S^+$, 2), 77 ($C_6H_5^+$, 11). HRMS calcd. for $C_{15}H_{11}NO_2S$: 269.0510. Found: 269.0490. IR (KBr): ṽ 3092 (w) cm^{-1}, 2901 (w), 1660 (s), 1610 (w), 1550 (w), 1519 (w), 1482 (w), 1448 (w), 1415 (s), 1354 (m), 1240 (s), 1209 (m), 1124 (m), 1060 (m), 992 (m), 865 (m), 733 (m), 712 (s), 703 (m), 695 (m), 652 (w). UV/Vis (CH_2Cl_2): λ_{max} (ε: 266 nm (36500), 274 (38200), 282 (37300).

4-Phenyl-1-(2-phenyl-oxazol-5-yl)-but-3-en-2-on (1f)[3]



According to the general procedure 143 mg (49 %) of **1f** were obtained as a yellow solid, Mp. 97 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 4.09 (s, 2 H), 6.84 (d, *J* = 15.8 Hz, 1 H), 7.13 (s, 1 H), 7.35–7.48 (m, 6 H), 7.52–7.58 (m, 2 H), 7.70 (d, *J* = 15.8 Hz, 1 H), 7.98–8.05 (m, 2 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 38.4 (CH_2), 124.3 (CH), 126.2 (CH), 126.7 (CH), 127.4 (C_{quat}), 128.5 (CH), 128.7 (CH), 129.0 (CH), 130.2 (CH), 130.9 (CH), 134.0 (C_{quat}), 144.4 (CH), 145.5 (C_{quat}), 161.7 (C_{quat}), 193.3 (C_{quat}). EI MS (*m/z* (%)): 289 (M^+, 7), 162 (13), 158 ($M^+ - C_8H_7CO$, 15), 131 ($C_8H_7CO^+$, 100), 130 (17), 104 (26), 103 ($C_8H_7^+$, 52), 89 (13), 77 ($C_6H_5^+$, 42), 63 (10). HRMS calcd. for $C_{19}H_{15}NO_2$: 289.1103. Found: 289.1096. IR (KBr): ṽ 1674 (m) cm^{-1}, 1612 (m), 1575 (w), 1547 (w), 1483 (w), 1449 (w), 1336 (w), 1176 (w), 1122 (w), 1073 (w), 989 (w), 978 (w), 781 (w), 749 (w), 714 (m), 690 (m), 578 (w), 457 (w), 419 (w). UV/Vis (CH_2Cl_2): λ_{max} (ε): 286 nm (5000), 300 (4400). Anal. calcd. for $C_{19}H_{15}NO_2$ (289.3): C 78.87, H 5.23, N 4.84. Found: C 78.62, H 5.21, N 4.81.

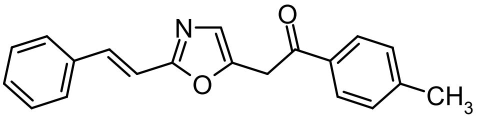
1-Phenyl-2-(2-thiophen-2-yl)-oxazol-5-yl) ethanone (1g)



According to the general procedure and after crystallization from dichloromethane/pentane 190 mg (70 %) of **1g** were obtained as a brown solid, Mp. 108 °C. ^{1}H NMR ($CDCl_3$, 500 MHz): δ

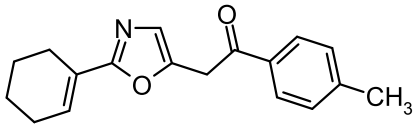
4.42 (s, 2 H), 7.06–7.11 (m, 2 H), 7.39 (d, *J* = 4.9 Hz, 1 H), 7.51 (t, *J* = 7.7 Hz, 2 H), 7.59–7.64 (m, 2 H), 8.03 (d, *J* = 7.7 Hz, 2 H). ^{13}C NMR ($CDCl_3$, 125 MHz): δ 35.9 (CH_2), 126.8 (CH), 127.5 (CH), 127.9 (CH), 128.1 (CH), 128.5 (CH), 128.8 (CH), 130.1 (C_{quat}), 133.8 (CH), 135.9 (C_{quat}), 145.0 (C_{quat}), 157.8 (C_{quat}), 193.6 (C_{quat}). EI MS (*m/z* (%)): 269 (M^+, 30), 164 (M^+ – C_6H_5CO, 30), 105 ($C_6H_5CO^+$, 100), 77 ($C_6H_5^+$, 30). HRMS calcd. for $C_{15}H_{11}NO_2S$: 269.0510. Found: 269.0502. IR (KBr): $\tilde{\nu}$ 3107 (w) cm^{-1}, 3095 (w), 3057 (w), 2944 (w), 2912 (w), 1693 (s), 1606 (s), 1581 (s), 1574 (s), 1453 (m), 1423 (m), 1332 (s), 1316 (w), 1232 (s), 1210 (s), 1113 (m), 997 (s), 975 (m), 852 (m), 766 (s), 726 (s), 708 (s), 695 (s), 659 (m). UV/Vis (CH_2Cl_2): λ_{max} (ε): 246 nm (17300), 294 (18700).

2-(2-Styryl-oxazol-5-yl)1-*p*-tolyl ethanone (1h)



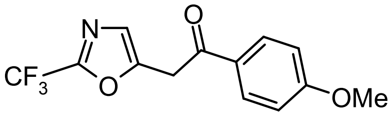
According to the general procedure 200 mg (66 %) of **1h** were obtained as a yellow solid, Mp. 101 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 2.43 (s, 3 H), 4.37 (d, *J* = 0.9 Hz, 2 H), 6.91 (d, *J* = 16.2 Hz, 1 H), 7.07 (s, 1 H), 7.26–7.41 (m, 5 H), 7.44 (d, *J* = 16.7 Hz, 1 H), 7.48–7.53 (m, 2 H), 7.92 (d, *J* = 8.3 Hz, 2 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 21.7 (CH_3), 35.9 (CH_2), 114.0 (CH), 126.9 (CH), 127.1 (CH), 128.6 (CH), 128.8 (CH), 129.1 (CH), 129.5 (CH), 133.4 (C_{quat}), 135.6 (CH), 135.6 (C_{quat}), 144.7 (C_{quat}), 145.4 (C_{quat}), 161.4 (C_{quat}), 193.3 (C_{quat}). EI MS (*m/z* (%)): 303 (M^+, 28), 184 (M^+ – C_7H_7CO, 18), 130 (11), 120 (16), 119 ($C_7H_7CO^+$, 100), 91 ($C_7H_7^+$, 37), 65 ($C_5H_5^+$, 10). HRMS calcd. for $C_{20}H_{17}NO_2$: 303.1259. Found: 303.1263. IR (KBr): $\tilde{\nu}$ 1686 (s) cm^{-1}, 1644 (m), 1607 (s), 1589 (m), 1521 (m), 1447 (m), 1372 (m), 1331 (m), 1228 (s), 1204 (m), 1184 (s), 1113 (m), 1009 (m), 966 (s), 814 (m), 756 (s), 713 (m), 690 (s), 634 (m). UV/Vis (CH_2Cl_2): λ_{max} (ε): 242 nm (12800), 258 (17900), 310 (30600), 318 (29700), 340 (14350). Anal. calcd. for $C_{20}H_{17}NO_2$ (303.4): C 79.19, H 5.65, N 4.62. Found: C 78.96, H 5.65, N 4.57.

2-(2-Cyclohex-1-enyl-oxazol-5-yl)1-*p*-tolyl ethanone (1i)



According to the general procedure 161 mg (57 %) of **1i** were obtained as a yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 1.59–1.77 (m, 4 H), 2.16–2.25 (m, 2 H), 2.40–2.49 (m, 5 H), 4.30 (d, J = 0.9 Hz, 2 H), 6.67–6.73 (m, 1 H), 6.96 (t, J = 0.9 Hz, 1 H), 7.28 (d, J = 7.9 Hz, 2 H), 7.90 (d, J = 8.3 Hz, 2 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 21.7 (CH_3), 21.8 (CH_2), 22.1 (CH_2), 24.5 (CH_2), 25.4 (CH_2), 35.9 (CH_2), 125.9 (CH), 126.0 (C_{quat}), 126.2 (C_{quat}), 128.6 (CH), 129.5 (CH), 131.0 (CH), 133.5 (C_{quat}), 144.6 (C_{quat}), 162.9 (C_{quat}), 193.6 (C_{quat}). EI MS (*m/z* (%)): 281 (M^+, 95), 162 (25), 119 ($C_7H_7CO^+$, 100), 91 ($C_7H_7^+$, 92), 65 ($C_5H_5^+$, 16). HRMS calcd. for $C_{18}H_{19}NO_2$: 281.1416. Found: 281.1424. IR (KBr): $\tilde{\nu}$ 2937 (m) cm^{-1}, 2862 (m), 1685 (s), 1607 (s), 1570 (m), 1527 (m), 1506 (m), 1448 (m), 1408 (m), 1331 (m), 1278 (m), 1233 (m), 1204 (m), 1183 (m), 1150 (m), 1119 (m), 1003 (m), 980 (m), 810 (m). UV/Vis (CH_2Cl_2): λ_{max} (ε): 260 nm (18200), 312 (3900), 330 (2500).

1-(4-Methoxyphenyl)-2-(2-trifluoromethyl-oxazol-5-yl) ethanone (8)



To a solution of 56 mg (1.00 mmol) of propargylamine (**4**) in 5 mL of dry degassed THF in a flame dried screw-cap vessel under argon were successively added 210 mg (1.00 mmol) of trifluoroacetic anhydride **6** and 0.14 mL (1.00 mmol) of triethylamine at 0 °C (external cooling with ice/water). After stirring for 1 h at room temp 35 mg (0.05 mmol) of $PdCl_2(PPh_3)_2$ and 4 mg (0.02 mmol) of CuI were added to the reaction mixture and a stream of carbon monoxide was bubbled through the solution for 5 min. Then, 239 mg (1.00 mmol) of 4-iodoanisole (**7**) and 0.14 mL (1.00 mmol) of triethylamine were added at room temp. The reaction mixture turned red within a couple of minutes. Stirring at room temp was continued for 26 h. Then, 190 mg (1.00 mmol) of *p*-toluenesulfonic acid monohydrate and 1 mL of *tert*-butanol were added and stirring was continued for 1 h at 60 °C. After cooling to room temp 20 mL of saturated brine were added and the reaction mixture was extracted three times with dichloromethane (3 × 20 mL). The combined organic layers were dried with anhydrous sodium sulfate and after evaporation of the solvents the residue was chromatographed on silica gel (ethyl acetate/hexanes 1:6) to give the analytically pure 132 mg (46 %) **8** as a yellow brown oil. ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.90 (s, 3 H), 4.40 (s, 2 H), 6.98 (d, *J* = 8.8 Hz, 2 H), 7.23 (s, 1 H), 7.98 (d, *J* = 8.8 Hz, 2 H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 35.2 (CH_2), 55.6 (CH_3), 114.2 (CH), 116.5 (q, *J* = 269.9 Hz, CF_3), 126.7 (CH), 128.6 (C_{quat}), 130.7 (CH), 149.1 (C_{quat}), 149.7 (q, *J* = 42.9 Hz, C_{quat}), 164.3 (C_{quat}), 190.9 (C_{quat}). EI MS (*m/z* (%)): 285 (M^+, 2), 150 (M^+ – C_7H_7OCO, 4), 135 ($C_7H_7OCO^+$, 100), 107 ($C_7H_7O^+$, 14), 92 (21), 77 (22), 64 (11). HRMS calcd. for $C_{13}H_{10}F_3NO_3$: 285.0613. Found: 285.0600. IR (KBr): $\tilde{\nu}$ 3139 (m) cm^{-1}, 3080 (w), 3057 (w), 3034 (w), 2989 (w), 2915 (w), 2851 (w), 1668 (s), 1604 (s), 1573 (s), 1514 (s), 1428 (s), 1389 (s), 1329 (s), 1288 (s), 1275 (s), 1242 (s), 1201 (s), 1181 (s), 1153 (s), 1136 (s), 1112 (m), 1099 (m), 1027 (s), 993 (s), 979 (s), 837 (s). UV/Vis (CH_2Cl_2): λ_{max} (ε): 280 nm (18000).

II. X-Ray structure data of 1b

Table 1: Crystal data and structure refinement for **1b**.

Identification code	**1b**	
Empirical formula	$C_{19}H_{17}NO_3$	
Formula weight	307.34	
Temperature	200(2) K	
Wavelength	0.71073 Å	
Crystal system	orthorhombic	
Space group	$P2_12_12_1$	
Z	4	
Unit cell dimensions	a = 4.6910(1) Å	α = 90 deg.
	b = 10.5327(2) Å	β = 90 deg.
	c = 31.2403(6) Å	γ = 90 deg.
Volume	1543.55(4) $Å^3$	
Density (calculated)	1.32 g/cm^3	
Absorption coefficient	0.09 mm^{-1}	
Crystal shape	needle	
Crystal size	0.38 x 0.12 x 0.12 mm^3	
Theta range for data collection	2.0 to 25.0 deg.	
Index ranges	$-5 \le h \le 5$, $-12 \le k \le 12$, $-37 \le l \le 37$	
Reflections collected	13309	
Independent reflections	2738 (R(int) = 0.049)	
Observed reflections	2324 ($I > 2\sigma(I)$)	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.99 and 0.97	
Refinement method	Full-matrix least-squares on F^2	
Data/restraints/parameters	2738 / 0 / 276	
Goodness-of-fit on F^2	1.05	
Final R indices ($I>2\sigma(I)$)	R1 = 0.035, wR2 = 0.074	
Absolute structure parameter	0.2(12)	
Largest diff. peak and hole	0.12 and -0.18 $eÅ^{-3}$	

Table 2: Atomic coordinates and equivalent isotropic displacement parameters ($Å^2$) for **1b**. U_{eq} is defined as one third of the trace of the orthogonalized U_{ij} tensor.

Atom	x	y	z	U_{eq}
O10	-0.0601(3)	0.9040(1)	0.7595(1)	0.0435(4)
O16	0.1698(3)	0.6391(1)	0.8524(1)	0.0348(3)
O27	0.7548(3)	0.4048(1)	1.0187(1)	0.0498(4)
N14	0.4134(4)	0.8115(2)	0.8712(1)	0.0449(4)
C1	-0.3776(4)	0.7700(2)	0.7225(1)	0.0291(4)
C2	-0.4805(4)	0.6484(2)	0.7146(1)	0.0344(4)
C3	-0.6714(4)	0.6263(2)	0.6819(1)	0.0364(4)
C4	-0.7712(4)	0.7242(2)	0.6561(1)	0.0333(4)
C5	-0.6709(4)	0.8464(2)	0.6643(1)	0.0362(4)
C6	-0.4766(4)	0.8690(2)	0.6965(1)	0.0355(4)
C7	-0.9797(5)	0.6987(2)	0.6208(1)	0.0431(5)
C10	-0.1687(4)	0.7990(2)	0.7568(1)	0.0307(4)
C11	-0.0954(4)	0.6953(2)	0.7886(1)	0.0335(4)
C12	0.1068(4)	0.7334(2)	0.8227(1)	0.0330(4)
C13	0.2541(5)	0.8364(2)	0.8347(1)	0.0421(5)
C15	0.3558(4)	0.6947(2)	0.8805(1)	0.0342(4)
C21	0.4621(4)	0.6194(2)	0.9162(1)	0.0347(4)
C22	0.3624(4)	0.4966(2)	0.9243(1)	0.0395(5)

C23	0.4651(5)	0.4281(2)	0.9585(1)	0.0428(5)
C24	0.6685(4)	0.4798(2)	0.9856(1)	0.0375(5)
C25	0.7697(4)	0.6020(2)	0.9781(1)	0.0426(5)
C26	0.6682(4)	0.6699(2)	0.9433(1)	0.0400(5)
C28	0.9521(6)	0.4570(3)	1.0485(1)	0.0541(6)

Table 3: Hydrogen coordinates and isotropic displacement parameters (Å^2) for **1b**.

Atom	x	y	z	U_{eq}
H2	-0.416(4)	0.5773(18)	0.7315(6)	0.041(5)
H3	-0.736(4)	0.5408(17)	0.6761(5)	0.035(5)
H5	-0.751(4)	0.9165(18)	0.6473(6)	0.051(5)
H6	-0.403(4)	0.9552(19)	0.7023(6)	0.050(5)
H7A	-0.936(4)	0.7442(19)	0.5953(7)	0.053(6)
H7B	-0.993(5)	0.606(2)	0.6135(6)	0.060(6)
H7C	-1.173(5)	0.7279(19)	0.6287(6)	0.059(6)
H11A	-0.278(4)	0.6720(16)	0.8023(5)	0.037(5)
H11B	-0.030(4)	0.6237(19)	0.7725(6)	0.054(6)
H13	0.261(4)	0.9153(18)	0.8199(5)	0.040(5)
H22	0.216(4)	0.4606(16)	0.9040(6)	0.039(5)
H23	0.404(5)	0.346(2)	0.9634(6)	0.057(6)
H25	0.911(4)	0.6365(17)	0.9960(6)	0.039(5)
H26	0.745(4)	0.7546(17)	0.9376(5)	0.034(4)
H28A	0.992(5)	0.388(2)	1.0709(8)	0.072(7)
H28B	1.142(6)	0.485(2)	1.0355(7)	0.079(8)
H28C	0.876(5)	0.5301(19)	1.0614(6)	0.053(6)

Table 4: Anisotropic displacement parameters (Å^2) for **1b**. The anisotropic displacement factor exponent takes the form: -2 pi^2 (h^2 a^{*2} U_{11} + ... + 2 h k a* b* U_{12}))

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
O10	0.0573(9)	0.0267(7)	0.0465(8)	0.0010(5)	-0.0069(7)	-0.0073(6)
O16	0.0416(7)	0.0286(6)	0.0341(6)	-0.0012(5)	-0.0041(6)	-0.0021(6)
O27	0.0590(9)	0.0482(8)	0.0422(7)	0.0043(6)	-0.0121(7)	0.0040(7)
N14	0.0532(10)	0.0342(9)	0.0472(10)	0.0013(7)	-0.0129(8)	-0.0063(8)
C1	0.0307(9)	0.0255(9)	0.0310(9)	-0.0001(7)	0.0063(7)	0.0056(7)
C2	0.0377(11)	0.0283(10)	0.0371(10)	0.0058(8)	-0.0009(9)	0.0011(8)
C3	0.0359(10)	0.0331(10)	0.0403(11)	0.0005(8)	0.0005(9)	-0.0025(9)
C4	0.0276(9)	0.0403(11)	0.0318(10)	0.0009(7)	0.0055(8)	0.0055(8)
C5	0.0377(10)	0.0343(10)	0.0365(10)	0.0058(8)	0.0023(9)	0.0093(9)
C6	0.0387(11)	0.0281(10)	0.0396(11)	0.0018(8)	0.0053(9)	0.0029(8)
C7	0.0372(12)	0.0531(14)	0.0391(12)	0.0012(10)	-0.0012(9)	0.0074(10)
C10	0.0337(10)	0.0271(9)	0.0312(9)	-0.0042(7)	0.0053(8)	0.0020(8)
C11	0.0370(11)	0.0285(9)	0.0349(10)	-0.0013(8)	-0.0016(9)	0.0004(8)
C12	0.0371(10)	0.0273(9)	0.0345(10)	0.0002(7)	0.0014(8)	0.0032(8)
C13	0.0503(12)	0.0297(10)	0.0462(11)	0.0037(9)	-0.0101(10)	-0.0061(9)
C15	0.0357(10)	0.0333(10)	0.0335(10)	-0.0071(7)	-0.0026(8)	0.0003(8)
C21	0.0367(10)	0.0342(10)	0.0333(10)	-0.0061(8)	0.0005(8)	0.0042(8)
C22	0.0477(12)	0.0361(10)	0.0346(10)	-0.0048(8)	-0.0049(10)	-0.0041(9)
C23	0.0552(14)	0.0333(11)	0.0400(11)	-0.0019(8)	-0.0029(10)	-0.0034(10)
C24	0.0432(12)	0.0383(10)	0.0311(10)	-0.0026(8)	0.0012(9)	0.0062(9)
C25	0.0409(11)	0.0469(12)	0.0401(11)	-0.0053(9)	-0.0082(10)	-0.0001(10)
C26	0.0416(11)	0.0350(10)	0.0436(11)	-0.0030(8)	-0.0031(10)	-0.0037(9)

C28	0.0507(15)	0.0724(17)	0.0393(13)	0.0064(12)	-0.0072(12)	-0.0006(13)

Table 5: Bond lengths (Å) and angles (deg) for **1b**.

O10-C10	1.221(2)
O16-C15	1.369(2)
O16-C12	1.3896(19)
O27-C24	1.362(2)
O27-C28	1.423(3)
N14-C15	1.293(2)
N14-C13	1.389(2)
C1-C2	1.391(2)
C1-C6	1.401(2)
C1-C10	1.483(2)
C2-C3	1.380(3)
C2-H2	0.963(19)
C3-C4	1.389(2)
C3-H3	0.966(17)
C4-C5	1.394(2)
C4-C7	1.498(3)
C5-C6	1.378(3)
C5-H5	0.98(2)
C6-H6	0.99(2)
C7-H7A	0.95(2)
C7-H7B	1.00(2)
C7-H7C	0.99(2)
C10-C11	1.517(2)
C11-C12	1.482(2)
C11-H11A	0.989(19)
C11-H11B	0.96(2)
C12-C13	1.339(2)
C13-H13	0.951(18)
C15-C21	1.457(2)
C21-C26	1.391(2)
C21-C22	1.399(3)
C22-C23	1.376(3)
C22-H22	1.009(19)
C23-C24	1.387(3)
C23-H23	0.92(2)
C24-C25	1.391(3)
C25-C26	1.386(3)
C25-H25	0.94(2)
C26-H26	0.979(18)
C28-H28A	1.03(2)
C28-H28B	1.02(3)
C28-H28C	0.94(2)
C15-O16-C12	104.87(13)
C24-O27-C28	117.67(16)
C15-N14-C13	104.51(16)
C2-C1-C6	117.90(16)
C2-C1-C10	123.13(15)
C6-C1-C10	118.98(15)
C3-C2-C1	120.75(16)
C3-C2-H2	118.5(11)
C1-C2-H2	120.7(11)
C2-C3-C4	121.58(17)
C2-C3-H3	119.8(10)
C4-C3-H3	118.6(10)
C3-C4-C5	117.69(16)

C3-C4-C7	120.90(17)
C5-C4-C7	121.41(16)
C6-C5-C4	121.16(16)
C6-C5-H5	121.1(12)
C4-C5-H5	117.6(11)
C5-C6-C1	120.91(18)
C5-C6-H6	121.6(11)
C1-C6-H6	117.5(12)
C4-C7-H7A	112.7(13)
C4-C7-H7B	112.5(12)
H7A-C7-H7B	108.2(16)
C4-C7-H7C	111.1(12)
H7A-C7-H7C	104.5(17)
H7B-C7-H7C	107.4(17)
O10-C10-C1	120.82(15)
O10-C10-C11	120.82(15)
C1-C10-C11	118.36(14)
C12-C11-C10	114.93(15)
C12-C11-H11A	108.1(10)
C10-C11-H11A	105.5(10)
C12-C11-H11B	112.7(12)
C10-C11-H11B	107.1(12)
H11A-C11-H11B	108.1(16)
C13-C12-O16	106.49(15)
C13-C12-C11	138.60(17)
O16-C12-C11	114.91(14)
C12-C13-N14	110.74(17)
C12-C13-H13	126.2(11)
N14-C13-H13	123.0(11)
N14-C15-O16	113.40(15)
N14-C15-C21	128.16(17)
O16-C15-C21	118.44(15)
C26-C21-C22	118.39(16)
C26-C21-C15	119.74(17)
C22-C21-C15	121.87(16)
C23-C22-C21	120.55(18)
C23-C22-H22	122.0(10)
C21-C22-H22	117.4(10)
C22-C23-C24	120.62(19)
C22-C23-H23	120.8(14)
C24-C23-H23	118.6(13)
O27-C24-C23	116.06(17)
O27-C24-C25	124.33(17)
C23-C24-C25	119.61(17)
C26-C25-C24	119.56(18)
C26-C25-H25	120.6(11)
C24-C25-H25	119.8(11)
C25-C26-C21	121.25(18)
C25-C26-H26	119.1(10)
C21-C26-H26	119.7(10)
O27-C28-H28A	106.9(13)
O27-C28-H28B	114.7(13)
H28A-C28-H28B	108.2(19)
O27-C28-H28C	110.4(13)
H28A-C28-H28C	111.0(18)
H28B-C28-H28C	105.7(19)

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