**Electronic Supplementary Information** 

## An Alternative One-pot Gold-Catalyzed Approach to the Assembly of 11H-Indolo[3,2-*c*]quinolines

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**General methods:** <sup>1</sup>H and <sup>13</sup>C NMR spectra were recorded on a Bruker Avance III at 400 and 100.6 MHz, respectively. The structures of **4k-l** were established by 2D-NMR techniques: COSY, HMBC and NOESY experiments. MS-EI (70eV) mass spectra were recorded with a Varian Saturn 2010T GC/MS spectrometer. ESI mass spectra were recorded with a LTQ, *Linear Ion Trap* Thermo Finnigan spectrometer. IR spectra were recorded in KBr pellets or neat in NaCl disks using a Perkin-Elmer FT-IR Spectrum Two spectrometer. Only the most significant IR absorptions are given. 2-Ethynyl-4,6-difluoro aniline and 2-ethynyl-4,6-dichloroaniline were prepared according to literature procedure.<sup>1</sup> Unless otherwise stated, all starting materials, catalysts, and solvents were commercially available and were used as purchased. Reaction products were purified by flash chromatography on silica gel by elution with *n*-hexane/EtOAc mixtures. The products **1a**,<sup>2</sup> **3a**,<sup>2</sup> **4f**, **4h** and **4m**<sup>3</sup> are known products and were identified by comparison of their physical and spectral data reported in the cited references.

#### Preparation and characterization of 2-[(2-aminophenyl)ethynyl]-4,6-difluoroaniline (1b):



to a solution of 2-ethynyl-4,6-difluoroaniline (0.200 g, 1.30 mmol) in THF (5.0 mL) were added 2-iodoaniline (0.284 g, 1.30 mmol), triethylamine (0.91 mL, 6.5 mmol), PdCl<sub>2</sub>(PPh<sub>3</sub>)<sub>2</sub> (0.027 g, 0.039 mmol), and CuI (0.004 g, 0.020 mmol). The mixture was stirred at 60 °C for 6 h under N<sub>2</sub>, then evaporated. Column chromatographic purification of the crude on silica gel (hexane-EtOAc, 90:10) afforded 2-[(2-aminophenyl)ethynyl]-4,6-difluoroaniline (**1b**): (0.273g, 86%). Found C, 68.7; H, 4.2; N, 11.35. Calcd. for C<sub>14</sub>H<sub>10</sub>F<sub>2</sub>N<sub>2</sub>: C, 68.85; H, 4.1; N, 11.5. IR (neat):  $v_{max}/cm^{-1}$  3430, 3402, 2224, 1590, 751.  $\delta_{\rm H}$  (400 MHz; acetone-d<sub>6</sub>; Me<sub>4</sub>Si) 4.95 (2H, bs, NH<sub>2</sub>), 5.18 (2H, bs, NH<sub>2</sub>), 6.61 (1H, dt, *J*=7.5 Hz, *J* = 1.1 Hz), 6.79-6. 82 (1H, m.), 6.95 (1H, ddd, *J* = 11.3 Hz, *J* = 8.7 Hz, *J* = 2.9 Hz), 7.04 (1H, ddd, *J* = 9.1 Hz, *J* = 2.8 Hz, *J* = 1.7 Hz), 7.10-7.15 (1H, m), 7.35 (1H, ddd, *J* = 7.7 Hz, *J* = 1.6 Hz, *J* = 0.4 Hz);  $\delta_{\rm C}$  (100.6 MHz; acetone-d<sub>6</sub>; Me<sub>4</sub>Si) 89.5 (dd, *J* = 5.5 Hz, *J* = 3.8 Hz, C), 94.2 (C), 102.6 (dd, *J* = 5.0 Hz, *J* = 2.6 Hz, C), 104.8 (dd, *J* = 27.1 Hz, *J* = 2.3 Hz, CH), 115.1 (CH), 117.4 (CH), 130.1 (d, *J* = 11.7 Hz, C), 131.0 (CH), 133.0 (CH), 150.3 (C), 151.2 (dd, *J* = 240.8 Hz, *J* = 12.8 Hz, *C* = 10.4 Hz, C). MS (EI) m/z: [244 (M)<sup>+</sup>, 99%], 224 (5).

#### Preparation and characterization of 2-[(2-aminophenyl)ethynyl]-4,6-dichloroaniline (1c):



to a solution of 2-ethynyl-4,6-dichloroaniline (0.164 g, 0.88 mmol) in THF (5.0 mL) were added 2-iodoaniline (0.192 g, 0.88 mmol), triethylamine (0.6 mL, 4.40 mmol), PdCl<sub>2</sub>(PPh<sub>3</sub>)<sub>2</sub> (0.018 g, 0.026 mmol), and CuI (0.02 g, 0.012 mmol). The mixture was stirred at 60 °C for 6 h under N<sub>2</sub>, then evaporated. Column chromatographic purification of the crude on silica gel (hexane–EtOAc, 95:5) afforded 2-[(2-aminophenyl)ethynyl]-4,6-dichloroaniline (1c): (0.122 g, 50%). Found C, 60.6; H, 3.6; N, 10.25. Calcd. for C<sub>14</sub>H<sub>10</sub>Cl<sub>2</sub>N<sub>2</sub>: C, 60.7; H, 3.6; N, 10.1. IR (neat):  $v_{max}/cm^{-1}$  3453, 3398, 2248, 1610, 1561, 786.  $\delta_{\rm H}$  (400 MHz; CDCl<sub>3</sub>; Me<sub>4</sub>Si) 4.48 (4H, bs, NH<sub>2</sub>), 6.74-6.78 (2H, m), 7.18 (1H, ddd, *J*=8.5 Hz, *J*=7.0 Hz, *J*=1.5 Hz), 7.22-7.23 (1H, m), 7.25-7.26 (1H, m), 7.35 (1H, ddd, *J*=7.6 Hz, *J*=1.5 Hz, *J*=0.5 Hz) and  $\delta_{\rm C}$  (100.6 MHz; CDCl<sub>3</sub>; Me<sub>4</sub>Si) 89.3 (C), 92.8 (C), 110.0 (C), 115.0 (CH), 118.6 (CH), 119.2 (C), 121.7 (C), 129.3 (CH), 129.9 (CH), 130.4 (CH), 130.7 (C), 132.3 (CH), 143.0 (C), 147.1 (C). MS (EI) *m*/*z*: [278 (M)<sup>+</sup>, (84%) and (M)<sup>+</sup>, 276 (99%)], 207 (48).

#### Preparation and characterization of 2-amino-3-[(2-aminophenyl)ethynyl]-5-nitrobenzonitrile (1d):



to a solution of 2-ethynylaniline (0.188 g, 1.61 mmol) in THF (5.0 mL) were added 2-amino-3-bromo-5-nitrobenzonitrile (0.300 g, 1.24 mmol), triethylamine (0.86 mL, 6.20 mmol), PdCl<sub>2</sub>(PPh<sub>3</sub>)<sub>2</sub> (0.026 g, 0.037 mmol), and CuI (0.004 g, 0.018 mmol). The mixture was stirred at 60 °C for 20 h under N<sub>2</sub>, then evaporated. Column chromatographic purification of the crude on silica gel (hexane–EtOAc, 80:20) afforded 2-amino-3-[(2-aminophenyl)ethynyl]-5-nitrobenzonitrile (**1d**): (0.263 g, 76%). Found C, 64.7; H, 3.6; N, 20.15. Calcd. for C<sub>15</sub>H<sub>10</sub>N<sub>4</sub>O<sub>2</sub>: C, 64.7; H, 3.6; N, 20.1. IR (KBr):  $v_{max}/cm^{-1}$  3477, 3367, 2229, 2192, 1627, 1506, 1353, 744.  $\delta_{H}$  (400 MHz; DMSO; Me<sub>4</sub>Si) 5.77 (2H, bs, NH<sub>2</sub>), 6.54 (1H, t, *J* = 7.5 Hz), 6.72 (1H, d, *J* = 8.3 Hz), 7.11 (1H, t, *J* = 7.7 Hz), 7.51 (1H, d, *J* = 8.4 Hz), 7.52 (2H, bs, NH<sub>2</sub>), 8.40-8.42 (1H, m), 8.59-8.60 (1H, m).  $\delta_{C}$  (100.6 MHz; DMSO; Me<sub>4</sub>Si) 87.1 (C), 93.6 (C), 95.3 (C), 104.6 (C), 109.1 (C), 114.1 (CH), 115.5 (CH), 115.9 (C), 129.8 (CH), 130.5 (CH), 131.9 (CH), 133.0 (CH), 136.0 (C), 150.1 (C), 154.5 (C). MS (EI) *m*/z: [ 278 (M)<sup>+</sup>, 99%], 232 (41), 207 (37).

#### Preparation of 2-(1H-indol-2yl)aniline (3a):



 $NaAuCl_4 \cdot 2H_2O$  (0.045 g, 0.11 mmol) was added to a solution of 2,2'-(ethyne-1,2-diyl)dianiline **1a** (0.600 g, 2.88 mmol) in EtOH (23 mL). The reaction mixture was stirred at r. t. for 4 h, then evaporated. Column chromatographic purification of the crude on silica gel (hexane–EtOAc, 80:20) afforded 2-(1H-indol-2-yl)aniline **3a:** 0.467 g, 78% yield.

#### Characterization of 2-amino-3-(1H-indol-2-yl)-5-nitrobenzonitrile (3d):

(0.052 g, 64%). Found C, 64.7; H, 3.55; N, 20.1. Calcd. for C<sub>15</sub>H<sub>10</sub>N<sub>4</sub>O<sub>2</sub>: C, 64.7; H, 3.6; N, 20.1. IR (KBr):  $\nu_{max}$ /cm<sup>-1</sup> 3418.26, 3332.43, 2224.79, 1620.94, 797.29, 711.  $\delta_{H}$  (400 MHz; DMSO; Me<sub>4</sub>Si) 6.83 (1H, dd, J = 2.2 Hz, J = 0.9 Hz), 7.05 (1H, ddd, J = 7.9 Hz, J = 7.0 Hz, J = 1.0 Hz), 7.17 (1H, ddd, J = 8.2 Hz, J = 7.0 Hz, J = 1.2 Hz), 7.20 (2H, bs, NH<sub>2</sub>), 7.44 (1H, ddd, J = 8.1 Hz, J = 1.8 Hz, J = 0.9 Hz), 7.57-7.60 (1H, m,), 8.31 (1H, d, J = 2.6 Hz), 8.45 (1H, d, J = 2.6 Hz), 11.60 (1H, d, J = 1.8 Hz, NH).  $\delta_{C}$  (100.6 MHz; DMSO; Me<sub>4</sub>Si) 94.7 (C), 102.3 (CH), 111.5 (CH), 116.0 (C), 118.7 (C), 119.6 (CH), 120.4 (CH), 122.3 (CH), 128.1 (C), 128.4 (CH), 129.3 (CH), 131.4 (C), 136.3 (C), 136.7 (C), 152.7 (C). MS (EI) m/z: [ 278 (M)<sup>+</sup>, 99%], 232 (23), 207 (27).

#### Structure assignment of 8,10-difluoro-6-(4-methylphenyl)-11H-indolo[3,2-c]quinoline (4k)



#### Reaction of 1b with 2g (entry 11, Table 2) could give regioisomers 4k or 12.

For **12** NOE interaction should be between H-25/H-11, H-32/H-11, H-31/H-28 and H-31/H-29, whereas for **4k** the NOE interaction should be between H-32/H-11, H-31/H-28 and H-31/H-29.

First we assigned the pick resonance to H-31 (or H-32 for **12**) by <sup>1</sup>H-<sup>19</sup>F HMBC ( $\delta_{1H}$  7.00 ppm), afterward, by <sup>1</sup>H-<sup>1</sup>H COSY and <sup>1</sup>H-<sup>1</sup>H NOE, we assigned the pick resonance at H-21,28 and H-29,30 (Me-1 show NOE interaction only with H-27,28). Finally the relevant cross signal in <sup>1</sup>H-<sup>1</sup>H NOE was correlations H-32/H-11, H-31/ H-28 and H-31/ H-29. The absence of NOE correlations between H-25/H-11, H-32/H-11, H-31/ H-28 and H-31/ H-29 for structure 12 confirmed regioisomer **4k**.

#### Structure assignment 8,10-dichloro-6-(4-methylphenyl)-11H-indolo[3,2-c]quinoline (4l):

For **4I**, 1D <sup>1</sup>H NMR and 2D <sup>1</sup>H-<sup>1</sup>H COSY showed the same pattern for the quinoline and the methylphenyl moiety as in **4k**, revealing that reacting **1c** with **2g** gave the regioisomer **4I** 

#### References:

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- 2 C. Koradin, W. Dole, A. L. Rodriguez, B. Schmid, P. Knochel, Tetrahedron, 2003, 59, 1571.
- 3 M. Xu, Q. Hou, S. Wang, H. Wang, Z.-J. Yao, Synthesis, 2011, 626.

Table of Spectra:





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