Supporting Information for

Rh-Catalyzed Intramolecular sp(2) C-H Bond Difluoromethylenation

Yajun Li, a,b Jiangtao Zhu, a Haibo Xie, a Shan Li, a Dongjie Peng, a Zhengke Li, a Yongming Wu a and Yuefa Gong a,b
General Information

Melting points were measured on a Melt-Temp apparatus and were uncorrected. $^1$H NMR spectra were recorded in CDCl$_3$ on a Bruker AM-300 spectrometer (300 MHz) with TMS as internal standard. $^{19}$F NMR spectra were taken on a Bruker AM-300(282 MHz) spectrometer using PhCF$_3$ as external standard. $^{13}$C NMR spectra were taken on a Bruker AM-400(100 MHz) spectrometer. IR spectra were obtained with a Nicolet AV-360 spectrophotometer. Mass spectra and elemental analyses were recorded in this institute. Solvents were purchased from commercial sources and purified before use by standard procedures. Unless otherwise specified, all reactions were carried out under a nitrogen atmosphere in a flame-dried Schlenk tube and magnetic stirring. TLC analysis was performed on silica gel plates, column chromatography over silica gel (mesh 300-400) and petroleum ethyl acetate combination was used as the eluent.

2-aryl indoles were prepared by fischer indole synthesis. 2-aryl pyrroles$^1$ were prepared according to literature. Substrate $3f^2$ was prepared according to literature.

Synthesis of N-(2-bromo-2,2-difluoro-1-(2-phenyl-1H-indol-1-yl)ethylidene)-4-methoxyaniline 1a and Anallogues

![Chemical Structure]

General procedure: A solution of 2-Phenyl indole (3.6 mmol) in THF (3 ml) was stirred at 0 °C for 10 min, and then n-BuLi (3.6 mmol) was added dropwise in 20 min. The mixture was stirred at 0 °C for another 1h before 2-bromo-2,2-difluoro-N-(4-methoxyphenyl)acetimidoyl chloride (3 mmol) in THF (3 ml) was added dropwise. Then the mixture was stirred overnight at room temperature. To the mixture saturated ammonium chloride solution was added, then extracted with ethyl acetate, and dried over anhydrous magnesium sulfate. After filtration the resulting solution was evaporated $in$ vacuo and the crude residue was purified by column chromatography (ethyl acetate and petrol ether) to give 1a as a yellow solid (91%).
Scheme S1. Structures and Yields of 1

1b, 72%  
1c, 89%  
1d, 85%  
1e, 85%  
1f, 83%  
1g, 50%  
1h, 46%  
i, 57%  
1j, 77%  
1k, 95%  
i, 72%  
m, 90%  
1n, 61%  
o, 75%  
p, 81%  
q, 77%  
r, 85%  
s, 68%

Scheme S2. Structures and Yields of 3

3a, 68%  
3b, 69%  
3c, 78%  
d, 92%  
e, 91%
General Procedure for Optimization of Intramolecular C-H Bond Difluoromethylenation of 1a

Rh(PPh₃)₃Cl (5 mol%, 9.2mg), base (1 equiv.), and 1a (0.2 mmol) were suspended in solvent (2 ml) in a Schlenk tube under nitrogen. The resulting mixture was stirred at 100 °C, and then detected directly by ¹⁹FNMR without purification.

### Table 1. Optimization of Intramolecular C-H Bond Difluoromethylenation of 1a

<table>
<thead>
<tr>
<th>Entry</th>
<th>Solvent</th>
<th>Base</th>
<th>Yield(%)⁴</th>
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<tr>
<td>1</td>
<td>toluene</td>
<td>Cs₂CO₃</td>
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<td>toluene</td>
<td>DBU</td>
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<td>7</td>
<td>toluene</td>
<td>Ag₂CO₃</td>
<td>62</td>
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<td>8</td>
<td>1, 4-dioxane</td>
<td>Ag₂CO₃</td>
<td>99(94)⁶</td>
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<tr>
<td>9</td>
<td>DMF</td>
<td>Ag₂CO₃</td>
<td>33</td>
</tr>
<tr>
<td>10</td>
<td>DMSO</td>
<td>Ag₂CO₃</td>
<td>12</td>
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<tr>
<td>11</td>
<td>CH₃CN</td>
<td>Ag₂CO₃</td>
<td>5</td>
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<tr>
<td>12</td>
<td>THF</td>
<td>Ag₂CO₃</td>
<td>74</td>
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<td>13</td>
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<td>Ag₂CO₃</td>
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<td>14</td>
<td>1, 4-dioxane</td>
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<td>13⁵</td>
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<tr>
<td>15</td>
<td>1, 4-dioxane</td>
<td>Ag₂CO₃</td>
<td>0⁵</td>
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</table>

¹⁾ General conditions: 1a (0.2mmol), base(1 equiv.), RhCl(PPh₃)₃ (5 mol %) in solvent at 100 °C. ⁶⁾ Yields were based on 1a determined by ¹⁹FNMR. ⁷⁾ Isolated yield in parenthesis. ⁸⁾ Reaction temperature is 90 °C. ⁹⁾ Without base. ¹⁰⁾ In the absence of RhCl(PPh₃)₃.

The reaction was optimized with respect to solvent, base and temperature. As show in table 1, compared to K₂CO₃ and K₃PO₄, Cs₂CO₃ provided the most encouraging result in toluene (entries 1 vs. 2 and 3, Table 1), obtaining the product 2a in up to 58% yield, which was confirmed by X-ray crystal diffraction studies. This effect may be due to the higher solubility of Cs₂CO₃ in organic solvents. However, the organic bases, such as Et₃N and DBU, were found not suitable for the reaction (entries 4 and 5, Table 1). When KOH was chosen as a base, it performed less efficiency than Cs₂CO₃ (entry 6, Table 1). Interestingly, when Ag₂CO₃ took place of Cs₂CO₃, 62% yield of 2a was detected (entry 7, Table 1). The solvent was also screened. While the polar solvents such as DMF (entry 9, Table 1), DMSO (entry 10, Table 1) and CH₃CN (entry 11, Table 1) couldn’t improve the product yield, 1, 4-dioxane offered the highest yield (entry 8, Table 1). Neither the catalyst nor the base alone could give satisfied performance (entries 14, 15 vs. 1, Table 1). Surprisingly, decreasing the reaction temperature to 90 °C would significantly affect the product yield (entry 13, Table 1), that might be due to the energy barrier of this reaction. In the end, the final optimized conditions (5 mol % of RhCl(PPh₃)₃, 1 equiv. Ag₂CO₃, at 100 °C in 1, 4-dioxane for 2h) provided intramolecular C-H bond difluoromethylenated product 2a in 94% isolated yield.
General procedure for the intramolecular difluoromethylenation of 2-arylindole

**Representative experimental procedure for the synthesis of 2a**

RhCl(Ph3)3 (5 mol%, 9.2mg), Ag2CO3 (1 equiv. 55.2mg), and 1a (0.2 mmol) were suspended in 1, 4-dioxane (2 ml) in a Schlenk tube under nitrogen. The resulting mixture was stirred at 100 °C for 2h. After cooling to room temperature, the solution was filtered through a short path of silica gel, eluting with ethyl acetate. The volatile compounds were removed *in vacuo* and the crude residue was purified by column chromatography (ethyl acetate and petrol ether) to give 2a as a yellow solid (94%).

**Hydrolysis of products 2a and 4e**

To a stirring solution of iminoethanones 2a or 4e (0.2 mmol) in THF (3 ml), 10% HCl (1 ml) was added. The reaction mixture was then stirred at room temperature for 10min and poured into water. The products were extracted with ethyl acetate, washed with brine, and dried over MgSO4. The solvent was evaporated and the residue was purified by silica gel column chromatography to obtain the products.

**Control Experiments and Mechanism Studies**

**Reaction under sulfinatodehalogenation reagent**

To a mixed solution of CH3CN and water (5:1, 2.4 ml) was added 1a (0.5 mmol) under nitrogen,
Na$_2$S$_2$O$_4$-NaHCO$_3$ mixture (1:1, 1.5 equiv.) was added partially. The resulting solution was stirred at room temperature for 5h. No corresponding product was detected.

**Reaction under Fenton reagent**

![Reaction scheme](image)

Substrate 1a (0.2 mmol), Cp$_2$Fe (9 mg, 0.05 mmol), and DMSO (2.0 mL) were charged in a two-neck flask in Ar atmosphere. Then, a 30% aqueous solution of H$_2$O$_2$ (40 uL) was added continuously over 5 min. The reaction solution was stirred at room temperature for 12 h, and then detected directly by $^{19}$F NMR without purification.

**Reaction using Hu’s strategy**

Under N$_2$ atmosphere, into a 10-mL Schlenk flask was added 1a (92 mg, 0.2 mmol), Cu powder (25 mg, 0.4mmol), and DMSO (2 mL). The reaction mixture was vigorously stirred at 65 °C for 3h, and then detected directly by $^{19}$FNMR without purification.

**General procedure for the controlling experiments and mechanism studies**

Rh(PPh$_3$)$_3$Cl (5 mol%, 9.2mg), Ag$_2$CO$_3$ (1 equiv. 55.2mg), additive (20 mol%) and 1a (0.2 mmol) were suspended in 1, 4-dioxane (2 ml) in a Schlenk tube under nitrogen. The resulting mixture was stirred at 100 °C for 2h. The product yield was determined by $^{19}$F NMR using PhCF$_3$ as external standard.

**References:**

Characterization data for the substrates and Products

N-(2-bromo-2,2-difluoro-1-(2-phenyl-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1a)

<table>
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<th>Functional Groups</th>
<th>Data (MHz, solvent)</th>
<th>δ (ppm)</th>
<th>Assignments</th>
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<td>H NMR</td>
<td>400</td>
<td>7.66-7.57</td>
<td>1H, 7.31 (m, 5H), 7.22-7.08 (m, 3H), 6.80 (s, 1H), 6.84-6.82 (m, 2H), 6.72-6.70 (m, 2H), 3.71 (s, 3H)</td>
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<td>F NMR</td>
<td>282</td>
<td>-49.49</td>
<td>2F (J = 428.5, 156.8 Hz)</td>
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<td>C NMR</td>
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<td>160.28, 140.79, 139.35, 135.97, 135.73, 131.97, 129.12, 128.78, 128.39, 127.32, 126.81, 123.55, 122.03, 120.97, 114.41, 114.85 (t, J=309.6Hz), 111.78, 105.89, 55.40</td>
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<td>MS (EI)</td>
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N-(2-bromo-2,2-difluoro-1-(2-(p-tolyl)-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1b)

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<td>MS (EI)</td>
<td>m/z (relative intensity)</td>
<td>468 (39, 79Br) [M⁺], 470 (39, 81Br) [M⁺], 262 (100), 264 (98)</td>
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N-(2-bromo-2,2-difluoro-1-(2-(4-methoxyphenyl)-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1c)

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<th>Data (MHz, solvent)</th>
<th>δ (ppm)</th>
<th>Assignments</th>
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<td>1H, 7.30 – 7.06 (m, 5H), 6.86-6.84 (m, 2H), 6.79 – 6.75 (m, 2H), 6.71 (s, 1H), 6.67-6.64 (m, 2H), 3.80 (s, 3H), 3.71 (s, 3H)</td>
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<td>MS (EI)</td>
<td>m/z (relative intensity)</td>
<td>486 (25, 79Br) [M⁺], 484 (23, 81Br) [M⁺], 43 (100)</td>
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N-(2-bromo-2,2-difluoro-1-(2-(4-fluorophenyl)-1H-indol-1-yl)ethylidene)-4-methoxyaniline
S8

yellow solid; mp: 140-141 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.66 – 7.60 (m, 1H), 7.27 – 7.13 (m, 5H), 7.00 (t, $J$ = 8.6 Hz, 2H), 6.74 (s, 1H), 6.72-6.70 (m, 2H), 6.66-6.64 (m, 2H), 3.72 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) δ -49.23 (q, $J$ = 158.3 Hz, 2F), -101.15 – -125.05 (m, 1F); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 164.07, 161.60, 160.35, 140.58 (q, $J$ = 34.3 Hz, 2F), 138.27, 136.03, 135.62, 129.33, 129.24, 129.00, 128.04, 126.74, 123.68, 122.14, 120.97, 115.89, 115.67, 114.41, 111.78, 55.42; IR (KBr, cm$^{-1}$): ν 3000, 2825, 1588, 1503, 1135, 970, 800, 520; MS (EI) m/z (relative intensity) 472 (5, 79Br) [M$^+$], 474 (5, 81Br) [M$^+$], 160 (100); Anal. Calcd. For C$_{23}$H$_{16}$BrF$_3$N$_2$O: C, 58.37; H, 3.41; N, 5.92. Found: C, 58.55; H, 3.63; N, 5.80.

N-(2-bromo-1-(2-(4-chlorophenyl)-1H-indol-1-yl)-2,2-difluoroethylidene)-4-methoxyaniline (1e)

yellow solid; mp: 169-172 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.65-7.62 (m, 1H), 7.30-7.28 (m, 2H), 7.22 – 7.14 (m, 5H), 6.78 (s, 1H), 6.74-6.71 (m, 2H), 6.67-6.65 (m, 2H), 3.73 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) δ -49.40 (q, $J$ = 158.1 Hz, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 159.50, 140.08 (q, $J$ = 158.1 Hz, 2F), 136.12, 134.45, 128.69, 125.27, 123.48, 121.71, 121.10, 114.49 (q, $J$ = 309.6 Hz), 114.20, 112.01, 106.79, 55.30; IR (KBr, cm$^{-1}$): ν 2931, 2840, 1589, 1503, 1113, 1027, 866, 543; MS (EI) m/z (relative intensity) 474 (5, 79Br) [M$^+$], 476 (5, 81Br) [M$^+$], 160 (100); Anal. Calcd. For C$_{23}$H$_{16}$BrClF$_2$N$_2$O: C, 56.41; H, 3.29; N, 5.72. Found: C, 56.41; H, 3.42; N, 5.68.

N-(2-bromo-1-(2-(4-bromophenyl)-1H-indol-1-yl)-2,2-difluoroethylidene)-4-methoxyaniline (1f)

yellow solid; mp: 171 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.64-7.62 (m, 1H), 7.44 (d, $J$ = 8.4 Hz, 2H), 7.23 – 7.11 (m, 5H), 6.78 (s, 1H), 6.74-6.71 (m, 2H), 6.67-6.65 (m, 2H), 3.72 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) δ -49.36 (q, $J$ = 158.0 Hz, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 160.39, 140.41 (q, $J$ = 158.0 Hz, 2F), 138.07, 136.17, 135.55, 131.92, 130.83, 128.94, 128.80, 126.77, 123.89, 122.62, 122.21, 121.07, 114.84 (t, $J$ = 28.6 Hz), 114.44, 111.83, 106.34, 55.43; IR (KBr, cm$^{-1}$): ν 3005, 2840, 1589, 1503, 1388, 1338, 1135, 970, 800, 746, 520; MS (ESI) m/z 535 [M+H$^+$]; Anal. Calcd. For C$_{23}$H$_{16}$Br$_2$F$_2$N$_2$O: C, 51.71; H, 3.02; N, 5.24. Found: C, 51.97; H, 3.19; N, 5.19.

N-(2-bromo-2,2-difluoro-1-(2-(4-nitrophenyl)-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1g)

Electronic Supplementary Material (ESI) for Chemical Communications
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yellow solid; mp: 169-171 °C; \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.19 (d, \(J = 8.6\) Hz, 2H), 7.74 – 7.66 (m, 1H), 7.44 (d, \(J = 8.6\) Hz, 2H), 7.28-7.19 (m, 3H), 6.96 (s, 1H), 6.70 (dd, \(J = 18.5\), 9.0 Hz, 4H), 3.75 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -49.34 (q, \(J = 159.5\) Hz, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 160.62, 147.30, 138.11, 136.79, 136.68, 135.26, 128.65, 127.67, 126.81, 124.89, 124.07, 122.62, 121.54, 114.55, 112.03, 108.47, 55.47; IR (KBr, cm\(^{-1}\)): \(\nu\) 3085, 2926, 2835, 1598, 1351, 1125, 967, 750, 522; MS (ESI) m/z 500 [M+H \(^+\)], 522 [M+Na \(^+\)]; HRMS (ESI) m/e calcd. for C\(_{23}\)H\(_{16}\)F\(_2\)N\(_3\)NaO\(_3\) [M+Na \(^+\)] 522.0235, Found: 522.02422.

Yellow solid; mp: 118-120°C; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.99 (d, \(J = 8.3\) Hz, 2H), 7.80 – 7.59 (m, 1H), 7.37 (d, \(J = 8.3\) Hz, 2H), 7.23 – 7.13 (m, 3H), 6.88 (s, 1H), 6.75 (d, \(J = 9.0\) Hz, 2H), 6.64 (d, \(J = 9.0\) Hz, 2H), 3.90 (s, 3H), 3.69 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -50.12 (q, \(J = 158.3\) Hz); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 166.56, 160.35, 140.28 (t, \(J = 29.2\) Hz), 138.05, 136.34, 136.18, 135.46, 130.04, 128.83, 126.95, 126.73, 124.21, 122.29, 121.53, 114.70 (t, \(J = 308.3\) Hz), 114.43, 111.87, 107.25, 55.39, 52.21; IR (KBr, cm\(^{-1}\)): \(\nu\) 2952, 1717, 1592, 1449, 1282, 1132, 964, 865, 510; MS (EI) m/z (relative intensity) 512 (12, \(^{79}\)Br) [M\(^+\)], 514 (11, \(^{81}\)Br) [M\(^+\)], 262 (100), 264 (99); Anal. Calcd. For C\(_{25}\)H\(_{19}\)BrF\(_2\)N\(_2\)O\(_3\): C, 58.49; H, 3.73; N, 5.46. Found: C, 58.55; H, 3.86; N, 5.18.

Yellow solid; mp: 120-122°C; \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\) 7.89 (d, \(J = 8.4\) Hz, 2H), 7.74 – 7.63 (m, 1H), 7.47 (d, \(J = 8.4\) Hz, 2H), 7.34 – 7.12 (m, 3H), 6.93 (s, 1H), 6.65-6.74 (m, 4H), 3.74 (s, 3H), 3.06 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -49.19 (q, \(J = 159.4\) Hz); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 160.60, 139.87 (t, \(J = 29.1\) Hz), 137.19, 136.97, 136.63, 135.29, 128.70, 127.80, 127.81, 126.81, 124.72, 122.58, 121.53, 114.79 (t, \(J = 307.1\) Hz), 114.56, 112.00, 108.16, 55.49, 44.51; IR (KBr, cm\(^{-1}\)): \(\nu\) 2920, 1645, 1590, 1505, 1448, 1310, 1148, 967, 537; MS (EI) m/z (relative intensity) 532 (6, \(^{79}\)Br) [M\(^+\)], 534 (6, \(^{81}\)Br) [M\(^+\)], 262 (100), 264 (98); Anal. Calcd. For C\(_{24}\)H\(_{18}\)BrF\(_2\)N\(_2\)O\(_3\)S: C, 54.04; H, 3.59; N, 5.25. Found: C, 54.27; H, 3.67; N, 5.43.
yellow solid; $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 7.61 (d, $J = 6.5$ Hz, 1H), 7.26 (d, $J = 8.6$ Hz, 2H), 7.19 – 7.07 (m, 3H), 6.85 (d, $J = 8.9$ Hz, 4H), 6.74 (s, 1H), 6.67 (d, $J = 9.0$ Hz, 2H), 3.92 – 3.75 (m, 4H), 3.71 (s, 3H), 3.31 – 3.07 (m, 4H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -50.33 (dd, $J = 560.5$, 155.5 Hz); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 160.28, 151.13, 141.06 (t, $J = 29.0$ Hz), 139.50, 135.79, 135.71, 129.36, 128.22, 126.94, 123.18, 123.07, 121.91, 120.65, 115.29, 114.83 (t, $J = 309.0$ Hz), 114.42, 111.60, 104.62, 66.78, 55.39, 48.69; IR (KBr, cm$^{-1}$): $\nu$ 2963, 2850, 1609, 1505, 1452, 1260, 1094, 800; MS (EI) m/z (relative intensity) 539 (38, 79Br) [M$^+$], 541 (35, 81Br) [M$^+$], 277 (100); HRMS (EI) calcd. For C$_{27}$H$_{24}$BrF$_2$N$_3$O$_2$: 539.1020, Found: 539.1017.

N-(2-bromo-2,2-difluoro-1-(2-(o-tolyl)-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1k)

yellow solid; mp: 79-80°C; $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 7.70-7.61 (m, 1H), 7.35 – 7.12 (m, 5H), 7.08 (s, 1H), 6.96-6.89 (m, 1H), 6.69 (s, 5H), 3.74 (s, 3H), 2.23 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -49.76 (s, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 160.32, 140.63 (t, $J = 29.3$ Hz), 137.67, 137.23, 135.80, 130.89, 130.79, 129.14, 128.94, 128.73, 126.91, 125.65, 124.98, 121.97, 120.98, 114.90 (t, $J = 310.3$ Hz), 114.45, 111.75, 107.56, 55.45, 20.43; IR (KBr, cm$^{-1}$): $\nu$ 3053, 2824, 1645, 1589, 1504, 1538, 969, 762, 529; MS (EI) m/z (relative intensity) 468 (22, 79Br) [M$^+$], 470 (26, 81Br) [M$^+$], 262 (97), 264 (100); Anal. Calcd. For C$_{24}$H$_{19}$BrF$_2$N$_2$O: C, 61.42; H, 4.08; N, 5.97. Found: C, 61.37; H, 4.15; N, 5.89.

N-(2-bromo-2,2-difluoro-1-(2-(3-methoxyphenyl)-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1l)

yellow solid; mp: 78-79°C; $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 7.68 – 7.61 (m, 1H), 7.26-7.13 (m, 4H), 6.96 – 6.72 (m, 6H), 6.66 (d, $J = 8.9$ Hz, 2H), 3.72 (s, 3H), 3.72 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -49.51 (dd, $J = 514.3$, 157.0 Hz, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 160.36, 140.80 (t, $J = 29.3$ Hz), 135.80, 130.79, 129.14, 128.94, 128.73, 126.91, 125.65, 124.98, 121.97, 120.98, 114.90 (t, $J = 310.3$ Hz), 114.45, 111.75, 105.67, 55.45, 20.43; IR (KBr, cm$^{-1}$): $\nu$ 2963, 2840, 1500, 1338, 969, 762, 529; MS (EI) m/z (relative intensity) 484 (31, 79Br) [M$^+$], 486 (34, 81Br) [M$^+$], 262 (100), 264 (96); Anal. Calcd. For C$_{24}$H$_{19}$BrF$_2$N$_2$O$_2$: C, 61.42; H, 4.08; N, 5.97. Found: C, 61.37; H, 4.15; N, 5.89.

N-(2-bromo-2,2-difluoro-1-(2-(3-chlorophenyl)-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1m)
yellow solid; mp: 88-92 °C; \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\) 7.66-7.64 (m, 1H), 7.28 – 7.19 (m, 6H), 7.14-7.12 (m, 1H), 6.79 (s, 1H), 6.64 (s, 4H), 3.74 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -42.12 – -51.39 (m, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 160.26, 140.74 (t, \(J = 29.4\) Hz), 137.85, 136.39, 135.68, 134.63, 132.87, 128.85, 128.39, 127.70, 126.32, 125.29, 124.06, 122.28, 121.19, 115.00 (t, \(J = 308.9\) Hz), 114.41, 111.89, 55.43; IR (KBr, cm\(^{-1}\)):\(\nu\) 3078, 2846, 1648, 1590, 1500, 970, 800, 531; MS (ESI) m/z 491 [M+H\(^+\)]; \(\text{Anal. Calcd.}\) For \(\text{C}_{23}\text{H}_{16}\text{BrClF}_2\text{N}_2\text{O}\): C, 56.41; H, 3.29; N, 5.72. Found: C, 56.70; H, 3.28; N, 5.63.

1-(1-(2-bromo-2,2-difluoro-1-((4-methoxyphenyl)imino)ethyl)-2-phenyl-1H-indol-3-yl)ethanone (1n)

\(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.49 (d, \(J = 7.0\) Hz, 1H), 7.45-7.37 (m, 2H), 7.35-7.30 (m, 4H), 7.05 (d, \(J = 7.4\) Hz, 2H), 6.72 (d, \(J = 9.2\) Hz, 2H), 6.64 (d, \(J = 9.2\) Hz, 2H), 3.77 (s, 3H), 1.98 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -50.56 (q, \(J = 161.4\) Hz, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 195.36, 160.83, 143.70, 138.76(t, \(J = 30.9\) Hz), 135.16, 135.07, 130.28, 130.11, 130.07, 128.40, 127.18, 126.90, 125.04, 124.05, 123.31, 122.34, 118.84, 114.60(t, \(J = 308.5\) Hz), 114.43, 111.13, 67.10, 55.49, 30.41; IR (KBr, cm\(^{-1}\)):\(\nu\) 2840, 1720, 1654, 1591, 1505, 1462, 1256, 1027, 747; MS (EI) m/z (relative intensity) 496 (3, \(^{79}\)Br \([M^+\]), 498 (3, \(^{81}\)Br \([M^+\]), 122 (100); HRMS (EI) calcd. For \(\text{C}_{25}\text{H}_{19}\text{BrF}_2\text{N}_2\text{O}_2\): 496.0598, Found: 496.0596.

N-(2-bromo-2,2-difluoro-1-(5-methyl-2-phenyl-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1o)

yellow solid; mp: 114-115°C; \(^1\)H NMR (300 MHz, CDCl\(_3\)) \(\delta\) 7.42 (s, 1H), 7.30 (s, 5H), 7.01 (s, 2H), 6.81 – 6.63 (m, 5H), 3.73 (s, 3H), 2.43 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -49.49 (dd, \(J = 409.7, 156.8\) Hz, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 139.41, 135.85, 134.39, 132.12, 131.47, 129.42, 128.78, 128.3, 127.26, 126.83, 125.15, 120.78, 114.90 (t, \(J = 309.6\) Hz), 114.42, 111.48, 55.41, 21.44; IR (KBr, cm\(^{-1}\)):\(\nu\) 3053, 2904, 2835, 1595, 1500, 1462, 1256, 1027, 800, 520; MS (EI) m/z (relative intensity) 468 (42, \(^{79}\)Br \([M^+\]), 470 (42, \(^{81}\)Br \([M^+\]), 262 (100), 264 (98); \(\text{Anal. Calcd.}\) For \(\text{C}_{24}\text{H}_{19}\text{BrF}_2\text{N}_2\text{O}:\) C, 61.42; H, 4.08; N, 5.97. Found: C, 61.66; H, 4.28; N, 5.85.
N-(2-bromo-2,2-difluoro-1-(5-fluoro-2-phenyl-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1p)

yellow solid; mp: 121-122 °C; $^1$H NMR (300 MHz, CDCl$_3$) δ 7.33-7.30 (m, 6H), 7.04-7.00 (m, 1H), 6.93-6.87 (m, 5H), 3.74 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) δ -49.76 (dd, J = 441.5, 156.6 Hz, 2F), -81.25 – -133.35 (m, 1F); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 160.45, 158.95 (d, J = 237.8 Hz), 140.98, 140.27 (t, J = 26.8 Hz), 135.52, 132.23, 131.68, 129.69 (d, J = 10.4 Hz), 128.87, 128.68, 127.27, 126.84, 114.64 (t, J = 305.7 Hz), 114.49, 112.58 (d, J = 9.6 Hz), 111.93, 111.67, 106.21, 105.97, 105.71 (d, J = 4.3 Hz), 55.43; IR (KBr, cm$^{-1}$): ν 3021, 2960, 2830, 1590, 1504, 1467, 967, 521; MS (EI) m/z (relative intensity) 472 (3) [M$^+$], 160 (100); Anal. Calcd. For C$_{23}$H$_{16}$BrF$_3$N$_2$O: C, 58.37; H, 3.41; N, 5.92. Found: C, 58.60; H, 3.61; N, 5.89.

N-(2-bromo-1-(5-bromo-2-phenyl-1H-indol-1-yl)-2,2-difluoroethylidene)-4-methoxyaniline (1q)

yellow solid; mp: 145-146 °C; $^1$H NMR (300 MHz, CDCl$_3$) δ 7.77 (s, 1H), 7.39-7.25 (m, 6H), 6.98-6.95 (m, 1H), 6.79-6.67 (m, 5H), 3.75 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) δ -49.84 (dd, J = 451.3, 156.8 Hz, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 160.54, 140.60, 139.83 (t, J = 27.5 Hz), 135.40, 134.53, 131.48, 130.77, 128.93, 128.80, 127.31, 126.89, 126.41, 123.55, 115.28, 114.55 (t, J = 310.3 Hz), 114.58, 113.20, 105.07, 55.45; IR (KBr, cm$^{-1}$): ν 3074, 2835, 1650, 1591, 1353, 840, 518; MS (EI) m/z (relative intensity) 534 (6) [M$^+$], 218 (100); Anal. Calcd. For C$_{23}$H$_{16}$Br$_2$F$_2$N$_2$O: C, 51.37; H, 3.41; N, 5.24. Found: C, 51.90; H, 3.21; N, 5.26.

N-(2-bromo-1-(4,6-dimethyl-2-phenyl-1H-indol-1-yl)-2,2-difluoroethylidene)-4-methoxyaniline (1r)

yellow solid; mp: 132-133 °C; $^1$H NMR (300 MHz, CDCl$_3$) δ 7.33–7.21 (m, 5H), 6.83-6.76 (m, 5H), 6.69-6.66 (m, 2H), 3.74 (s, 3H), 2.54 (s, 3H), 2.35 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) δ -49.09 (q, J = 157.6 Hz, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 160.18, 158.88, 133.66, 132.20, 130.08, 128.66, 128.06, 127.23, 126.86, 126.75, 124.18, 115.02 (t, J = 308.1 Hz), 114.37, 109.28, 104.40, 55.40, 21.87, 18.58; IR (KBr, cm$^{-1}$): ν 3021, 2915, 2840, 1587, 1503, 1255, 1026, 831, 532; MS (EI) m/z (relative intensity) 482 (41, 79Br) [M$^+$], 484 (39, 81Br) [M$^+$], 262 (100), 264 (93); Anal. Calcd. For C$_{25}$H$_{21}$Br$_2$F$_2$N$_2$O: C, 62.12; H, 4.38; N, 5.80. Found: 61.94; H, 4.48; N, 5.66.
N-(2-bromo-2,2-difluoro-1-(7-methyl-2-phenyl-1H-indol-1-yl)ethylidene)-4-methoxyaniline (1s)

[Chemical structure image]
yellow solid; mp: 85-86 °C; \( ^1\)H NMR (300 MHz, CDCl$_3$) \( \delta \): 7.51 (d, \( J = 8.0 \) Hz, 1H), 7.25-7.30 (m, 5H), 7.02 (d, \( J = 8.0 \) Hz, 1H), 6.77-6.65 (m, 5H), 3.74 (s, 3H), 2.39 (s, 3H); \( ^19\)F NMR (282 MHz, CDCl$_3$) \( \delta \): -49.10 (q, \( J = 157.9 \) Hz, 2F); \( ^{13}\)C NMR (100 MHz, CDCl$_3$) \( \delta \): 160.23, 141.09 (t, \( J = 28.6 \) Hz), 138.78, 136.56, 135.86, 133.65, 132.09, 128.72, 128.20, 127.29, 126.95, 126.81, 123.82, 120.60, 115.01 (t, \( J = 310.8 \) Hz), 114.39, 111.72, 105.85, 55.41, 21.98; IR (KBr, cm$^{-1}$): \( \nu \): 3050, 2910, 2835, 1590, 1503, 1259, 1027, 837, 522; MS (EI) m/z (relative intensity) 468 (36, 79Br) [M$^+$], 470 (36, 81Br) [M$^+$], 262 (100), 264 (95); Anal. Calcd. For C$_{24}$H$_{19}$BrF$_2$N$_2$O: C, 61.42; H, 4.08; N, 5.97. Found: C, 61.70; H, 4.21; N, 5.92.

N-(2-bromo-2,2-difluoro-1-(2-phenyl-1H-pyrrol-1-yl)ethylidene)-4-methoxyaniline (3a)

[Chemical structure image]
\( ^1\)H NMR (300 MHz, CDCl$_3$) \( \delta \): 7.14-7.16 (m, 3H), 6.97-7.00 (m, 3H), 6.57 (d, \( J = 7.0 \) Hz, 2H), 6.43 (m, 1H), 6.32 (m, 1H), 6.20 (d, \( J = 7.0 \) Hz, 2H), 3.74 (s, 3H); \( ^19\)F NMR (282 MHz, CDCl$_3$) \( \delta \): -50.13 (dd, \( J = 516.8, 162.3 \) Hz); \( ^{13}\)C NMR (100 MHz, CDCl$_3$) \( \delta \): 159.23, 140.98 (t, \( J = 27.3 \) Hz), 136.19, 134.93, 131.59, 128.23, 127.15, 126.75, 124.94, 120.75, 114.92 (t, \( J = 306.2 \) Hz), 113.92, 112.06, 111.64, 55.44; IR (KBr, cm$^{-1}$): \( \nu \): 2920, 1663, 1605, 1509, 1446, 1134, 750, 537; MS (EI) m/z (relative intensity) 404 (24, 79Br) [M$^+$], 406 (24, 81Br) [M$^+$], 133 (100); HRMS (EI) calcd. For C$_{19}$H$_{15}$BrF$_2$N$_2$O: 404.0336, Found: 404.0335.

N-(2-bromo-2,2-difluoro-1-(2-phenyl-1H-imidazol-1-yl)ethylidene)-4-methoxyaniline (3b)

[Chemical structure image]
\( ^1\)H NMR (300 MHz, CDCl$_3$) \( \delta \): 7.47-7.06 (m, 7H), 6.62 (d, \( J = 7.0 \) Hz, 2H), 6.35 (d, \( J = 7.0 \) Hz, 2H), 3.74 (s, 3H); \( ^19\)F NMR (282 MHz, CDCl$_3$) \( \delta \): -51.31 (dd, \( J = 653.9, 163.2 \) Hz); \( ^{13}\)C NMR (100 MHz, CDCl$_3$) \( \delta \): 159.85, 147.40, 138.66 (t, \( J = 28.3 \) Hz), 135.27, 130.84, 129.27, 128.41, 127.03, 124.94, 119.38, 114.39 (t, \( J = 306.8 \) Hz), 114.03, 55.36; IR (KBr, cm$^{-1}$): \( \nu \): 3061, 2840, 1592, 1504, 1388, 1254, 971, 816; MS (EI) m/z (relative intensity) 405 (22, 79Br) [M$^+$], 407 (21, 81Br) [M$^+$], 264 (100), 262(97); HRMS (EI) calcd. For C$_{18}$H$_{14}$BrF$_2$N$_3$O: 405.0288, Found: 405.0292.

N-(2-bromo-1-(2,4-diphenyl-1H-pyrrol-1-yl)-2,2-difluoroethylidene)-4-methoxyaniline(3c)
**N-(2-bromo-1-(2-(4-chlorophenyl)-4-phenyl-1H-pyrrol-1-yl)-2,2-difluoroethylidene)-4-methoxyaniline (3d)**

**1H NMR** (300 MHz, CDCl₃) δ 7.63 (d, J = 7.6 Hz, 2H), 7.43 (m, 2H), 7.31 (m, 2H), 7.19 (m, 3H), 7.06 (m, 2H), 6.68 (s, 1H), 6.61 (d, J = 8.8 Hz, 2H), 6.33 (d, J = 8.8 Hz, 2H), 3.75 (s, 3H); **19F NMR** (282 MHz, CDCl₃) δ -50.69 (dd, J = 549.3, 162.8 Hz); **13C NMR** (100 MHz, CDCl₃) δ 159.34, 140.49 (t, J = 27.5 Hz), 136.14, 135.99, 133.98, 131.41, 128.91, 128.33, 128.08, 127.45, 126.84, 126.79, 125.53, 125.01, 116.69, 114.93 (t, J = 308.2 Hz), 114.06, 109.87, 55.47; **IR** (KBr, cm⁻¹): ν 2963, 2830, 1654, 1479, 1504, 1249, 964, 758; **MS (ESI)** m/z 481 [M+H⁺], 503 [M+Na⁺]; **HRMS (ESI)** m/e calcd. for C₂₅H₂₀BrF₂N₂O⁺ [M+Na⁺] 481.07216, Found: 481.07036.

**N-(2-bromo-1-(4-(tert-butyl)-2-(4-methoxyphenyl)-1H-pyrrol-1-yl)-2,2-difluoroethylidene)-4-methoxyaniline (3e)**

**1H NMR** (300 MHz, CDCl₃) δ 7.59 (d, J = 7.1 Hz, 2H), 7.41 (m, 2H), 7.30 (d, J = 14.0 Hz, 2H), 7.13 (d, J = 8.5 Hz, 2H), 6.93 (d, J = 8.6 Hz, 2H), 6.66 – 6.52 (m, 3H), 6.29 (d, J = 9.0 Hz, 2H), 3.75 (s, 3H); **19F NMR** (282 MHz, CDCl₃) δ -49.89 (dd, J = 505.1, 163.8 Hz); **13C NMR** (100 MHz, CDCl₃) δ 159.04, 158.84, 141.75 (t, J = 27.4 Hz), 139.15, 134.71, 133.72, 133.44, 129.85, 128.91, 128.47, 128.18, 128.01, 126.95, 126.51, 125.53, 116.91, 114.87 (t, J = 307.8 Hz), 114.09, 110.25, 67.12, 55.46; **IR** (KBr, cm⁻¹): ν 2958, 2835, 1650, 1613, 1525, 1505, 1250, 963, 815; **MS (EI)** m/z (relative intensity) 514 (3) [M⁺], 88 (100); **HRMS (EI)** calcd. For C$_{25}$H$_{18}$BrClF$_2$N$_2$O: 514.0259, Found: 514.0255.
N-(5,5-difluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2a)

yellow solid; \( \text{mp} \): 193-195°C; \( ^1\text{H NMR} \) (400 MHz, CDCl\(_3\)) \( \delta \): 8.55 (s, 1H), 7.63 (d, \( J = 7.6 \text{ Hz} \), 1H), 7.63 (d, \( J = 7.6 \text{ Hz} \), 1H), 7.53 (t, \( J = 7.6 \text{ Hz} \), 1H), 7.37 (t, \( J = 7.6 \text{ Hz} \), 1H), 7.30-7.24 (m, 2H), 7.05 (s, 1H), 7.02-7.00 (m, 2H), 6.94-6.92 (m, 2H), 3.83 (s, 3H); \( ^{19}\text{F NMR} \) (282 MHz, CDCl\(_3\)) \( \delta \): -79.61 (s, 2F); \( ^{13}\text{C NMR} \) (100 MHz, CDCl\(_3\)) \( \delta \): 156.18, 141.41 (t, \( J = 28.6 \text{ Hz} \)), 140.36, 136.65, 132.88, 131.90, 130.40, 128.73, 127.21 (t, \( J = 28.5 \text{ Hz} \)), 125.94, 125.73, 123.92, 123.63, 121.15, 120.79, 116.82, 113.87, 104.00, 55.52; \( \text{IR} \) (KBr, cm\(^{-1}\)): \( \nu \): 3101, 2835, 1668, 1504, 1449, 1240, 1028, 749, 488; \( \text{MS (EI)} \) m/z (relative intensity) 374 (100) \[M^+\]; \textbf{Anal. Calcd.} For C\(_{23}\)H\(_{16}\)F\(_2\)N\(_2\)O: C, 73.79; H, 4.31; N, 7.48. Found: C, 73.77; H, 4.54; N, 7.30.

N-(5,5-difluoro-3-methylindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2b)

yellow solid; \( \text{mp} \): 223-224 °C; \( ^1\text{H NMR} \) (400 MHz, CDCl\(_3\)) \( \delta \): 8.54 (s, 1H), 7.69 (d, \( J = 8.1 \text{ Hz} \), 1H), 7.56 (d, \( J = 7.7 \text{ Hz} \), 1H), 7.43 (s, 1H), 7.34-7.21 (m, 3H), 7.07 – 6.88 (m, 5H), 3.83 (s, 3H), 2.37 (s, 3H); \( ^{19}\text{F NMR} \) (282 MHz, CDCl\(_3\)) \( \delta \): -79.65 (s, 2F); \( ^{13}\text{C NMR} \) (100 MHz, CDCl\(_3\)) \( \delta \): 156.13, 140.45, 139.11, 136.53, 133.13, 132.92, 130.52, 127.07 (t, \( J = 29.1 \text{ Hz} \)), 126.07, 125.46, 123.85, 123.65, 116.74, 113.84, 103.24, 55.53, 21.41; \( \text{IR} \) (KBr, cm\(^{-1}\)): \( \nu \): 3058, 2835, 1669, 1504, 1450, 1242, 1013, 806, 747, 488; \( \text{MS (EI)} \) m/z (relative intensity) 388 (100) \[M^+\]; \textbf{HRMS (EI)} calcd. For C\(_{24}\)H\(_{18}\)F\(_2\)N\(_2\)O: 388.1387, Found: 388.1391.

N-(5,5-difluoro-3-methoxyindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2c)

yellow solid; \( \text{mp} \): 206-207 °C; \( ^1\text{H NMR} \) (400 MHz, CDCl\(_3\)) \( \delta \): 8.53 (s, 1H), 7.69 (d, \( J = 8.9 \text{ Hz} \), 1H), 7.54 (d, \( J = 7.8 \text{ Hz} \), 1H), 7.27-7.20 (m, 2H), 7.08 (d, \( J = 7.8 \text{ Hz} \), 2H), 7.01 (d, \( J = 8.2 \text{ Hz} \), 2H), 6.97 – 6.86 (m, 3H), 3.83 (s, 3H), 3.80 (s, 3H); \( ^{19}\text{F NMR} \) (282 MHz, CDCl\(_3\)) \( \delta \): -79.65 (s, 2F); \( ^{13}\text{C NMR} \) (100 MHz, CDCl\(_3\)) \( \delta \): 160.06, 156.13, 140.46, 136.40, 133.06, 130.67, 128.40 (t, \( J = 23.5 \text{ Hz} \)), 125.41, 125.23, 123.85, 120.82, 119.85, 119.65, 116.67, 113.84, 109.04, 102.46, 55.57, 55.52; \( \text{IR} \) (KBr, cm\(^{-1}\)): \( \nu \): 3064, 2830, 1662, 1503, 1450, 1348, 1233, 1040, 805, 542; \( \text{MS (EI)} \) m/z (relative intensity) 404 (100) \[M^+\]; \textbf{Anal. Calcd.} For C\(_{24}\)H\(_{18}\)F\(_2\)O\(_2\): C, 71.28; H, 4.49; N, 6.93. Found: C, 71.25; H, 4.56; N, 6.86.

4-methoxy-N-(3,5,5-trifluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)aniline (2d)

yellow solid; \( \text{mp} \): 206-207 °C; \( ^1\text{H NMR} \) (400 MHz, CDCl\(_3\)) \( \delta \): 8.53 (s, 1H), 7.69 (d, \( J = 8.9 \text{ Hz} \), 1H), 7.54 (d, \( J = 7.8 \text{ Hz} \), 1H), 7.27-7.20 (m, 2H), 7.08 (d, \( J = 7.8 \text{ Hz} \), 2H), 7.01 (d, \( J = 8.2 \text{ Hz} \), 2H), 6.97 – 6.86 (m, 3H), 3.83 (s, 3H), 3.80 (s, 3H); \( ^{19}\text{F NMR} \) (282 MHz, CDCl\(_3\)) \( \delta \): -79.65 (s, 2F); \( ^{13}\text{C NMR} \) (100 MHz, CDCl\(_3\)) \( \delta \): 160.06, 156.13, 140.46, 136.40, 133.06, 130.67, 128.40 (t, \( J = 23.5 \text{ Hz} \)), 125.41, 125.23, 123.85, 120.82, 119.85, 119.65, 116.67, 113.84, 109.04, 102.46, 55.57, 55.52; \( \text{IR} \) (KBr, cm\(^{-1}\)): \( \nu \): 3064, 2830, 1662, 1503, 1450, 1348, 1233, 1040, 805, 542; \( \text{MS (EI)} \) m/z (relative intensity) 404 (100) \[M^+\]; \textbf{Anal. Calcd.} For C\(_{24}\)H\(_{18}\)F\(_2\)O\(_2\): C, 71.28; H, 4.49; N, 6.93. Found: C, 71.25; H, 4.56; N, 6.86.
yellow solid; **mp**: 199-200 °C; **$^1$H NMR** (400 MHz, CDCl$_3$) $\delta$ 8.54 (s, 1H), 7.80-7.87 (m, 1H), 7.07 – 6.90 (m, 5H), 7.36 – 7.18 (m, 4H), 3.84 (s, 3H); **$^{19}$F NMR** (282 MHz, CDCl$_3$) $\delta$ -79.93 (s, 2F), -109.63 (s, 1F); **$^{13}$C NMR** (100 MHz, CDCl$_3$) $\delta$ 163.70, 161.21, 156.28, 140.11, 136.54, 132.07, 126.00 (d, $J$ = 8.1 Hz), 123.80, 124.03, 123.27, 121.14, 120.77, 119.98 (d, $J$ = 22.6 Hz), 116.78, 113.90, 112.77 (d, $J$ = 24.2 Hz), 103.82, 100.00, 55.52; **IR** (KBr, cm$^{-1}$): ν 3069, 2835, 1658, 1498, 1449, 1241, 1036, 858, 750, 530; **MS (EI)** m/z (relative intensity) 392 (100) [M+]; **HRMS (EI)** calcd. For C$_{23}$H$_{15}$F$_{3}$N$_{2}$O: 392.1136, Found: 392.1135.

N-(3-chloro-5,5-difluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2e)

yellow solid; **mp**: 220-222 °C; **$^1$H NMR** (400 MHz, CDCl$_3$) $\delta$ 8.54 (d, $J$ = 6.8 Hz, 1H), 7.72 (d, $J$ = 8.5 Hz, 1H), 7.58-7.57 (m, 2H), 7.48 – 7.20 (m, 2H), 7.02-6.92 (m, 5H), 3.84 (s, 3H); **$^{19}$F NMR** (282 MHz, CDCl$_3$) $\delta$ -80.20 (s, 2F); **$^{13}$C NMR** (100 MHz, CDCl$_3$) $\delta$ 156.33, 140.72 (t, $J$ = 26.0 Hz), 140.07, 136.65, 134.53, 132.34, 131.91, 130.23, 128.50 (t, $J$ = 22.6 Hz), 126.09, 126.05, 125.10, 124.07, 121.26, 120.78, 116.81, 113.91, 110.29 (t, $J$ = 24.2 Hz), 104.47, 55.54; **IR** (KBr, cm$^{-1}$): ν 3080, 2835, 1668, 1505, 1398, 1242, 1034, 748, 490; **MS (EI)** m/z (relative intensity) 408 (100) [M+]; **Anal. Calcd.** For C$_{23}$H$_{15}$ClF$_{2}$N$_{2}$O: C, 67.57; H, 3.70; N, 6.85. Found: C, 67.54; H, 3.86; N, 6.83.

N-(3-bromo-5,5-difluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2f)

yellow solid; **mp**: 222-224 °C; **$^1$H NMR** (400 MHz, CDCl$_3$) $\delta$ 8.55 (s, 1H), 7.76 (s, 1H), 7.65 (s, 2H), 7.59 (d, $J$ = 7.7 Hz, 1H), 7.44 – 7.19 (m, 2H), 7.05 (s, 1H), 6.96 (dd, $J$ = 29.4, 8.1 Hz, 4H), 3.84 (s, 3H); **$^{19}$F NMR** (282 MHz, CDCl$_3$) $\delta$ -80.16 (s, 2F); **$^{13}$C NMR** (100 MHz, CDCl$_3$) $\delta$ 156.34, 140.42 (t, $J$ = 27.8 Hz), 140.05, 136.69, 135.18, 131.96, 130.22, 129.08, 128.66 126.06, (t, $J$ = 25.4 Hz), 125.69, 125.19, 124.08, 122.24, 121.27, 120.77, 116.80, 113.90, 110.19 (t, $J$ = 246.9 Hz), 104.54, 55.54; **IR** (KBr, cm$^{-1}$): ν 3075, 2830, 1669, 1504, 1448, 1398, 1242, 1033, 748, 495; **MS (EI)** m/z (relative intensity) 454 (100, 79Br) [M+] , 542 (92, 81Br) [M+] ; **Anal. Calcd.** For C$_{23}$H$_{15}$BrF$_{2}$N$_{2}$O: C, 60.94; H, 3.34; N, 6.18. Found: C, 61.15; H, 3.57; N, 6.13.

N-(5,5-difluoro-3-nitroindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2g)

eyellow solid; **mp**: 259-260 °C; **$^1$H NMR** (300 MHz, CDCl$_3$) $\delta$ 8.63 – 8.50 (m, 1H), 8.38 (d, $J$ = 8.7 Hz, 1H), 7.96 (d, $J$ = 8.8 Hz, 1H), 7.66 (d, $J$ = 7.6 Hz, 1H), 7.48 – 7.20 (m, 3H), 6.99 (dd, $J$ = 23.4, 8.3 Hz, 4H), 3.86 (s, 3H); **$^{19}$F NMR** (282 MHz, CDCl$_3$) $\delta$ -80.47 (s, 2F); **$^{13}$C NMR** (100 MHz, CDCl$_3$) $\delta$ 156.60, 147.17, 140.02 139.63, 137.20, 132.18, 130.75, 129.94, 128.01 (t, $J$ = 26.3 Hz), 127.29, 126.71, (t, $J$ = 28.2 Hz), 124.68, 124.46, 122.36, 121.88, 120.79, 117.01, 113.98, 109.82 (t, $J$ = 247.5 Hz), 107.67, 55.54; **IR** (KBr, cm$^{-1}$): ν 3069, 2920, 2835, 1656, 1603, 1341,
methyl-5,5-difluoro-6-((4-methoxyphenylimino)-5,6-dihydroindolo[2,1-a]isoquinoline-3-carboxylate (2h)

yellow solid; mp: 217-219°C; $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 8.58-8.55 (m, 1H), 8.32 (s, 1H), 8.16 (d, $J$ = 8.0 Hz, 1H), 7.84 (d, $J$ = 8.0 Hz, 1H), 7.61 (d, $J$ = 7.2 Hz, 2H), 7.43 – 7.20 (m, 2H), 7.15 (s, 1H), 7.03 (d, $J$ = 7.3 Hz, 2H), 6.94 (d, $J$ = 7.1 Hz, 2H), 3.91 (s, 3H), 3.85 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -80.65; $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 165.48, 156.35, 140.08, 136.92, 132.65, 131.87, 130.15, 127.87, 127.19 (t, $J$ = 24.7 Hz), 126.51, 124.15, 123.68, 121.54, 120.78, 116.93, 113.89, 106.04, 55.54, 52.43; IR (KBr, cm$^{-1}$): ν 2954, 1716, 1668, 1505, 1450, 1239, 1042, 751; MS (EI) m/z (relative intensity) 432 (100) [M$^+$]; Anal. Calcd. For C$_{25}$H$_{18}$F$_2$N$_2$O$_3$: C, 69.44; H, 4.20; N, 6.48. Found: C, 69.29; H, 4.22; N, 6.40.

N-(5,5-difluoro-3-(methylsulfonyl)indolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2i)

yellow solid; mp: 259-261°C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.57 (s, 1H), 8.23 (s, 1H), 8.08 (d, $J$ = 8.1 Hz, 1H), 7.98 (d, $J$ = 8.4 Hz, 1H), 7.64 (d, $J$ = 7.7 Hz, 1H), 7.47 – 7.20 (m, 3H), 7.01 (d, $J$ = 7.9 Hz, 2H), 6.94 (d, $J$ = 7.6 Hz, 2H), 3.85 (s, 3H), 3.07 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -79.56; $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 156.56, 151.31, 140.58, 137.08, 131.51, 130.97, 130.45, 129.95, 127.13, 124.38, 121.80, 120.77, 116.96, 113.96, 107.09, 55.55, 44.44; IR (KBr, cm$^{-1}$): ν 2926, 1666, 1605, 1504, 1446, 1305, 1134, 750, 540; MS (EI) m/z (relative intensity) 452 (100) [M$^+$]; Anal. Calcd. For C$_{25}$H$_{19}$F$_2$NO$_3$S: C, 63.71; H, 4.01; N, 6.19. Found: C, 63.43; H, 3.98; N, 6.13.

N-(5,5-difluoro-3-morpholinoindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2j)

yellow solid; mp: 245-247°C; $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 8.53 (s, 1H), 7.67 (d, $J$ = 8.5 Hz, 1H), 7.53 (m, 1H), 7.24 (m, 2H), 6.96 (m, 7H), 3.83 (m, 7H), 3.18 (m, 4H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -80.35 (s, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 156.07, 151.31, 140.58, 136.34, 133.37, 130.82, 128.16 (t, $J$ = 22.4 Hz), 125.03, 123.81, 120.72, 120.66, 119.12, 117.88 (t, $J$ = 5.3 Hz), 116.61, 113.81, 110.59 (t, $J$ = 4.3 Hz), 101.83, 66.58, 55.52, 48.35; IR (KBr, cm$^{-1}$): ν 2830, 1659, 1504, 1449, 1239, 917, 749; MS (EI) m/z (relative intensity) 459 (100); HRMS (EI) calcd. For C$_{27}$H$_{23}$F$_2$N$_3$O$_2$: 459.1758, Found: 459.1760.

N-(5,5-difluoro-1-methylindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2k)
yellow solid; mp: 209-212 °C; \(^1^H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.53 (d, \(J = 8.0\) Hz, 1H), 7.64 (d, \(J = 7.5\) Hz, 1H), 7.57 (d, \(J = 7.6\) Hz, 1H), 7.44 (d, \(J = 7.3\) Hz, 1H), 7.38 – 7.26 (m, 3H), 7.13 (s, 1H), 6.98 (dd, \(J = 25.5, 8.2\) Hz, 4H), 3.84 (s, 3H), 2.72 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -81.77 (s, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 156.21, 140.40, 136.00, 135.35, 135.14, 132.34, 130.33, 128.03, 125.92, 123.90, 123.71, 121.25, 116.15, 113.92, 109.64, 55.51, 23.80; IR (KBr, cm\(^{-1}\)): v 2915, 2840, 1662, 1504, 1458, 1245, 1016, 748, 552; MS (EI) m/z (relative intensity) 389 (100) [M\(^+\)]; HRMS (EI) calcd. For C\(_{24}\)H\(_{18}\)F\(_2\)N\(_2\)O: 388.1387, Found: 388.1386.

mixture of N-(5,5-difluoro-2-methoxyindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2l) and N-(5,5-difluoro-4-methoxyindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2l’)

yellow solids; \(^1^H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.60 (m, 1.1H), 7.60 (m, 1.2H), 7.50-7.46 (m, 2.2H), 7.37 – 7.19 (m, 3.5H), 7.08 (s, 1.2H), 7.05 – 6.84 (m, 4.4H), 3.85 (s, 3H), 3.84 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -77.92, -81.70; IR (KBr, cm\(^{-1}\)): v 3042, 2963, 2835, 1587, 1454, 1340, 1258, 1130, 810, 538; MS (EI) m/z (relative intensity) 404 (100) [M\(^+\)]; Anal. Calcd. For C\(_{24}\)H\(_{18}\)F\(_2\)N\(_2\)O: C, 71.28; H, 4.49; N, 6.93. Found: C, 71.30; H, 4.55; N, 6.89.

Mixture of N-(2-chloro-5,5-difluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2m) and N-(4-chloro-5,5-difluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2m’)

yellow solids; \(^1^H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.60 (s, 1H), 7.78 (d, \(J = 8.5\) Hz, 1H), 7.63-7.59 (m, 1H), 7.52 – 7.20 (m, 4H), 7.11-6.92 (m, 5H), 3.85 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -79.75 (s), -81.29 (s); IR (KBr, cm\(^{-1}\)): v 3080, 2915, 2835, 1505, 1454, 1340, 1258, 1130, 810, 538; MS (EI) m/z (relative intensity) 408 (100) [M\(^+\)]; HRMS (EI) calcd. For C\(_{23}\)H\(_{15}\)ClF\(_2\)N\(_2\)O: 408.0844, Found: 408.0845.

1-(5,5-difluoro-6-((4-methoxyphenyl)imino)-5,6-dihydroindolo[2,1-a]isoquinolin-12-yl)ethanone (2n)
yellow solid; **mp**: 198-200°C; **1H NMR** (400 MHz, CDCl$_3$) δ 8.51 (s, 1H), 7.88 (s, 1H), 7.78 (d, $J = 8.8$ Hz, 1H), 7.70 (s, 1H), 7.57 (t, $J = 7.2$ Hz, 1H), 7.48 (d, $J = 6.4$ Hz, 1H), 7.34 (m, 2H), 7.02-6.94 (m, 4H), 3.83 (s, 3H), 2.71 (s, 3H); **19F NMR** (282 MHz, CDCl$_3$) δ -85.46 (s, 2F); **13C NMR** (100 MHz, CDCl$_3$) δ 198.96, 156.71, 140.67, 139.75, 135.69, 132.18, 131.94, 129.89, 128.33, 127.81, 126.15, 125.67, 125.64, 120.73, 119.96, 116.17, 114.01, 55.51, 31.95; **IR** (KBr, cm$^{-1}$): ν 2915, 1659, 1504, 1449, 1241, 1139, 1035, 747; **MS (EI)** m/z (relative intensity) 416 (100) [M$^+$]; **Anal. Calcd.** For C$_{25}$H$_{18}$F$_2$N$_2$O$_2$: C, 72.11; H, 4.36; N, 6.73. Found: C, 72.38; H, 4.46; N, 6.78.

N-(5,5-difluoro-10-methylindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2o) yellow solid; **mp**: 187-189°C; **1H NMR** (300 MHz, CDCl$_3$) δ 8.42 (s, 1H), 7.81 (d, $J = 7.0$ Hz, 1H), 7.62 (s, 1H), 7.58 - 7.49 (m, 1H), 7.38 (s, 2H), 7.12 (s, 1H), 7.00-6.93 (m, 5H), 3.84 (s, 3H), 2.44 (s, 3H); **19F NMR** (282 MHz, CDCl$_3$) δ -79.63 (s, 2F); **13C NMR** (100 MHz, CDCl$_3$) δ 156.11, 141.35 (t, $J = 28.9$ Hz), 140.51, 134.90, 133.52, 132.85, 131.84, 130.65, 128.58, 127.11, 126.78, 110.95, 125.92, 123.55, 121.07, 120.83, 116.52, 113.86, 103.82, 55.53, 21.40; **IR** (KBr, cm$^{-1}$): ν 3000, 2839, 1656, 1505, 1463, 1399, 1238, 1017, 761, 490; **MS (EI)** m/z (relative intensity) 389 (100) [M$^+$]; **Anal. Calcd.** For C$_{24}$H$_{18}$F$_2$N$_2$O: C, 74.21; H, 4.67; N, 7.21. Found: C, 74.21; H, 4.46; N, 7.01.

4-methoxy-N-(5,5,10-trifluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)aniline (2p) yellow solid; **mp**: 192-193°C; **1H NMR** (300 MHz, CDCl$_3$) δ 8.54 (s, 1H), 7.81 (d, $J = 7.9$ Hz, 1H), 7.65 (d, $J = 7.8$ Hz, 1H), 7.57 (t, $J = 7.6$ Hz, 1H), 7.41 (t, $J = 7.6$ Hz, 1H), 7.25 (d, $J = 6.3$ Hz, 1H), 7.03-6.92 (m, 6H), 3.85 (s, 3H); **19F NMR** (282 MHz, CDCl$_3$) δ -79.70 (s, 2F), -118.72 - -118.63 (m, 1F); **13C NMR** (100 MHz, CDCl$_3$) δ 161.04, 158.65, 156.29, 141.23 (t, $J = 27.2$ Hz), 140.10, 134.32, 133.00, 131.99, 131.37 (d, $J = 9.3$ Hz), 129.08, 127.35 (t, $J = 24.9$ Hz), 126.31, 126.01, 123.72, 120.82, 118.03, 113.88, 113.30 (d, $J = 24.0$ Hz), 106.52 (d, $J = 24.0$ Hz), 103.41 (d, $J = 4.0$ Hz), 55.52; **IR** (KBr, cm$^{-1}$): ν 3048, 2835, 1659, 1505, 1461, 1146, 1034, 770, 515; **MS (EI)** m/z (relative intensity) 393 (100) [M$^+$]; **Anal. Calcd.** For C$_{23}$H$_{15}$F$_3$N$_2$O: C, 70.40; H, 3.85; N, 7.14. Found: C, 70.41; H, 4.06; N, 7.03.

N-(10-bromo-5,5-difluoroindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2q)
N-(5,5-difluoro-9,11-dimethylindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2r)

yellow solid; mp: 205-206 °C; \(^1\)H NMR (300 MHz, CDCl₃) \(\delta 8.44 \text{ (d, } J = 7.9 \text{ Hz, } 1\text{H}), 7.82 \text{ (d, } J = 7.9 \text{ Hz, } 1\text{H}), 7.73 \text{ (s, } 1\text{H}), 7.65 \text{ (d, } J = 8.0 \text{ Hz, } 1\text{H}), 7.57 \text{ (t, } J = 7.5 \text{ Hz, } 1\text{H}), 7.45\text{-}7.37 \text{ (m, } 2\text{H}), 7.03\text{-}9.92 \text{ (m, } 5\text{H}), 3.85 \text{ (s, } 3\text{H}); \(^{19}\)F NMR (282 MHz, CDCl₃) \(\delta -79.98 \text{ (s, } 2\text{F}); \(^{13}\)C NMR (100 MHz, CDCl₃) \(\delta 156.38, 139.96, 135.25, 133.98, 132.11, 132.02, 129.18, 128.38, 127.38 \text{ (t, } J = 24.9 \text{ Hz}), 126.01, 123.80, 123.65, 120.80, 118.25, 117.14, 113.89, 102.81, 55.52; IR (KBr, cm \(^{-1}\)):\nu 3021, 2825, 1654, 1505, 1448, 1248, 1031, 902, 768, 546; MS (ESI) \(m/z 453 [M+H]^+\); HRMS (ESI) \(m/e \text{ calcd for C}_{23}\text{H}_{16}\text{F}_{2}\text{N}_{2}\text{O}^+ [M+H^+] 453.0409, \text{ Found: 453.04105.}\)

N-(5,5-difluoro-8-methylindolo[2,1-a]isoquinolin-6(5H)-ylidene)-4-methoxyaniline (2s)

yellow solid; mp: 254-255 °C; \(^1\)H NMR (300 MHz, CDCl₃) \(\delta 8.21 \text{ (s, } 1\text{H}), 7.82 \text{ (d, } J = 7.7 \text{ Hz, } 1\text{H}), 7.62 \text{ (d, } J = 7.5 \text{ Hz, } 1\text{H}), 7.53 \text{ (t, } J = 7.6 \text{ Hz, } 1\text{H}), 7.36 \text{ (t, } J = 7.5 \text{ Hz, } 1\text{H}), 7.14\text{-}6.83 \text{ (m, } 6\text{H}), 3.85 \text{ (s, } 3\text{H}), 2.53 \text{ (s, } 3\text{H}), 2.42 \text{ (s, } 3\text{H}); \(^{19}\)F NMR (282 MHz, CDCl₃) \(\delta -79.61 \text{ (s, } 2\text{F}); \(^{13}\)C NMR (100 MHz, CDCl₃) \(\delta 156.05, 141.57 \text{ (t, } J = 20.2 \text{ Hz), 140.55, 137.07, 136.24, 131.80, 130.14, 128.27, 127.92, 126.02, 125.89, 123.38, 120.75, 114.37, 113.82, 102.60, 55.53, 22.10; IR (KBr, cm \(^{-1}\)):\nu 3003, 2830, 1660, 1506, 1400, 1242, 1039, 764, 482; MS (EI) \(m/z \text{ (relative intensity) 403 (100) [M]^+};\) HRMS (EI) \(m/e \text{ calcd for C}_{24}\text{H}_{18}\text{F}_{2}\text{N}_{2}\text{O: 388.1387, Found: 388.1384.}\)

N-(6,6-difluoropyrrolo[2,1-a]isoquinolin-5(6H)-ylidene)-4-methoxyaniline(4a)

\(^1\)H NMR (300 MHz, CDCl₃) \(\delta 7.67\text{-}7.40 \text{ (m, } 4\text{H}), 7.40\text{-}7.16 \text{ (m, } 1\text{H}), 6.99\text{-}6.89 \text{ (m, } 4\text{H}), 6.68\)
N-(6,6-difluoroimidazo[2,1-a]isoquinolin-5(6H)-ylidene)-4-methoxyaniline (4b)

Yellow solid; mp: 157-160°C; \(^1H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.17 (d, \(J = 7.7\) Hz, 1H), 7.75 (s, 1H), 7.62 (m, 2H), 7.49 (d, \(J = 6.5\) Hz, 1H), 7.00 (s, 1H), 6.93 (d, \(J = 7.3\) Hz, 2H), 3.84 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -81.76 (s, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 171.08, 157.13, 142.70, 138.66, 132.41, 131.85, 130.08, 128.65, 126.00, 124.12, 121.05, 116.26, 113.90, 55.45; IR (KBr, cm\(^{-1}\)):\(\nu\) 3144, 2907, 1687, 1504, 1414, 1266, 834, 778, 575; MS (EI) \(m/z\) (relative intensity) 325 (100); Anal. Calcd. For C\(_{18}\)H\(_{13}\)F\(_2\)N\(_3\)O: C, 66.46; H, 4.03; N, 12.92. Found: C, 66.71; H, 4.11; N, 13.03.

N-(6,6-difluoro-2-phenylpyrrolo[2,1-a]isoquinolin-5(6H)-ylidene)-4-methoxyaniline (4c)

Yellow solid; mp: 179-181°C; \(^1H\) NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.98 (s, 1H), 7.79 – 7.58 (m, 3H), 7.54 (s, 1H), 7.49 – 7.29 (m, 5H), 7.16 – 6.79 (m, 5H), 3.88 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -81.03 (s, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 156.54, 139.81, 133.58, 132.00, 129.69, 128.84, 127.50, 127.13, 126.83, 126.67, 126.43, 126.19, 126.10, 125.54, 122.38, 121.00, 115.60, 113.85, 107.09, 55.48; IR (KBr, cm\(^{-1}\)):\(\nu\) 2825, 1734, 1665, 1504, 1418, 1410, 1275, 1241, 1034, 764, 750; MS (EI) \(m/z\) (relative intensity) 400 (100); Anal. Calcd. For C\(_{25}\)H\(_{18}\)F\(_2\)N\(_2\)O: C, 74.99; H, 4.53; N, 7.00. Found: C, 75.28; H, 4.76; N, 7.08.

N-(8-chloro-6,6-difluoro-2-phenylpyrrolo[2,1-a]isoquinolin-5(6H)-ylidene)-4-methoxyaniline (4d)

Yellow solid; mp: 195-197°C; \(^1H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 7.91 (s, 1H), 7.56 (m, 3H), 7.49 – 7.35 (m, 3H), 7.35 – 7.19 (m, 2H), 6.96 (m, 5H), 3.83 (s, 3H); \(^{19}\)F NMR (282 MHz, CDCl\(_3\)) \(\delta\) -81.39 (s, 2F); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 156.73, 139.51, 133.36, 133.10, 132.36, 129.69, 128.86, 127.76, 127.52, 127.24, 126.23, 125.52, 123.81, 120.99, 115.90, 113.89, 107.51, 55.49; IR (KBr, cm\(^{-1}\)):\(\nu\) 2920, 2846, 1734, 1665, 1504, 1407, 1240, 885, 833, 543; MS (EI) \(m/z\) (relative intensity) 400 (100).
N-(2-(tert-butyl)-6,6-difluoro-8-methoxypyrrolo[2,1-a]isoquinolin-5(6H)-ylidene)-4-methoxy aniline(4e)

yellow solid; mp: 140-141°C; \(^1H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 7.49 (d, \(J = 9.0\) Hz, 1H), 7.33 (s, 1H), 7.01 (m, 2H), 6.93 (m, 4H), 6.52 (s, 1H), 3.82 (s, 3H), 3.78 (s, 3H), 1.29 (s, 9H); \(^19F\) NMR (282 MHz, CDCl\(_3\)) \(\delta\) -81.75 (s, 2F); \(^{13}C\) NMR (100 MHz, CDCl\(_3\)) \(\delta\) 158.80, 156.26, 140.89 (t, \(J = 27.9\) Hz), 140.80, 140.22, 128.42, 127.41 (t, \(J = 24.1\) Hz), 123.89, 120.88, 120.34, 119.45, 114.98, 113.78, 113.62, 110.94, 109.48, 106.40, 55.44, 30.96, 30.87; IR (KBr, cm\(^{-1}\)): \(\nu\) 2975, 1671, 1506, 1045, 841, 586; MS (EI) m/z (relative intensity) 410 (27) [M+]; Anal. Calcd. For C\(_{25}\)H\(_{17}\)ClF\(_2\)N\(_2\)O: C, 69.05; H, 3.94; N, 6.44. Found: C, 69.20; H, 4.12; N, 6.43.

5,5-difluoroindolo[2,1-a]isoquinolin-6(5H)-one (2aa)

white solid; mp: 157-158°C; \(^1H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 8.38 (d, \(J = 8.0\) Hz, 1H), 7.84 – 7.69 (m, 2H), 7.57-7.50 (m, 2H), 7.47 – 7.22 (m, 3H), 7.01 (s, 1H); \(^{19F}\) NMR (282 MHz, CDCl\(_3\)) \(\delta\) -91.91 (2F); \(^{13}C\) NMR (100 MHz, CDCl\(_3\)) \(\delta\) 158.53 (t, \(J = 31.6\) Hz), 135.82, 132.89, 132.14, 130.48, 129.34, 126.93, 126.67 (t, \(J = 3.1\) Hz), 125.73, 123.74, 121.50, 116.58, 107.91 (t, \(J = 240.5\) Hz), 107.50; IR (KBr, cm\(^{-1}\)): \(\nu\) 3117, 1717, 1610, 1455, 1402, 1155, 1024, 750, 549; MS (EI) m/z (relative intensity) 269 (100) [M+]; Anal. Calcd. For C\(_{16}\)H\(_{9}\)F\(_2\)NO: C, 71.37; H, 3.37; N, 5.20. Found: C, 71.34; H, 3.37; N, 5.28.

2-(tert-butyl)-6,6-difluoro-8-methoxypyrrolo[2,1-a]isoquinolin-5(6H)-one(4ea)

white solid; mp: 132-133°C; \(^1H\) NMR (300 MHz, CDCl\(_3\)) \(\delta\) 7.52 (d, \(J = 8.7\) Hz, 1H), 7.18 (s, 1H), 7.16 (s, 1H), 7.06 (d, \(J = 8.9\) Hz, 1H), 6.54 (s, 1H), 3.87 (s, 3H), 1.26 (s, 3H); \(^{19F}\) NMR (282 MHz, CDCl\(_3\)) \(\delta\) -95.04 (s); \(^{13}C\) NMR (100 MHz, CDCl\(_3\)) \(\delta\) 159.43, 158.14 (t, \(J = 31.4\) Hz), 143.29, 129.97, 127.32 (t, \(J = 23.3\) Hz), 124.36, 119.61, 119.33 (t, \(J = 6.1\) Hz), 109.15, 107.92 (t, \(J = 241.7\) Hz), 55.60, 30.83, 30.86; IR (KBr, cm\(^{-1}\)): \(\nu\) 3108, 2966, 1728, 1620, 1604, 1538, 1491, 1343, 1023, 754, 630; MS (EI) m/z (relative intensity) 305 (61) [M+]; Anal. Calcd. For C\(_{17}\)H\(_{17}\)F\(_2\)NO: C, 66.87; H, 5.61; N, 4.59. Found: C, 66.90; H, 5.62; N, 4.58.

N-(2-chloro-2,2-difluoro-1-(2-phenyl-1H-indol-1-yl)ethylidene)-4-methoxyaniline (5a)
yellow solid; \textit{mp}: 78-79 °C; $^1$H NMR (300 MHz, CDCl$_3$) $\delta$ 7.65 (d, $J = 3.7$ Hz, 1H), 7.37 – 7.24 (m, 5H), 7.21- (m, 3H), 6.79 (s, 1H), 6.67 (q, $J = 9.0$ Hz, 4H), 3.73 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -48.07 – -60.67 (m, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 160.19, 140.27 (t, $J = 27.3$ Hz), 139.51, 136.14, 135.78, 131.79, 129.08, 128.69, 128.35, 127.38, 126.60, 123.63, 122.37 (t, $J = 296.6$ Hz), 122.04, 121.01, 114.32, 111.50, 105.90, 55.40; IR (KBr, cm$^{-1}$): v 3059, 2835, 1650, 1588, 1504, 1453, 1338, 979, 748, 523; MS (ESI) m/z 411 [M+H$^+$]; \textbf{Anal. Caled.} For C$_{23}$H$_{17}$ClF$_2$N$_2$O: C, 67.24; H, 4.17; N, 6.82. Found: C, 67.34; H, 4.22; N, 6.77.

N-(2-bromo-2,2-difluoro-1-(1H-indol-1-yl)ethylidene)-4-methoxyaniline (6a)

white solid; \textit{mp}: 57-59 °C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.57 (d, $J = 7.8$ Hz, 1H), 7.23 (s, 1H), 7.09 (t, $J = 7.4$ Hz, 1H), 7.03 (t, $J = 7.5$ Hz, 1H), 6.82 (d, $J = 7.7$ Hz, 1H), 6.72 (d, $J = 3.4$ Hz, 1H), 6.63-6.57 (m, 4H), 3.65 (s, 3H); $^{19}$F NMR (282 MHz, CDCl$_3$) $\delta$ -53.04 (s, 2F); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 159.50, 140.08 (t, $J = 26.8$ Hz), 136.12, 134.45, 128.69, 125.27, 123.48, 121.71, 121.10, 114.20, 112.01, 106.79, 55.30; IR (KBr, cm$^{-1}$): v 3016, 2846, 1650, 1591, 1503, 1452, 1325, 959, 812, 532; MS (EI) m/z (relative intensity) 378 (50, $^{79}$Br) [M$^+$], 380 (47, $^{81}$Br) [M$^+$], 262 (100), 264 (98); \textbf{Anal. Caled.} For C$_{17}$H$_{13}$BrF$_2$N$_2$O: C, 53.85; H, 3.46; N, 7.39. Found: C, 54.09; H, 3.58; N, 7.39.
NMR Spectra for the Substrates and Products

1a
$1b$

![Chemical structure and NMR spectrum](image-url)

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3a

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3b
3c
3e

![Chemical structure and NMR spectrum for 3e](image)

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2d
2k
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4d