Supporting Information

A Shape Selective Fluorescent Sensing Ensemble using a Tweezer-type Metallo-Receptor

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Spectroscopic Analysis:

Fluorescence spectra were recorded on a Shimadzu RF-5301 PC spectrofluorimeter at ambient temperature. The excitation wavelength was 384 nm with excitation and emission slit widths of 5 nm each. The host solution consisted of 40 µM compound 2 and 10 µM in DMASP. All guest solutions were prepared as above and contained 40 µM 2 and 10 µM DMASP to prevent dilution. Absorption spectra were recorded on a Cary 1E spectrophotometer at ambient temperature. Solutions of compound 2 were prepared at 10 µM in acetone. Guest solutions were prepared as above and contained 10 µM 2 to prevent dilution. At high concentrations of certain guests, notably DMAP, the absorption spectrum indicated that the guest could compete for copper ion and liberate free ligand 1. Thus, all titrations were performed below this concentration of guest.

Guest binding stoichiometry was demonstrated by X-ray crystallographic analysis with three different guests: pyridine, pyridine-2-aldehyde, and isonicatinamide. The fluorescence data was linearized according to a method described by Connors. The binding affinity of DMASP to the host was determined by absorbance spectroscopy and the data fit to one-site binding isotherm using Graphpad Prism software. A 1:1 binding model was assumed and the data fit this model well.

Synthetic Procedures:

General Methods. All reactions were carried out in dried glassware under N₂ atmosphere. Tetrahydrofuran (THF) and diethyl ether were distilled from sodium benzophenone ketyl under N₂ before use. Toluene was distilled from sodium prior to use. Solvents used for crystallization were all of HPLC grade and used without further
purification. Flash chromatography was performed with 32-63 µm silica gel. All melting points are uncorrected. NMR spectra were recorded on Bruker ARX 250 or DRX 300 instruments as noted below in the solvents recorded. IR spectra were recorded on a Nexus 670 FT-IR E.S.P. spectrometer.

Synthesis of 4: Acetaldehyde (200 µl, 3.54 mmol) and Methylamine (1.8 ml, 2.0 M in THF, 3.6 mmol) was added to dry DMF (30 ml) in a flame dried flask under N₂. The solution was allowed to stir for 1 hour then compound 3 (0.7760g, 2.13 mmol) was added along with K₂CO₃ (426.3 mg, 3.08 mmol), and then allowed to stir overnight. The solvent was removed in vacuo and the oily solid was redissolved in MeCl₂ and water. The layers were separated and the aqueous layer extracted with MeCl₂ (3x 100 ml). The combined organic extracts were dried (Na₂SO₄) and the solvent removed under reduced pressure. The compound was purified by flash chromatography (SiO₂, MeCl₂ to 10% MeOH in MeCl₂) to yield compound 4 (425 mg, 98%) as a yellow solid. m.p. 88 °C; ¹H NMR (300 MHz, CDCl₃, 25 °C, TMS): δ=7.55 (d, 3 J(H,H)=8.8 Hz, 2 ArH), 7.38 (s, ArH), 6.92 (d, 3 J(H,H)=8.8 Hz, 2ArH), 3.79 (s, CH₃), 3.49 (s, CH₃), 2.31 (s, CH₃); ¹³C NMR (75 Mhz, CDCl₃ 25 °C, TMS) δ= 157.9, 137.4, 135.9, 128.1, 127.8, 122.6, 113.6, 55.0, 31.2, 9.3; IR(thin film): = 3093 cm⁻¹, 2839, 1511, 1248, 1175, 831; HRMS (FAB): m/z : 209.1263 [M+Li⁺], C₁₂H₁₄N₂O₂Li requires 209.1266.

Synthesis of 5: A dry flask was charged with compound 4 (400 mg, 1.98 mmol) and dry THF (40 ml). The solution was cooled to 0°C then NBS (385.4 mg, 2.0 mmol) was added and the solution stirred for 3 hours. The solvent was removed under reduced pressure and the residue was dissolved in Et₂O (200 ml) and washed with 10% aq. NaOH (3x100 ml). The organic layer were dried (Na₂SO₄) and the solvent evaporated. The residue was subjected to flash chromatography (SiO₂, MeCl₂ to 10% MeOH MeCl₂) to yield compound 5 as an oil that solidified upon standing (275.1 mg, 50%). m.p. 114 °C; ¹H NMR (250 MHz, CDCl₃, 25 °C, TMS): δ=7.49 (d, 3 J(H,H)=8.8 Hz, 2 ArH), 6.90 (d, 3 J(H,H)=8.8 Hz, 2 ArH), 3.79 (s, CH₃), 3.47 (s, CH₃), 2.32 (s, CH₃); ¹³C NMR (75 Mhz, CDCl₃ 25 °C, TMS) δ= 158.3, 138.3, 128.1, 127.1, 125.3, 118.1, 113.6, 55.1, 32.0, 10.6;
IR(thin film): = 2936 cm\(^{-1}\), 1508, 1250, 1174, 1036; HRMS (FAB): \(m/z\) : 287.0365 \([M+Li^+]\), \(C_{12}H_{13}N_2OBrLi\) requires 287.0371.

Synthesis of 1: Compound 5 (275 mg 0.97 mmol) was added to a flame dried flask followed by \(\text{Et}_2\)O. The solution was chilled to -78\(^\circ\)C and a solution of \(n\)BuLi (1.6 ml, 1.6 M in hexanes, 1 mmol) was added dropwise, and then allowed to stir for 30 minutes after which \(\text{Bu}_3\text{SnCl}\) (330 \(\mu\)l, 1.22 mmol) was added. The solution was allowed to warm to room temperature over 20 minutes followed by removal of the solvent with a stream of \(\text{N}_2\). To this flask was added toluene (40 ml), 2,6-dibromopyridine (91.9 mg 0.38 mmol) and tetrakistriphenylphosphinepalladium(0) (80.5mg, 0.07mmol). The flask was then and then backfilled with \(\text{N}_2\) thrice and then allowed to stir at 90 \(^\circ\)C for 14 hours. The solvent was removed under reduced pressure and the residue underwent chromatography (SiO\(_2\), MeCl\(_2\) to 15\% MeOH/MeCl\(_2\)) to yield compound 1 as a white powder (137 mg, 75%). An analytically pure sample was obtained by recrystallization from CH\(_3\)CN. m.p. 268 \(^\circ\)C; \(^1\)H NMR (300 MHz, CDCl\(_3\), 25 \(^\circ\)C, TMS): \(\delta=8.14\) (d, \(\text{J}(H,H)=7.8\), 2 ArH), 7.85 (t, \(\text{J}(H,H)=7.8\) Hz, ArH), 7.64 (d, \(\text{J}(H,H)=8.5\) Hz, 4 ArH), 6.99 (d, \(\text{J}(H,H)=8.5\) Hz, 4 ArH), 4.05 (s, 2 CH\(_3\)), 3.86 (s, 2 CH\(_3\)), 2.46 (s, 2 CH\(_3\)); \(^{13}\)C NMR (75 Mhz, CDCl\(_3\) 25 \(^\circ\)C, TMS) \(\delta=158.4, 149.5, 144.1, 137.7, 137.5, 128.6, 128.0, 126.2, 122.4, 113.9, 55.3, 32.7, 10.3\); IR(thin film): = 1488 cm\(^{-1}\), 1246, 1174, 1017, 836; HRMS (FAB): \(m/z\) : 486.2497 \([M+Li^+]\), \(C_{29}H_{29}N_5O_2Li\) requires 486.2481.

Synthesis of 2: Compound 1 (25.7 mg, 0.053 mmol) was added to a flask followed by CH\(_3\)CN (10 ml) and the flask was sonicated to produce a fine suspension. CuCl\(_2\) (7.6 mg, 0.056 mmol) was added and the solution allowed to stir for 4 hours. The solvent was removed under reduced pressure and the residue was redissolved in CH\(_3\)CN (15 ml) and protected from the light. AgClO\(_4\) hydrate (27.5 mg 0.132 mmol) was added and the solution allowed to stir overnight. The suspension was centrifuged and the supernatant poured off and the solvent removed under reduced pressure. The residue was resuspended in acetone (30 ml) and filtered through a 10 \(\mu\)m syringe filter. The solvent was concentrated and then crystallized by vapor diffusion of benzene into a concentrated acetone solution.
Synthesis of 6: Compound 1 (19.6 mg, 0.0409 mmol) was added to a vial and suspended in CH$_3$CN (10 ml). Cu(ClO$_4$)$_2$·6H$_2$O (7.5 mg, 0.0202 mmol) was added and the solution allowed to stir for 4 hours. The solvent was removed under reduced pressure and the residue dissolved in CH$_3$CN and crystallized by vapor diffusion with benzene.

Figure S1. ORTEP representation of 2-pyridine-2-aldehyde showing the interaction of the aldehyde oxygen with the copper center.
$^1$H and $^{13}$C data for compound 4.
1H and 13C data for compound 5.

Chemical Shifts:
- 1H: 6.98, 7.23
- 13C: 130, 135, 140, 150

NMR Spectra:
- 13C NMR spectrum is shown with peaks at various ppm values.
- 1H NMR spectrum is shown with peaks at various ppm values.

Other Parameters:
- NMR: 300 MHz
- Dil: 0.00020002 sec
- T1: 1.0000000 sec
- T2: 6.00 usec
- FO: 62.500.0 Hz
- NUCLEUS: 13C
- 0.00000100 sec

Processing Parameters:
- SF: 62.500.00 Hz
- EM: 62
- L0: 1.00 Hz
- PC: 1.00

Plot Parameters:
- CX: 20.00 cm
- CY: 10.00 cm
- F1: 600.000 ppm
- F2: 10.000 ppm
- PPM: 130.000 ppm
- NMR: 617.0384 Hz
$^1$H and $^{13}$C data for compound 1.