Supporting Materials

A Triazole-bearing picket fence type nickel porphyrin as a cyanide selective allosteric host

Kyeong-Im Hong, Hongsik Yoon, and Woo-Dong Jang*

Materials and Measurements.

All commercially available reagents were reagent grade and were used without further purification. Tetrahydrofuran (THF) and acetonitrile were freshly distilled before each use. All anions used for selectivity tests were in the form of the tetrabutylammonium salt. UV/Vis absorption spectra were recorded on a JASCO model V-660 spectrometer. ^{1}H and ^{13}C NMR spectra were recorded on Bruker Advance PDX 250 and DPX 400 spectrometers, respectively, at 25 ^{o}C in $CDCl_3$ or acetonitrile-*d*$_3$. MALDI-TOF-MS was performed on a BrukerDaltonics LRF20 with dithranol (1,8,9-trihydroxyanthracene) as the matrix.

Synthesis.

3: A Schlenk flask was degassed under high vacuum. Diisopropylamine (7.13 mL, 32 mmol) was added in anhydrous THF (300 mL) under N_2. n-BuLi (20 mL, 32 mmol) was added dropwise to the stirred solution at -78 ^{o}C. After stirring 30 min, 1,3-dibromobenzene (5.11 mL, 26.6 mmol) and *N, N*-dimethylformamide (DMF, 6.5 mL, 84.7 mmol) were added to the orange suspension. The reaction mixture was stirred for 10 min at -78 ^{o}C, and then dilute sulfuric acid was slowly added to terminate the reaction. The solution was extracted with H_2O/CH_2Cl_2, and the organic layer was concentrated. The residue was purified by column chromatography eluting with CH_2Cl_2 to give **3** (10 g, 91%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 ^{o}C) δ = 10.24 (s, 1 H), 7.62 - 7.64 (d, J = 8 Hz, 2 H), 7.20 - 7.24 ppm (t, J = 8 Hz, 1 H).

4: 3 (5 g, 18.9 mmol), CuI (18 mg, 0.09 mmol), and $Pd(PPh_3)_2Cl_2$ (66 mg, 0.09 mmol) were placed in a Schlenk flask. The flask was degassed under high vacuum and back-filled with N_2. Anhydrous THF (20 mL), Et_3N (10 mL), and trimethylsilylacetylene (4.6 g, 47.3 mmol) were added, and the reaction mixture was refluxed for 12 h. After evaporation of the THF, the residue was dissolved in CH_2Cl_2, washed with H_2O, and concentrated. The residue was purified by column chromatography eluting with 5% ethyl acetate/hexane to give **4** (10 g, 91%). ^{1}H NMR (250 MHz, $CDCl_3$, 25 °C) δ = 10.63 (s, 1 H), 7.51 – 7.55 (t, J = 7.5Hz, 2 H), 7.39 – 7.45 (m, 1 H), 0.28 ppm (s, 18 H).

6: A mixture of phenyldipyrrolemethane (2 g, 9 mmol) and **4** (2.68 g, 9 mmol) in propionic acid (150 mL) was refluxed for 2 h. The solution was cooled to 30 °C and concentrated under high vacuum to remove the propionic acid. The residue was dissolved in CH_2Cl_2 and washed with 1 M NaOH solution. The organic layer was concentrated, and the residue was chromatographed on silica gel with CH_2Cl_2 as eluent to obtain the crude product (**5**). **5** was dissolved in 10% MeOH/CH_2Cl_2 containing $Zn(OAc)_2$ (2.962 g, 13.5 mmol), and the mixture was stirred for 6 h at 25 °C. The reaction mixture was diluted with CH_2Cl_2, washed with H_2O, and concentrated. The residue was purified by column chromatography eluting with 20% CH_2Cl_2/hexane to obtain **6** (0.166 g, 4%). ^{1}H NMR (250 MHz, $CDCl_3$, 25 °C) δ = 8.89 - 8.91 (d, J = 5 Hz, 4 H), 8.86 - 8.88 (d, J = 5 Hz, 4 H), 8.19 - 8.23 (m, 4 H), 7.66 -7.77 (m, 8 H), -1.27 ppm (s, 36 H). MALDI-TOF-MS *m/z*: cald. for $C_{64}H_{60}N_4Si_4Zn$: 1060.32 [M^+]; found: 1059.646.

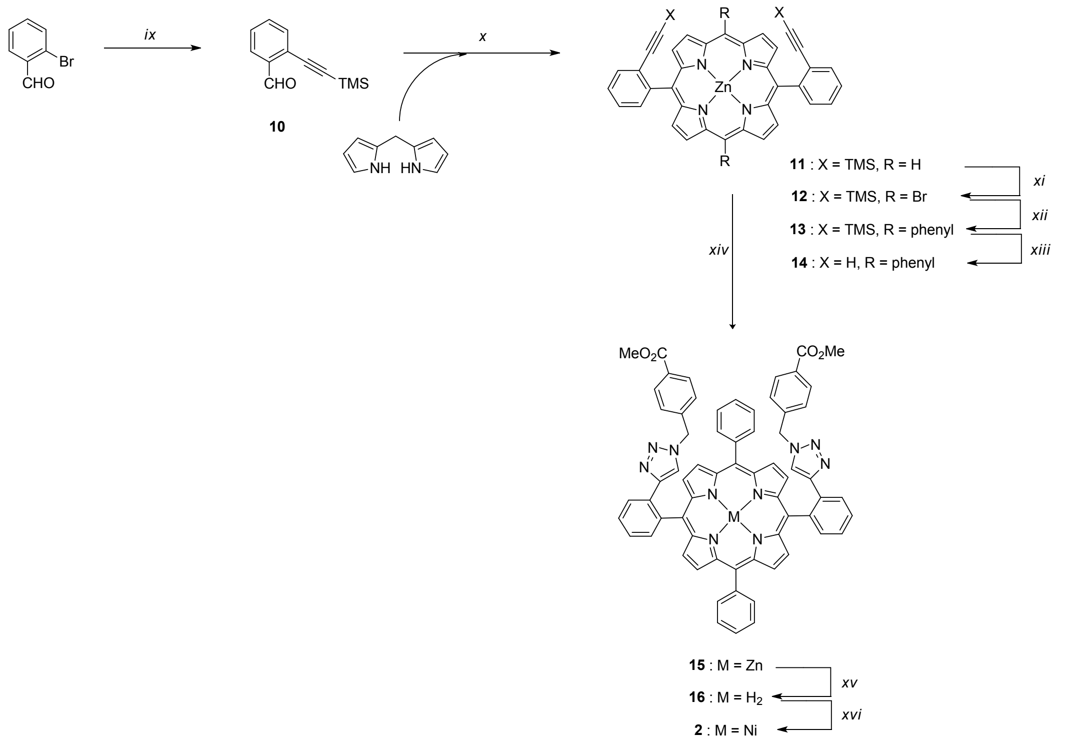
7: Tetrabutylammonium fluoride (TBAF; 0.1 mL, excess) was added to a solution of **6** (70 mg, 0.065 mmol) in THF (2 mL), and the mixture was stirred for 1 h at 25 °C, then the solvent was removed under reduced pressure. The residue was purified by column chromatography eluting with 5% MeOH/CH_2Cl_2 to give **7** (51 mg, 100%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ = 8.93 - 8.95 (d, J = 8 Hz, 4 H), 8.76 - 8.77 (d, J = 4 Hz, 4 H), 8.24 - 8.25 (d, J = 4 Hz, 4 H), 7.92 - 7.94 (d, J = 8 Hz, 4 H), 7.72 - 7.76 (t, J = 8 Hz, 8 H), 2.06 ppm (s, 4 H). MALDI-TOF-MS *m/z*: cald. for $C_{52}H_{28}N_4Zn$: 772.16 [M^+]; found: 771.55.

8: $CuSO_4 \cdot 5H_2O$ (0.321 g, 1.3 mmol) and sodium ascorbate (0.26 g, 1.3 mmol) were added to a mixture of **7** (0.1 g, 0.13 mmol) and methyl 4-(azidomethyl)benzoate (0.12 g, 0.65 mmol) in 6 mL of THF/H_2O (1:1). The reaction mixture was refluxed for 12 h, and then the organic layer was separated. After evaporation of the solvent under reduced pressure, the residue was purified by column chromatography eluting with 30% ethyl acetate/CH_2Cl_2, and the resulting solid was recrystallized from CH_2Cl_2/hexane to produce **8** as a purple solid (99 mg, 50%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ = 8.83 - 8.84 (d, J = 4 Hz, 4 H), 8.78 - 8.79 (d, J = 4 Hz, 4 H), 8.42 - 8.44 (d, J = 8 Hz, 4 H), 8.01 - 8.04 (t, J = 4 Hz, 8 Hz, 2 H), 7.95 - 7.96 (d, J = 4 Hz, 4 H), 7.70 - 7.73 (t, J = 8 Hz, 4 Hz, 2 H), 7.63 - 7.67 (t, J = 8 Hz, 4 H), 6.42 - 6.44 (d, J = 8 Hz, 8 H), 5.18 - 5.20 (d, J = 8 Hz, 8 H), 5.15 (s, 4 H), 3.99 (s, 8 H), 3.65 ppm (s, 12 H). MALDI-TOF-MS *m/z*: cald. For $C_{88}H_{64}N_{16}O_8Zn$: 1537.44 [M^+]; found: 1538.15.

9: Trifluoroacetic acid (0.5 mL) was added to **8** (50 mg, 0.032 mmol) in CH_2Cl_2. The reaction mixture was stirred for 1 h at 25 °C. The solution was washed three times with H_2O and concentrated, and the residue was purified by column chromatography eluting with 5% MeOH/CH_2Cl_2 to give **9** (43 mg 90%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ = 8.84 - 8.86 (d, J = 8 Hz, 4 H), 8.76 - 8.78 (d, J = 8 Hz, 4 H), 8.49 - 8.52 (d, J = 12 Hz, 4 H), 8.07 - 8.11 (t, J = 8 Hz, 4 H), 7.89 - 7.91 (d, J = 8 Hz, 2 H), 7.70 - 7.74 (t, J = 8 Hz, 2 H), 7.63 - 7.66 (t, J = 4 Hz, 8 Hz, 4 H), 6.03 - 6.05 (d, J = 8 Hz, 8 H), 4.79 (s, 4 H), 4.73 - 4.75 (d, J = 8 Hz, 8 H), 3.64 (s, 8 H), 3.62 (s, 12 H), -2.52 ppm (s, 2 H). MALDI-TOF-MS *m/z*: cald. for $C_{88}H_{66}N_{16}O_8$: 1474.52 [M^+]; found: 1475.23.

1: Nickel(II) acetylacetonate (74 mg, 0.29 mmol) was added to a solution of **9** (43 mg, 0.029 mmol) in toluene. The reaction mixture was refluxed for 24 h. After cooling, the solution was diluted with ethyl acetate and then washed with H_2O. The organic layer was concentrated, and the residue was purified by column chromatography eluting with 1:2 ethyl acetate/CH_2Cl_2. The resulting solid was recrystallized from $CHCl_3$/pentane to produce **1** as a purple solid (31 mg, 69%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ = 8.74 - 8.75(d, J = 4 Hz, 4 H), 8.65 - 8.67 (d, J = 8 Hz, 4 H), 8.42 - 8.44 (d, J = 4 Hz, 4 H), 7.99 - 8.02 (t, J = 4 Hz, 8 Hz, 2 H), 7.71 - 7.72 (d, J = 4 Hz, 4 H), 7.65 - 7.68 (t, J = 4 Hz, 8

Hz, 2 H), 7.56 - 7.59 (t, *J* = 8 Hz, 4 Hz, 4 H), 6.24 - 6.26 (d, *J* = 8Hz, 8H), 5.23 - 5.25 (d, *J* = 8 Hz, 8 H), 4.96 (s, 4 H), 4.01 (s, 8 H), 3.59 ppm (s, 12 H); ^{13}C NMR (100 MHz, $CDCl_3$, 25 ^{o}C) □ = 165.67, 147.35, 143.57, 143.22, 140.21, 138.54, 136.42, 134.01, 133.88, 133.79, 131.72, 129.97, 129.16, 128.97, 128.90, 128.27, 127.15, 126.17, 121.87, 120.10, 116.64, 52.25, 51.95 ppm; MALDI-TOF-MS *m/z*: cald. for $C_{88}H_{64}N_{16}NiO_8$: 1530.44[M^+]; found: 1531.29.



Scheme S1. Synthesis of **2**

10: 2-bromobenzaldehyde (6 g, 32 mmol), CuI (30 mg, 0.16 mmol), and $Pd(PPh_3)_2Cl_2$ (100 mg, 0.16 mmol) were placed in a Schlenk flask. The flask was degassed under high vacuum and back-filled with N_2. Anhydrous THF (10 mL), Et_3N (10 mL), and trimethylsilylacetylene (6.37 g, 64 mmol) were added, and the reaction mixture was refluxed for 12 h. After evaporation of the THF, the residue was dissolved in CH_2Cl_2, washed with H_2O, and concentrated. The residue was purified by column chromatography eluting with 20% CH_2Cl_2/hexane to give **10** (6 g, 89%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ= 10.56 (s, 1 H), 7.90 - 7.92 (d, J = 8 Hz, 1 H), 7.51 - 7.58 (m, 2 H), 7.41 - 7.45 (t, J = 8 Hz, 1 H), 0.28 ppm (s, 9 H).

11: TFA (1 mL) was added to a mixture solution of dipyrrolemethane (2 g, 13.6 mmol) and **9** (2.76 g, 13.6 mmol) in CH_2Cl_2 (800 mL) and stirred for 2 h at 25 °C. Then, *p*-Chloranil (10 g, 40.8 mmol) was added, and the reaction mixture was further stirred for 4 h. The reaction mixture was concentrated to a volume of 200 mL and then chromatographed in silica gel with CH_2Cl_2. Without further purification, the product was dissolved in 10% MeOH/CH_2Cl_2 containing $Zn(OAc)_2$ (4.47g, 20.4 mmol) and then stirred for 6 h at 25 °C. The reaction mixture was purified by column chromatography eluting with 50% CH_2Cl_2/hexane where the first fraction was collected, giving **11** (0.35 g, 7%). ^{1}H NMR (250 MHz, $CDCl_3$, 25 °C) δ= 10.31 (s, 2 H), 9.41 - 9.43 (d, J = 5 Hz, 4 H), 9.07 - 9.09 (d, J = 5 Hz, 4 H), 8.21 - 8.24 (m, 2 H), 7.93 - 7.96 (m, 2 H), 7.75 - 7.79 (m, 4 H), -1.23 ppm (s, 18 H). MALDI-TOF-MS *m/z*: cald. for $C_{42}H_{36}N_4Si_2Zn$: 716.18 [M^+]; found: 716.52.

12: **11** (0.35 g, 0.48 mmol) were placed in a Schlenk flask. The flask was degassed under high vacuum and back-filled with N_2. *N*-bromosuccinimide (NBS; 0.17 g, 0.98 mmol) and pyridine (0.5 mL) were added to a solution of **10** in CH_2Cl_2 (200 mL) at 0 °C. The reaction mixture was quenched with acetone (20 mL) and evaporated. The residue was purified by column chromatography eluting with 100% CH_2Cl_2 to give **12** (0.36 g, 85%). ^{1}H NMR (250 MHz, $CDCl_3$, 25 °C) δ= 9.70 - 9.72 (d, J = 5.0 Hz, 4 H), 8.88 - 8.90 (d, J = 5 Hz, 4 H), 8.11 - 8.14 (m, 2 H), 7.90 - 7.93 (m, 2 H), 7.75 - 7.80 (m, 4 H), -1.12 ppm (s, 18 H). MALDI-TOF-MS *m/z*: cald. for $C_{42}H_{34}Br_2N_4Si_2Zn$: 872.0 [$M^+$]; found: 875.94

13: **12** (0.36 g, 0.41 mmol), phenylboronic acid (0.40 g, 3.28 mmol), K_3PO_4 (0.87 g, 4.1 mmol) were placed in a Schlenk flask. The flask was degassed under high vacuum and back-filled with N_2. Anhydrous THF (10 mL), $Pd(PPh_3)_4$ (2.3 mg, 0.002 mmol) were added, and the reaction mixture was refluxed for 6 h. After evaporation of the THF, the residue was dissolved in CH_2Cl_2, washed with H_2O, and concentrated. The residue was purified by column chromatography eluting with 1 : 2 CH_2Cl_2/hexane where the first fraction was collected, giving **13** (0.28 g, 77%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ= 8.90 - 8.91 (d, J = 4 Hz, 4 H), 8.88 - 8.90 (d, J = 8 Hz, 4 H), 8.19 - 8.22 (m, 6 H), 7.89 - 7.91 (m, 2 H), 7.71 - 7.78 (m, 10 H), -1.14 ppm (s, 18 H). MALDI-TOF-MS *m/z*: cald. for $C_{54}H_{44}N_4Si_2Zn$: 868.24 [M^+]; found: 868.13.

14: Tetrabutylammonium fluoride (TBAF; 0.1 mL, excess) was added to a solution of **13** (0.16 g, 0.17 mmol) in THF (10 mL), and the mixture was stirred for 1 h at 25 °C, then the solvent was removed under reduced pressure. The residue was purified by column chromatography eluting with 5% MeOH/CH_2Cl_2 to give **14** (0.13 g, 98%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ= 8.93 - 8.94 (d, J = 4 Hz, 4 H), 8.82 - 8.83 (d, J = 4 Hz, 4 H), 8.22 - 8.24 (d, J = 8 Hz, 4 H), 8.11 - 8.13 (d, J = 8 Hz, 2 H), 7.94 - 7.96 (d, J = 8 Hz, 2 H), 7.72 - 7.75 (m, 10 H), 2.13 (s, 2 H). MALDI-TOF-MS *m/z*: cald. for $C_{48}H_{28}N_4Zn$: 724.16 [M^+]; found: 722.99

15: $CuSO_4\cdot 5H_2O$ (0.147 g, 0.59 mmol) and sodium ascorbate (0.117 g, 0.59 mmol) were added to a mixture of **14** (43 mg, 0.059 mmol) and methyl 4-(azidomethyl)benzoate (0.113 mg, 0.59 mmol) in 4 mL of THF/H_2O (1:1). The reaction mixture was refluxed for 12 h, and then the organic layer was separated. After evaporation of the solvent under reduced pressure, the residue was purified by column chromatography eluting with 20% ethyl acetate/CH_2Cl_2 where the first fraction was collected, giving **15** (54 mg, 83%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ= 8.85 - 8.86 (d, J = 4 Hz, 4 H), 8.79 - 8.81 (d, J = 8 Hz, 4 H), 8.63 - 8.65 (d, J = 8 Hz, 2 H), 8.07 - 8.10 (m, 6 H), 7.90 - 7.93 (m, 2 H), 7.69 - 7.77 (m, 8 H), 6.77 - 6.79 (d, J = 8 Hz, 4 H), 5.61 - 5.63 (d, J = 8 Hz, 4 H), 4.40 (s, 2 H), 4.15 (s, 4 H), 3.67 ppm (s, 6 H). MALDI-TOF-MS *m/z*: cald. for $C_{66}H_{46}N_{10}O_4Zn$: 1106.30 [M^+]; found: 1106.21.

16: Trifluoroacetic acid (0.5 mL) was added to **15** (30 mg, 0.027 mmol) in CH_2Cl_2. The reaction mixture was stirred for 1 h at 25 °C. The solution was washed three times with H_2O and concentrated, and the residue was purified by column chromatography eluting with 5% MeOH/CH_2Cl_2 to give **16** (27 mg, 98%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ = 8.79 - 8.80 (d, J = 4 Hz, 4 H), 8.74 - 8.77 (m, 6 H), 8.09 - 8.11 (d, J = 8 Hz, 6 H), 7.93 - 7.97 (t, J = 8 Hz, 2 H), 7.71 - 7.79 (m, 8 H), 7.04 - 7.06 (d, J = 8 Hz, 4 H), 5.83 - 5.85 (d, J = 8 Hz, 4 H), 4.58 (s, 2 H), 4.28 (s, 4 H), 3.78 (s, 6 H), -2.72 pm (s, 2 H). MALDI-TOF-MS *m/z*: cald. for $C_{66}H_{48}N_{10}O_4$: 1044.39 [M^+]; found: 1044.10

2: Nickel(II) acetylacetonate (61 mg, 0.24 mmol) was added to a solution of **16** (27 mg, 0.024 mmol) in toluene. The reaction mixture was refluxed for 24 h. After cooling, the solution was diluted with ethyl acetate and then washed with H_2O. The organic layer was concentrated, and the residue was purified by column chromatography eluting with 20% ethyl acetate/CH_2Cl_2 where the first fraction was collected, giving **2**. The resulting solid was recrystallized from $CHCl_3$/pentane to produce **2** as a purple solid (11 mg, 38%). ^{1}H NMR (400 MHz, $CDCl_3$, 25 °C) δ = 8.66 - 8.68 (d, J = 8 Hz, 4 H), 8.60 - 8.63 (m, 6 H), 8.01 - 8.03 (d, J = 8 Hz, 2 H), 7.93 - 7.95 (d, J = 8 Hz, 4 H), 7.85 - 7.89 (t, J = 8 Hz, 2 H), 7.66 - 7.72 (q, J = 8 Hz, 8 H), 6.60 - 6.62 (d, J = 8 Hz, 4 H), 5.68 - 5.70 (d, J = 8 Hz, 4 H), 4.40 (s, 4 H), 4.20 (s, 2 H), 3.57 ppm (s, 6 H). MALDI-TOF-MS *m/z*: cald. for $C_{66}H_{46}N_{10}NiO_4$: 1100.31 [M^+]; found: 1101.18.

UV/Vis titration of Ni(II)TPP

The UV/Vis titration for cyanide with **Ni(II)TPP** have been performed in dichloromethane because it is insoluble in acetonitrile.

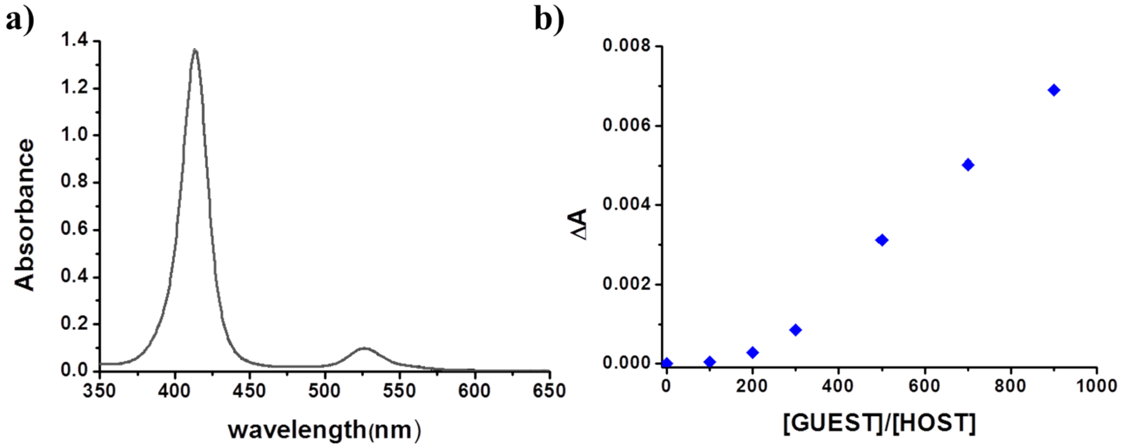


Figure S1. a) UV/Vis titration for cyanide with **Ni(II)TPP** (6 μM) in CH_2Cl_2 b) Binding isotherm monitored at 413.5 nm.

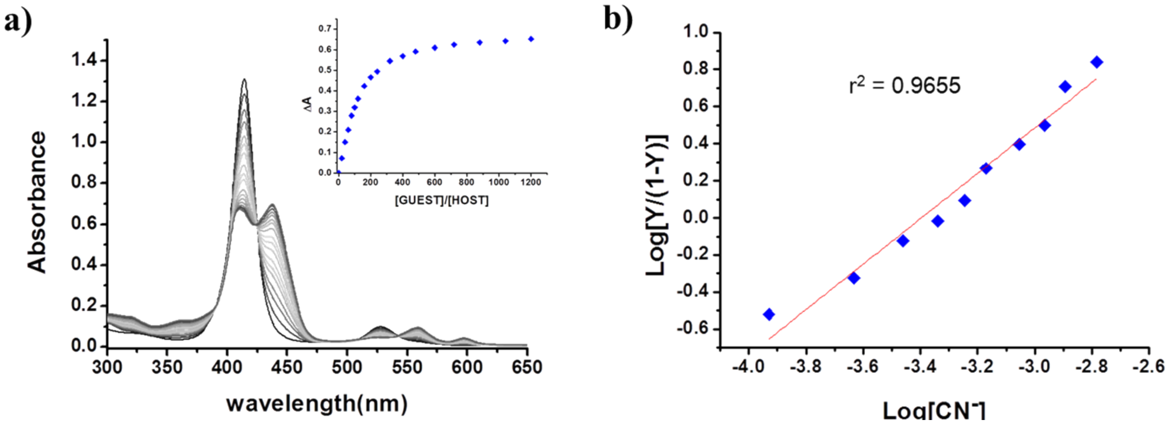


Figure S2. a) UV/Vis titration of CN^- (0-1200 eq.) to **2** (inset: binding isotherm monitored at 413 nm) b) Hill plot of **2** with cyanide.

	Binding constant (M^{-1})		Hill coefficient
	K_1	K_2	n
1	2.4×10^4	6.8×10^4	1.96
2	1.9×10^3	1.2×10^3	1.22

Table S1. Binding constants and Hill coefficient for cyanide bindings to **1** and **2**.