# Electronic Supplementary Information

## Tripodal-Oxazoline-Based Homochiral Coordination Cages with Internal Binding Sites

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### 1. General Methods

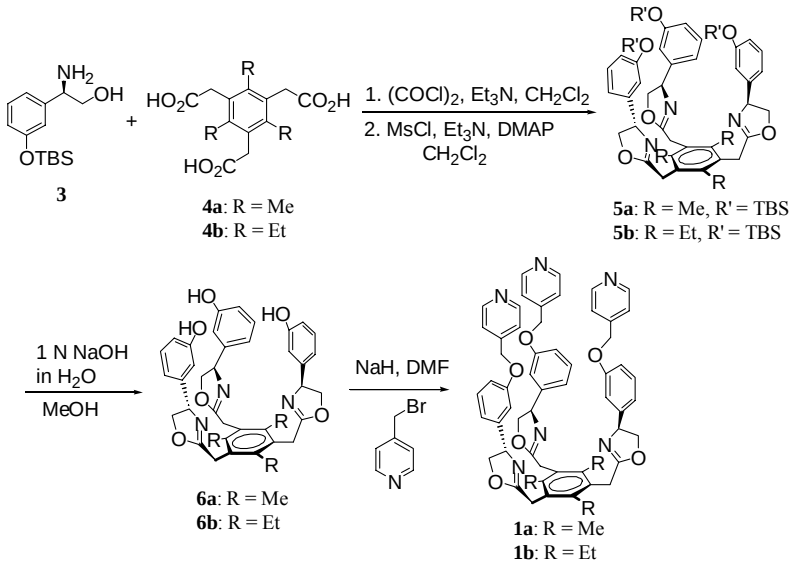
All commercial reagents are of ACS reagent grade and used as supplied. DMF and $CH_2Cl_2$ were dried over 4 Å molecular sieves and CaH, respectively, and distilled before use. Metal precursors were prepared following the established procedures.[1-3] Column chromatography was carried out on Merck silica gel 60 (230-400 mesh). Melting points were obtained with an electrothermal capillary apparatus and were uncorrected. Optical rotations were measured using Rudolph Research Autopol Ⅲ digital polarimeter using a sodium lamp (D line, 589 nm) and are reported in degrees with concentration in unit of 10 mg $mL^{-1}$. $^1H$ and $^{13}C$ spectra were recorded using a Bruker AMX 300 or DRX 500 spectrometer and all chemical shifts were reported as δ in parts per million (ppm) downfield from tetramethylsilane (δ = 0.0). $^{31}P$ NMR spectra were recorded using a Bruker XP200 (81 MHz) spectrometer, and all chemical shifts were reported in ppm relative to external 80% $H_3PO_4$ at 0.00 ppm. $^{19}F$ NMR spectra were recorded using a Buruker XP200 (188.3 MHz) spectrometer, and all chemical shifts were reported relative to external $CFCl_3$ at 0.00 ppm. Mass spectral analysis was recorded on Jeol JMS-AX505WA and is reported in units of mass to charge (*m/z*). CSI mass spectra were recorded on a QSTAR XL Hybrid LC/MS/MS System. Elemental

analyses and HRMS were performed by the Korea Basic Science Institute at Kyung-Pook Branch Analytical Laboratory.

Reference:

1. S. Fallis, G. K. Anderson and N. P. Rath, *Organometallics*, 1991, ***10***, 3180-3184.
2. P. J. Stang, D. H. Cao, S. Saito and A. M. Arif, *J. Am. Chem. Soc.* 1995, ***117***, 6273-6283.
3. M. Fujita, J. Yazaki and K. Ogura, *J. Am. Chem. Soc.* 1990, ***112***, 5645-5647.

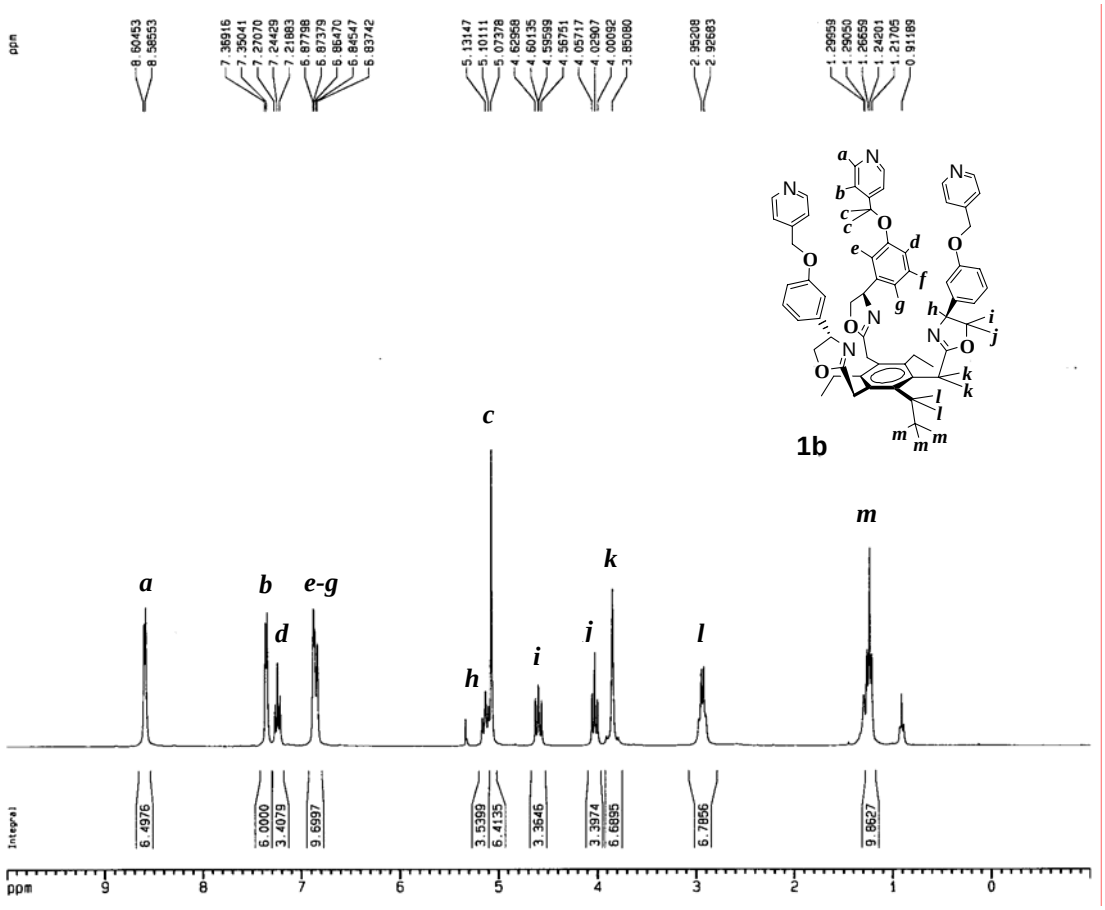
## 2. Syntheses and Characterization of compounds 1a and 1b.




The Synthesis of intermediates **6** has been followed by the procedure reported in the reference 4 in the main paper. More specifically, compounds **5** and **6** have been used in the synthesis of other tripodal receptors, and their characterization data are included in a submitted paper.

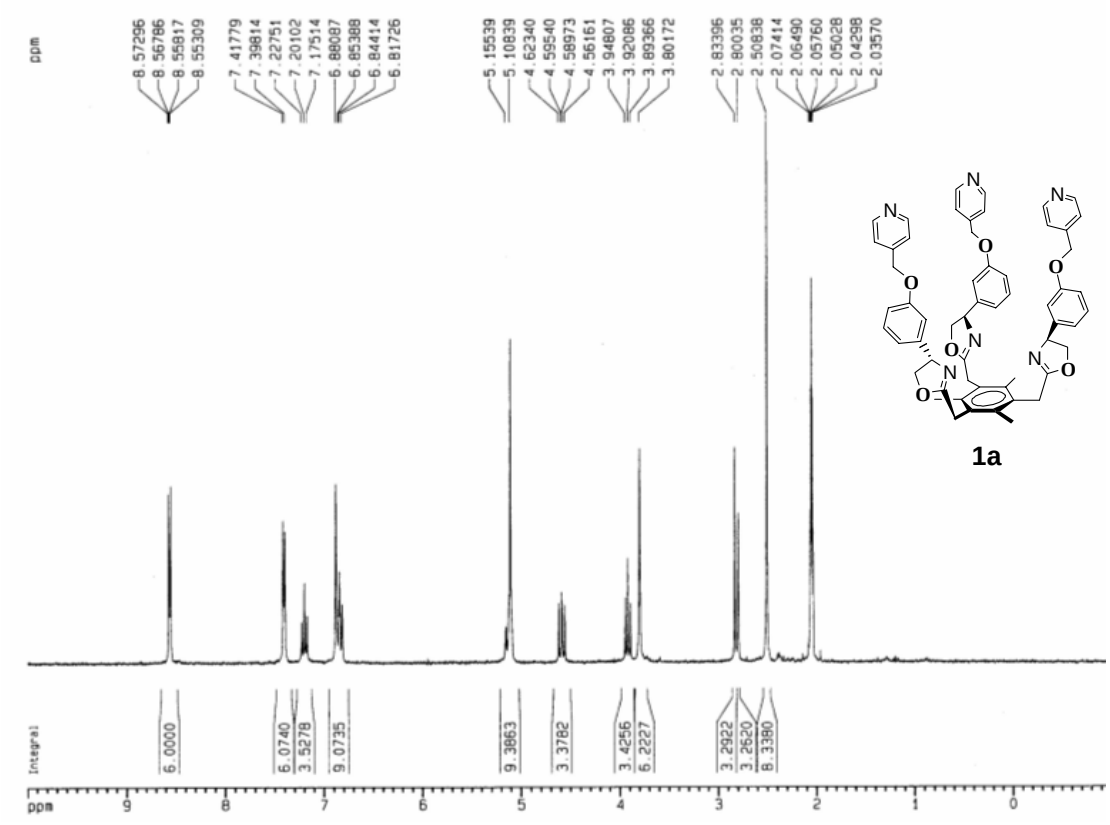
**2-[(3,5-Bis{[4-(3-hydroxyphenyl)-4,5-dihyrooxazol-2-yl]methyl}-2,4,6-triethyl)-phenyl]methyl-4-(3-hydroxyphenyl)-4,5-dihydrooxazole-4-yl]phenoxy}methyl-4-pyridine (1b).** NaH (350 mg, 14.55 mmol) was added in small portions into a solution of **6b** (1.0 g, 1.46 mmol) in dry DMF (20 mL). After hydrogen gas evolution is subsided, the mixture was stirred at room temperature for 30 min. A solution of 4-bromomethylpyridine (1.84 g, 7.27 mmol) in $CH_2Cl_2$ (100 mL) was introduced into the reaction mixture using a syringe. The resulting mixture was stirred at room temperature for 24 h, and it was poured into an Erlenmeyer flask containing a mixture of water/dichloromethane. The organic layer was separated, washed with brine, dried over anhydrous $MgSO_4$, and concentrated to dryness. The residue was purified by column

chromatography (MeOH:EtOAc, 3:7) to afford the desired pyridyl-tris(oxazoline) **1b** as white powders (0.75 g, 54%). (4-Bromomethylpyridine was freshly prepared before use by the following method: A saturated aqueous $Na_2CO_3$ solution was added to a stirred solution of 4-bromomethylpyridine·HBr (1.84 g, 7.27 mmol) in distilled water (50 ml) at 0 ℃, at such a rate to maintain the temperature <5 ℃ and to reach pH ~7. Then, 4-bromomethylpyridine was extracted with dichloromethane, dried over anhydrous $MgSO_4$, and filtered. The filtrate (100 ml) was used without further purification.) **1b**: mp 109-101 ℃; $[\alpha]^{21}_D$ = +2.5 (*c* = 1.0, $CH_2Cl_2$); $^1$H NMR (300 MHz, $CD_2Cl_2$) $\delta$ 8.59 (d, *J* = 5.7 6H), 7.36 (d, *J* = 5.6 6H), 7.24 (dd, *J* = 7.9, 7.5 3H), 6.88-6.84 (m, 9H), 5.13 (dd, *J* = 9.1, 8.4 3H), 5.07 (s, 6H), 4.60 (dd, *J* = 9.4, 8.6 3H), 4.03 (dd, *J* = 8.4, 7.9 3H), 3.85 (s, 6H), 2.94 (q, *J* = 7.5 6H), 1.24 (t, *J* = 7.5 9H); $^{13}$C NMR (75 MHz, $CD_2Cl_2$) $\delta$ 167.9, 159.0, 150.5, 146.6, 145.1, 142.6, 130.7, 130.2, 121.9, 120.0, 114.0, 113.5, 75.1, 70.0, 68.6, 29.1, 23.9, 14.9; MS (FAB) *m/z* (rel. intensity) 962 (M+1, 100), 871 (12), 735 (8); HRMS (FAB) cald. for $C_{60}H_{61}O_6N_6$ 961.4653, found 961.4650.



***d*** ***f*** **1a**

**2-[(3,5-Bis{[4-(3-hydroxyphenyl)-4,5-dihyrooxazol-2-yl]methyl}-2,4,6-trimethyl)-phenyl]methyl-4-(3-hydroxyphenyl)-4,5-dihydrooxazole-4-yl]phenoxy}methyl-4-pyridine (1a)**. This compound was synthesized similarly as above starting from compound **5a**. The crude product was purified by column chromatography (MeOH:EtOAc, 3:7) to afford **1a** in 63% yield as white solids: mp 92-94 ℃; $^{1}$H NMR (300 MHz, acetone-$d_6$) $\delta$ 8.48 (d, $J$ = 5.3 6H), 7.44 (d, $J$ = 4.8 6H), 7.20 (dd, $J$ = 8.3, 7.6 3H), 6.89-6.79 (m, 9H), 5.06 (s, 9H), 4.59 (dd, $J$ = 9.4, 8.6 3H), 3.99 (dd, $J$ = 8.7, 8.1 3H), 3.86 (s, 6H), 2.45 (s, 9H); $^{13}$C NMR (75 MHz, acetone-$d_6$) $\delta$ 170.3, 160.2, 150.4, 149.5, 145.6, 137.3, 132.0, 131.2, 123.4, 120.8, 115.2, 114.4, 76.4, 70.1, 69.1, 30.8, 17.8; MS (FAB) *m/z* (rel. intensity) 919 (M+1, 100), 846 (41); HRMS (FAB) cald. for $C_{57}H_{54}N_6O_6$ 918.4105, found 918.4112.




Cage **2b**. This complex was assembled by mixing tripodal oxazoline **1b** with *trans*-$Pd(OTf)_2(PEt_3)_2$ in a molar ratio of 2:3 in $CH_2Cl_2$ at room temperature for 5 min. Removal of the solvent in vacuo afforded the desired cage in a quantitative yield. The

peak at 1.2 ppm in the $^{1}H$ NMR spectrum is owing to the presence of "free" $Et_3P$ because a slight excess amount of the palladium source was used:

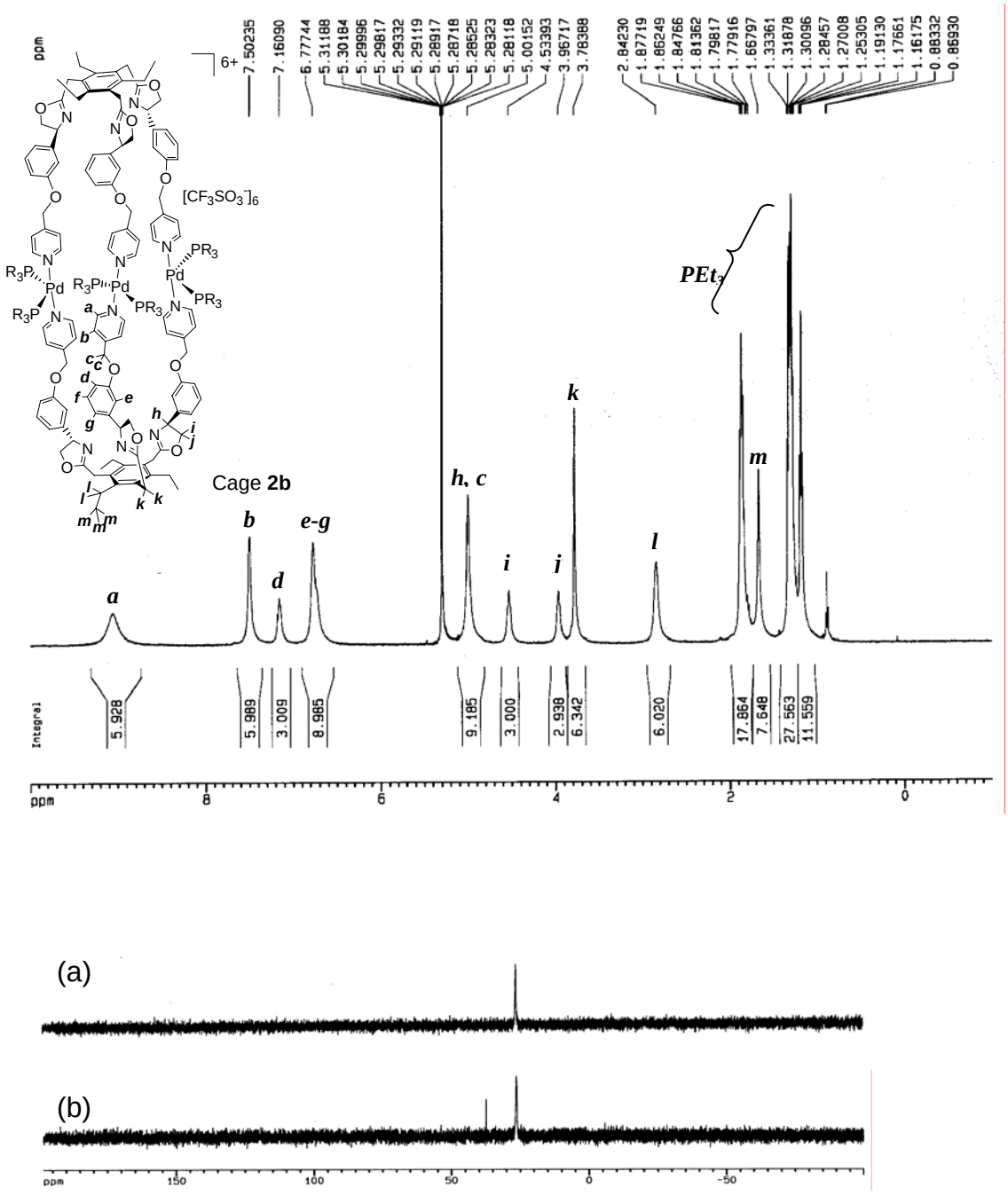
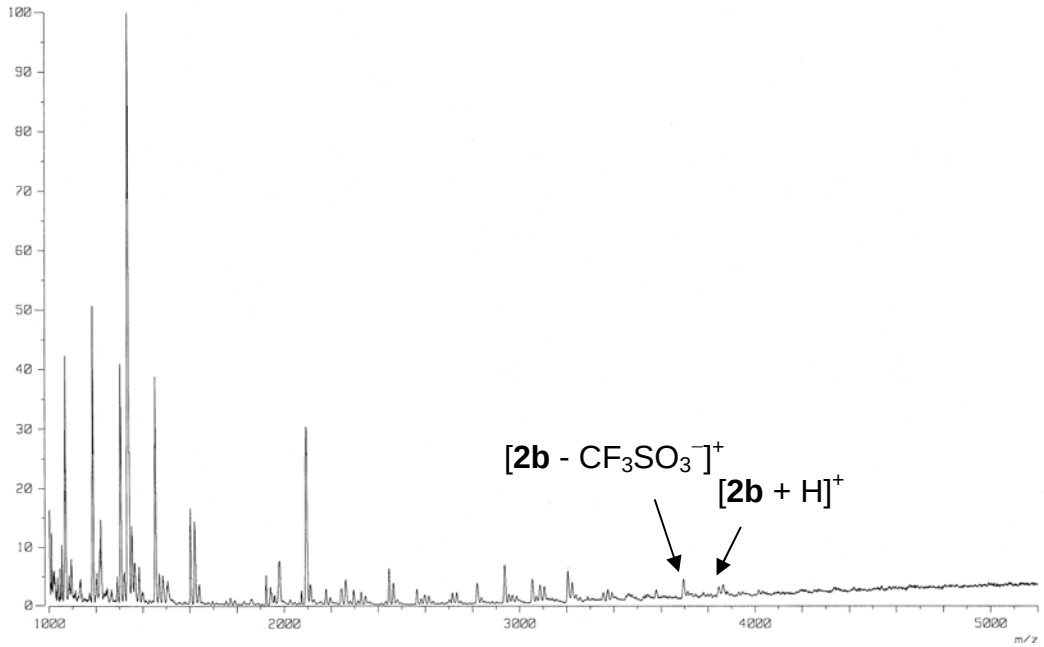




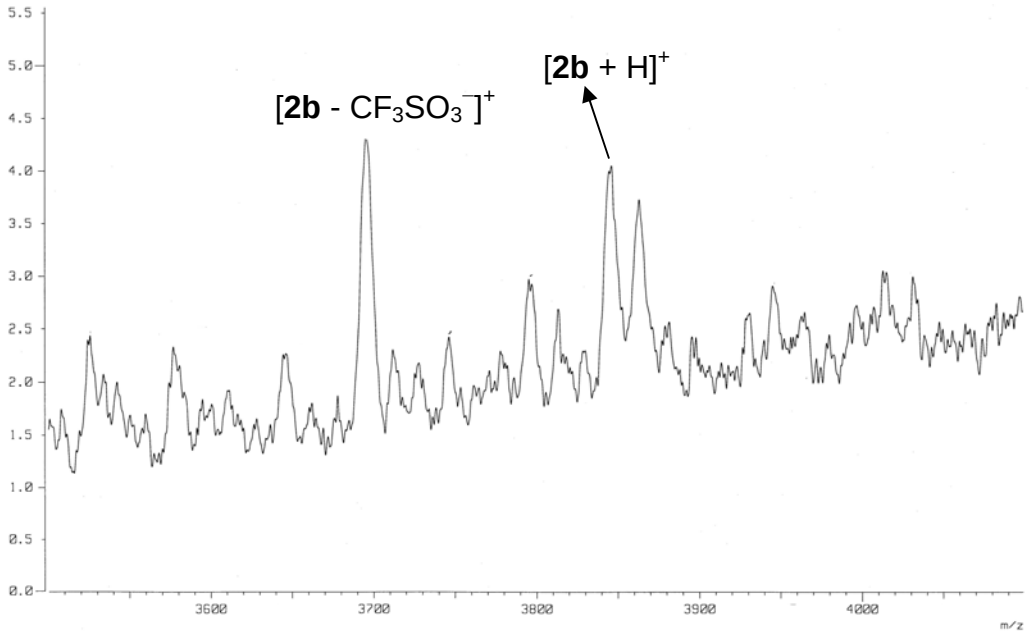


**Fig. S1** $^{31}P$ NMR spectra obtained for a mixture of **1b** and $Pd(PEt_3)_2(OTf)_2$ in $CD_2Cl_2$ at 25 ℃ with different molar ratios**:** (a) at a molar ratio of 2:3; (b) when more than 1.5 equiv of the Pd source was added to the solution (a).

(a)


[2b - CF3SO3−]+
[2b + H]+
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
m/z

**(b)**


[2b + H]+
[2b - CF3SO3−]+
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3600
3700
3800
3900
4000
m/z

**(c)**

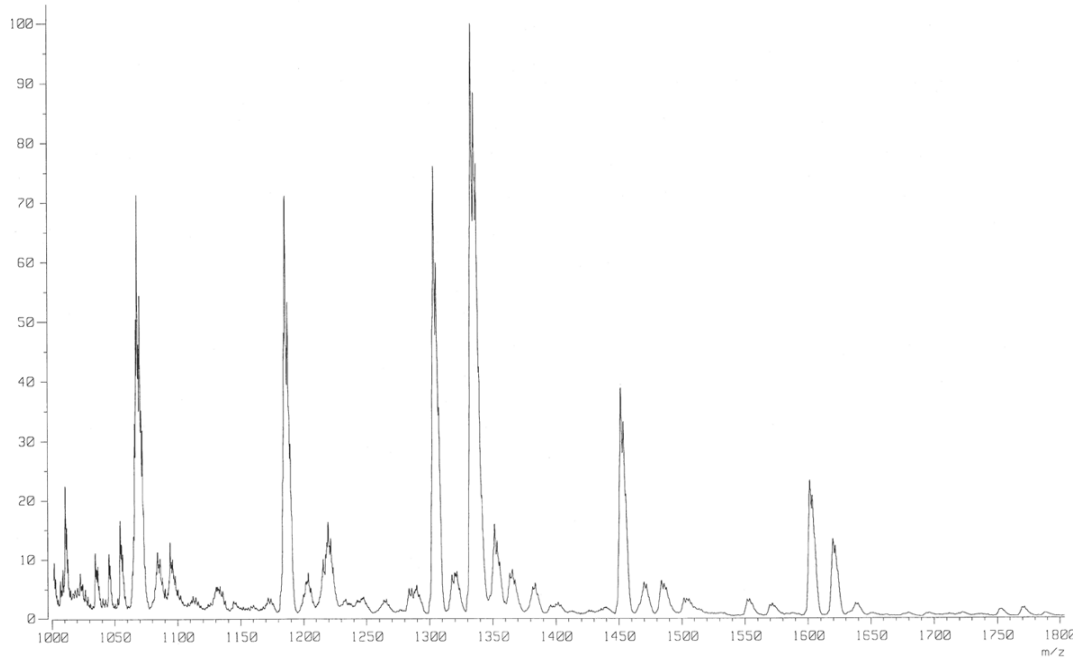



**Fig. S2** (a) CSI-MS spectrum for the cage **2b,** (b) an enlarged part of the *m/z* range 3500-4100, (c) an enlarged part of the *m/z* range 1000-1800. Experimental conditions: acceleration voltage, 5.0 kV; needle voltage, 2.8 kV; orifice voltage, 202 V; ring lens voltage, 254 V; spray temperature, 20 ℃; resolution: 1000; flow rate, 1.0 mL/h; solvent: $CH_2Cl_2$.

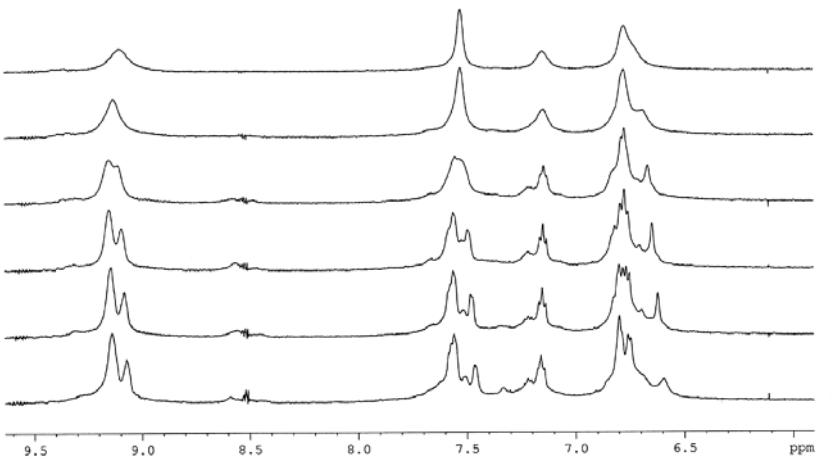



**Fig. S3** A selected region of the VT-NMR experimental data for the cage **2b** (from the bottom, taken at -40, -20, -5, 10, 25, 40 ℃)

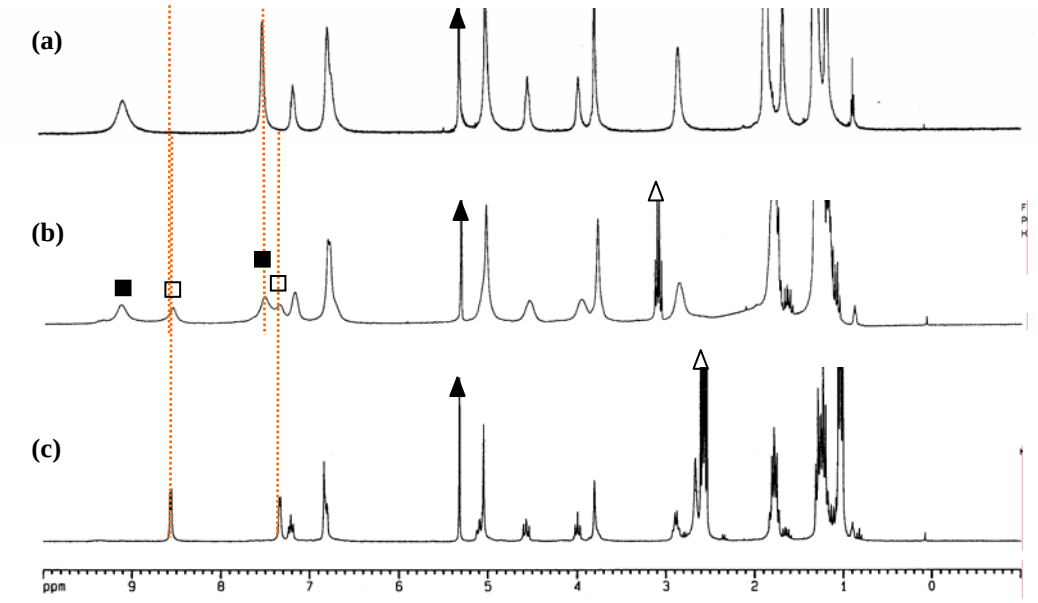



**Fig. S4** The disassembly experiment of the cage **2b** in the presence of $Et_3N$: (a) cage **2b** as single component, (b) partial disassembly into its free ligand **1b** after addition of 0.7 equiv of $Et_3N$, (c) complete disassembly into **1b** in the presence of excess $Et_3N$ (10 equiv) at 300K. ( ■: cage, □: ligand, ▲: solvent, △: $Et_3N$)

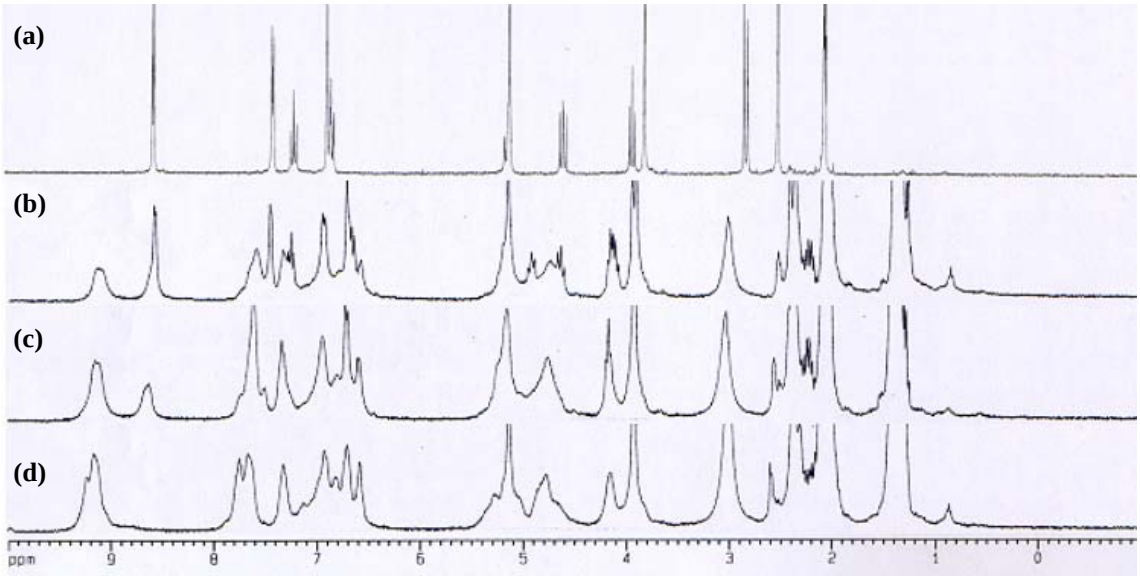



**Fig. S5** Self-assembly of **1a** and $[Pd(OTf)_2(PEt_3)_2]$, monitored by $^1H$ NMR in acetone-$d_6$ at 25 °C: (a) free **1a**; (b) a mixture of [**1a**]/$[Pd(OTf)_2(PEt_3)_2]$ in a ratio of 2/1; (c) in a ratio of 1/1; (d) in a ratio of 2/3.

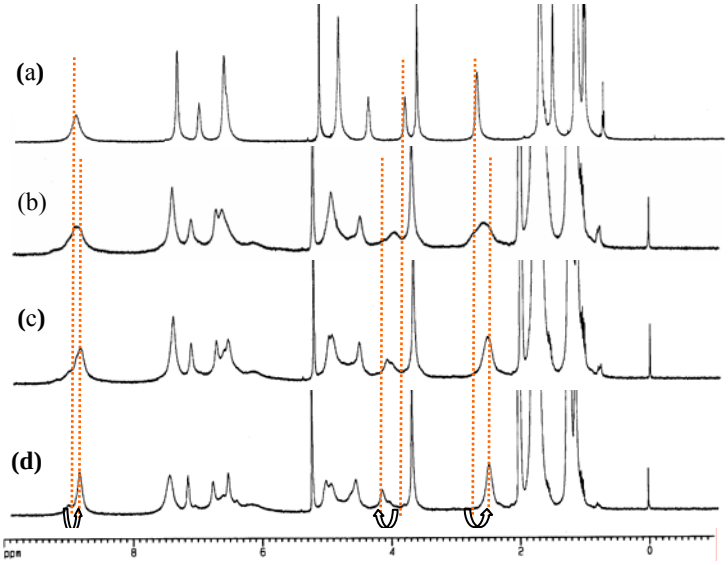



**Fig. S6** $^1$H NMR spectral change of the cage **2b** upon gradual addition of $NH_4 \cdot PF_6$ in $CD_2Cl_2$ at 25 °C: (a) free cage **2b**, (b) 0.5 equiv. of the guest added, (c) 1.0 equiv. of the guest added, (d) 2.0 equiv. the guest added (Note: a small amount of acetone was used to dissolve the guest).

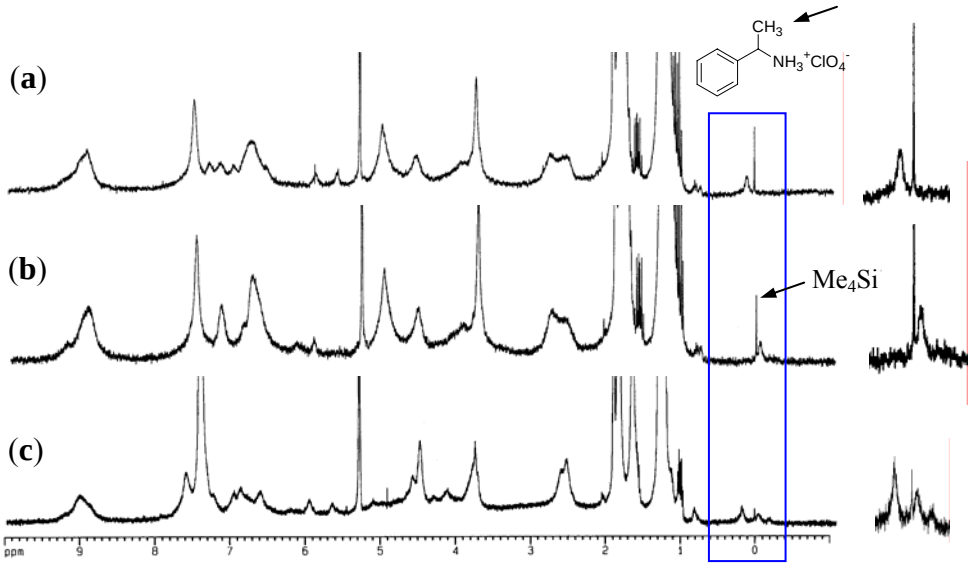



**Fig. S7** $^1$H NMR spectral change of cage **2b** upon addition of enantiomeric and racemic α-phenylethylammonium perchlorate (The guest methyl group indicated in the box is enlarged and shown at the right side): (a) [**2b**]/[(*R*)-guest] = 1/2; (b) [**2b**]/[(*S*)-guest] = 1/2; (c) [**2b**]/[racemic guest] = 1/4.