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Heavily-substituted Calix[4]arenes Derived from *p*-Cyanomethylcalix[4]arene[1]

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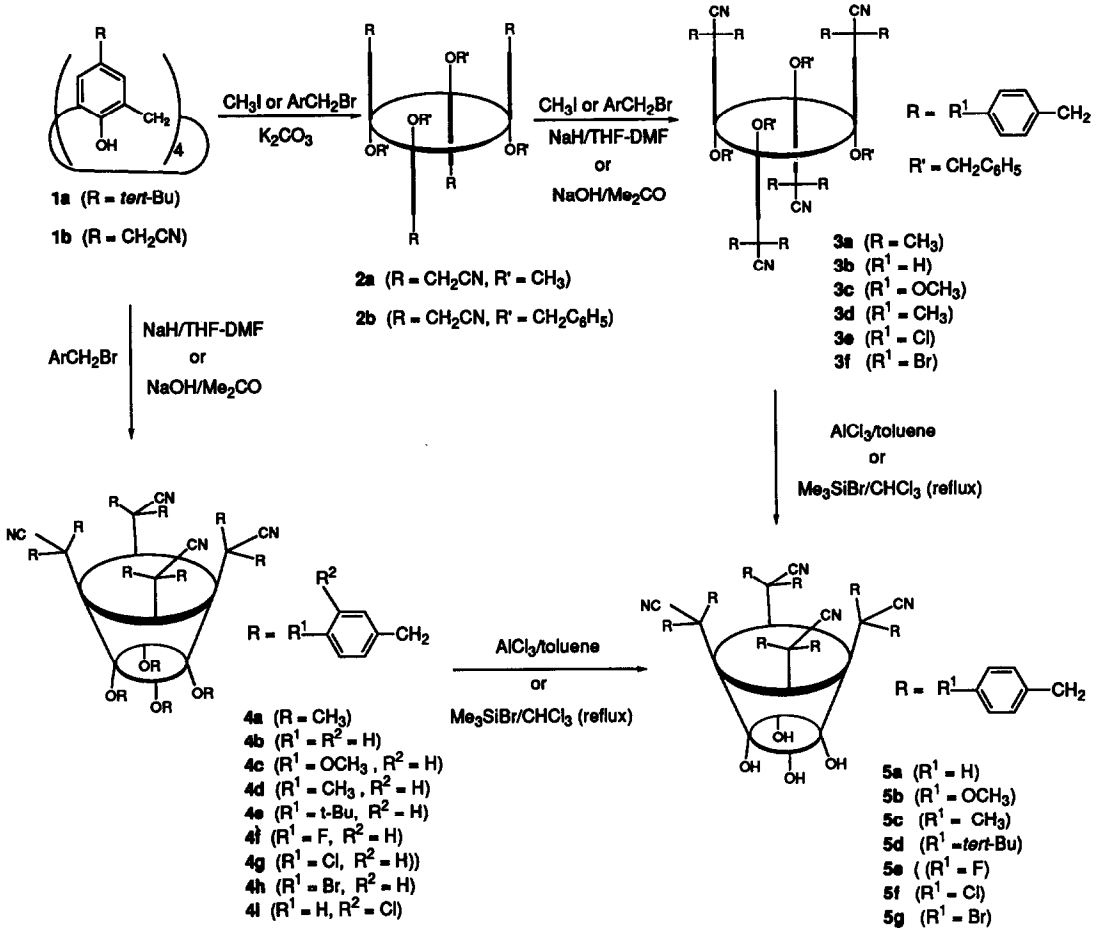
Abstract: *p*-Cyanomethylcalix[4]arene (**1b**) can be converted in good yield to compounds containing twelve arylmethyl groups, four attached to the phenolic oxygens and eight to the carbons α to the CN groups. Depending upon the reaction protocol the products can be obtained either in the 1,3-alternate (**3**) or cone (**4**) conformation. Complete debenzylation or selective debenzylation (to monohydroxy and trihydroxy compounds) can be effected with $AlCl_3$ and Me_3SiBr, respectively.

p-Cyanomethylcalix[4]arene (**1b**)[2], easily prepared from *p-tert*-butylcalix[4]arene (**1a**) by $AlCl_3$-induced removal of the *tert*-butyl groups followed by Mannich condensation with $HCHO/Me_2NH$, quaternization with MeI, and treatment with NaCN, provides a convenient starting material for the introduction of alkyl and arylmethyl groups at both the lower and upper rims of the calix[3]. The "deep pockets" created by the bulky substituents introduced at the upper rim, along with the functionality derivable from the cyano groups, provide potential complexation sites for various guests, making these compounds attractive for the construction of polyfunctional catalysts.

Much effort has been devoted in this laboratory[4] and other laboratories to the study of base-induced esterification and etherification reactions at the lower rim of calixarenes. For example, treatment of *p*-cyanomethylcalix[4]arene (**1b**) with methyl iodide in the presence of K_2CO_3 yields the tetramethyl ether **2a** which, like the tetramethyl ether of *p-tert*-butylcalix[4]arene, exists as a mixture of readily interconverting conformers[4a,5]. Similarly, reaction of **1b** with benzyl bromide in the presence of K_2CO_3 (24 hours at room temperature or 5 hours at reflux) yields a tetrabenzyl ether **2b** possessing the 1,3-alternate conformation, as indicated by a singlet in the ^1H NMR spectrum for the $ArCH_2Ar$ methylene protons[6] and a resonance near δ 37 in the ^{13}C NMR spectrum for the methylene carbon[7]. This contrasts with *p-tert*-butylcalix[4]arene (**1a**) which under similar conditions yields the 1,3-dibenzyl ether in a flattened cone conformation[4b]. When bases stronger than K_2CO_3 are used to effect the methylation or benzylation of **1b** the reaction occurs not only at the phenolic oxygens but also at the carbon α to the cyano group, resulting in the introduction of eight methyl or benzyl groups at the upper rim of the calix in addition to the four at the lower rim to give the conformationally flexible compound **4a** and the conformationally fixed compound **4b**, respectively. The isolation of the tetrabenzyl ether **2b** in the 1,3-alternate conformation might lead one to predict that the dodecabenzylated compound **4b** should have the same conformation. Surprisingly, however, **4b** is produced in the cone conformation, as indicated by a pair of doublets at δ 3.96 and 2.65 in the ^1H NMR spectrum arising from the

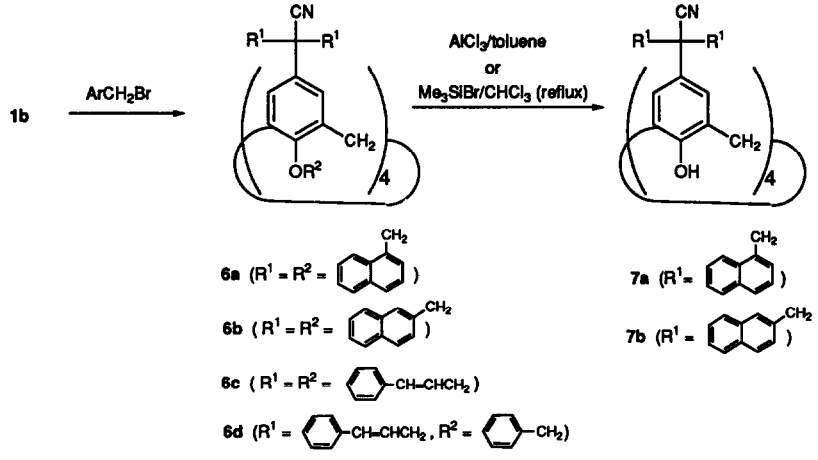
$ArCH_2Ar$ methylene protons and a resonance at δ 30.59 in the ^{13}C NMR spectrum arising from the methylene carbons. This conformational outcome suggests that **2b** is not an intermediate in the formation of **4b**, a conclusion that is corroborated by using **2b** as the starting material and subjecting it to further benzylation with a strong base to produce the dodecabenzylated compound **3b** in the 1,3-alternate conformation. It is postulated that in the presence of a strong base **1b** forms a polyanion in which one or more of the anionic sites resides on the carbon α to a cyano group and that benzylation then occurs preferentially at this more nucleophilic carbanion, possibly producing **5a** as an intermediate.



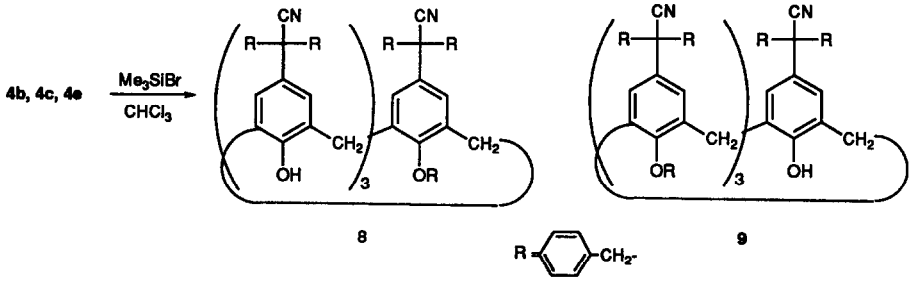
The strong base-induced reaction of **1b** with a variety of benzyl halides affords the cone conformers of compounds **4b-4i** in yields generally in the range 75-92%, falling to 34% only in the case of the *tert*-butyl compound **4e**. Some benzyl halides, however, fail to afford characterizable products as, for example, the nitrobenzyl bromides which yield dark yellow, very insoluble and intractible materials. The bifunctional compound *p*-chloromethylbenzoyl chloride reacts in similar fashion with **1b** in the presence of a strong base to give uncharacterized products. In the presence of the weak base 1-methylimidazole, however, it gives the

tetraester[8], a result that is in accord with a previous report that O-aroylation of calixarenes proceeds more rapidly than O-alkylation[4b]. There appears to be considerable latitude in the strong base that can be used to induce the *per*-benzylation reaction, for NaH, NaOH, and KOH are all effective. Curiously, however, $KOBu^t$ fails to work.

To further explore the utility of this process with the aim of generating calixarenes containing especially deep cavities, strong base-induced reactions of **1b** with α and β-naphthylmethyl halides were carried out and found to yield the cone conformers of **6a** and **6b**, respectively. *trans*-Cinnamyl bromide reacts in similar fashion with **1b** to yield **6c**, and the corresponding 1,3-alternate conformer **6d** can be obtained by first effecting K_2CO_3-induced benzylation followed by treatment with *trans*-cinnamyl bromide. 9-Chloromethylanthracene, however, fails to react with **1b**.



The 1,3-alternate conformer compounds **3b-3f** and the cone conformer compounds **4b-4i**, **6a**, and **6b** yield the corresponding tetrahydroxy compounds **5a-5g**, **7a** and **7b** in the cone conformation when treated with $AlCl_3$/toluene. The *tert*-butyl compound **4e** additionally loses its *tert*-butyl groups to give **5a**, the same compound obtained directly from **3b** and **4b**. *de-tert*-Butylation can be avoided in this case by using the weaker Lewis acid Me_3SiBr. Complete debenzylation with this reagent requires refluxing for 24 hours, milder conditions yielding partially debenzylated products. Thus, treatment of **4b** with Me_3SiBr, even a large



excess, at room temperature for 7 days produces the trihydroxy mono-O-benzyl compound **8**. A somewhat shorter reaction gives a mixture of **8** and the monohydroxy tri-O-benzyl compound **9**, and the much shorter reaction time of 2 minutes affords an almost quantitative yield of **9**. The results of various other reaction conditions are noted in Table 1. Attempts to isolate a dihydroxy di-O-dibenzyl compound were unsuccessful,

Substrate	Lewis Acid	Temperature	Time	% Conversion	Product Distribution,%		
					5	**8**	**9**
4b	Me_3SiBr (12)	RT	3 min	100		10	90
	Me_3SiBr (12)	RT	20 min	100		90	10
	Me_3SiBr (5)	RT	5 min	100		10	90
	Me_3SiBr (5)	RT	15 min	100		50	50
	Me_3SiBr (4)	RT	10 min	100		20	80
	Me_3SiBr (4)	RT	1 hr	100		25	75
	Me_3SiBr (4)	RT	1.5 hr	100		33	66
	Me_3SiBr (20)	reflux	24 hrs	100	100		
	Me_3SiBr (10)	reflux	5 min	100		90	10
	Me_3SiBr (10)	reflux	16 hrs	100		90	10
	Me_3SiBr (6)	reflux	1 hr	100	50	50	
	Me_3SiBr (4)	reflux	3 hrs	100	50	50	
	$AlCl_3$ (3)	RT	2 min	70	75	25	
	$AlCl_3$ (2)	RT	3 min	50	80	20	
4c	Me_3SiBr (8)	RT	24 hrs	100	100		
	Me_3SiBr (5)	RT	8 hrs	100	100		
	Me_3SiBr (4)	RT	30 min	100	100		
	Me_3SiBr (3)	RT	10 min	70	80	20	
	Me_3SiBr (2)	RT	10 min	50	75	25	
	Me_3SiBr (20)	RT	2 days	100	80	20	

Table 1. Product distribution in the Lewis acid-catalyzed O-debenzylation of perbenzylated compound **4b** and **4c**.

and it appears that the first debenzylation proceeds very rapidly, the second and third debenzylations essentially simultaneously, and the fourth debenzylation with considerable difficulty. The selectivity of debenzylation is also dependent on the conformation of the starting material and the particular benzyl moiety being removed. Thus, the conditions that result in partial debenzylation of the cone conformer **4b** effect complete debenzylation of the 1,3-alternate conformer **3b**, and the *p*-methoxybenzyl compound **4c** yields only the tetrahydroxy compound **5b** even under the mildest of conditions. When less than four equivalents of Me_3SiBr are used in the latter case the product consists of **5b** and unreacted starting material.

^{1}H NMR Spectra. The ^{1}H NMR spectrum of **4b**, shown in Fig 1, is representative of the dodecabenzylated compounds in the cone conformation. It contains a complex pattern of resonances at δ 6.8-

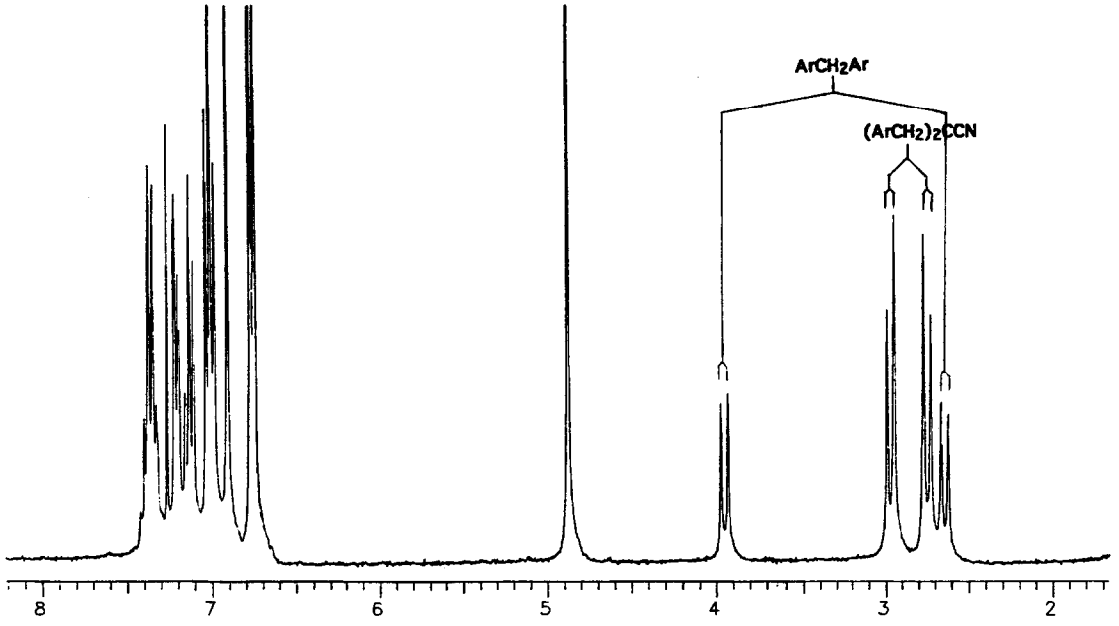


Fig 1. 300 MHz ^{1}H NMR spectrum of **4b** in $CDCl_3$ at 20° C

7.5 arising from the hydrogens on the three sets of aromatic rings ($ArCH_2O$, $ArCH_2Ar$, and $ArCH_2C$), a singlet at δ 4.9 for the $ArCH_2O$ methylene hydrogens, a pair of doublets with centers at δ 3.95 and 2.65 for the $ArCH_2Ar$ methylene hydrogens, and a pair of doublets with centers at δ 2.96 and 2.75 from the $ArCH_2C$ methylene hydrogens which bear a diastereotopic relationship to each other. The ^{1}H NMR spectrum of **3b**,

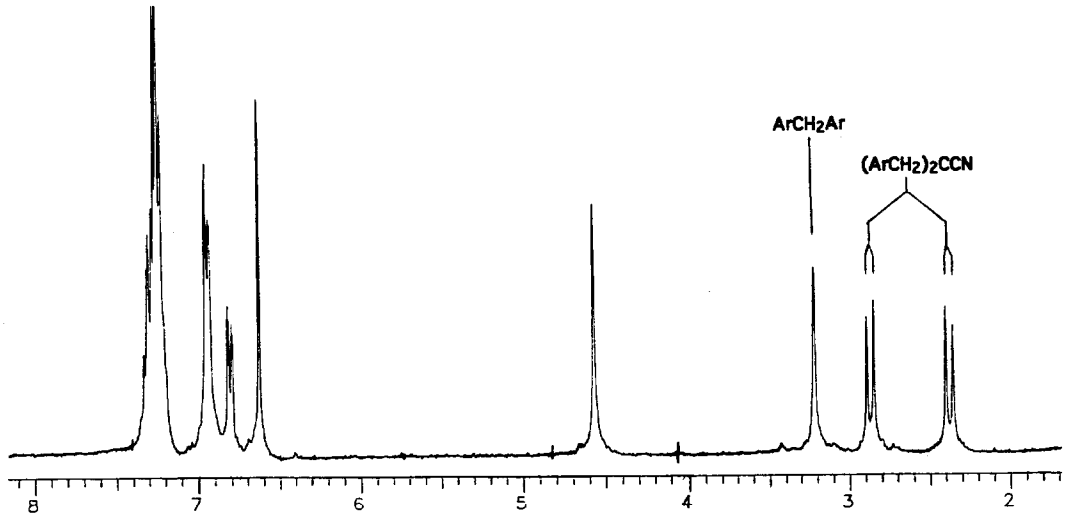
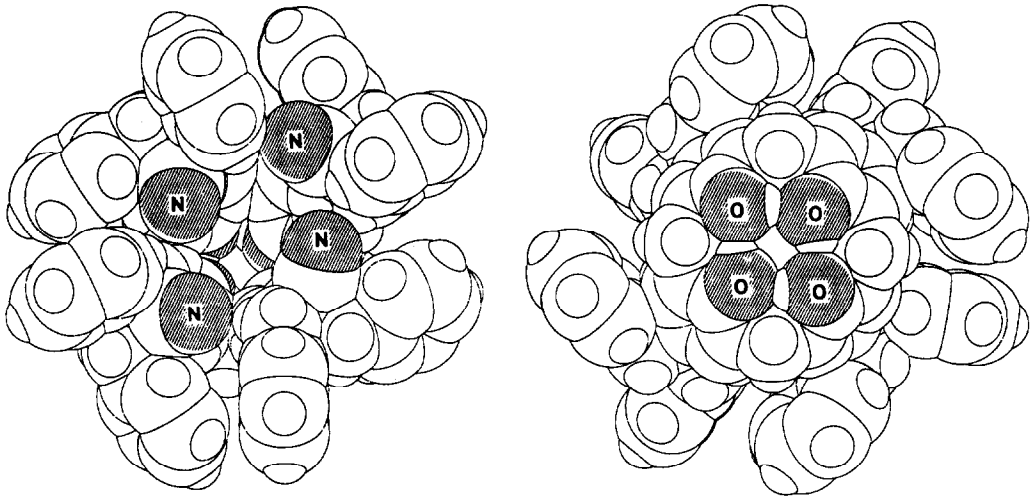


Fig 2. 300 MHz ^{1}H NMR spectrum of **3b** in $CDCl_3$ at 20° C.

shown in Fig 2, is representative of the dodecabenzylated compounds in the 1,3-alternate conformation. It differs from the spectrum of **4b** only in showing a singlet at δ 3.2 rather than a pair of doublets for the $ArCH_2Ar$ methylene hydrogens. Compounds **5**, obtained by removal of the O-benzyl groups of compounds **3** and **4**, possess ^1H NMR spectra in which an OH resonance appears at *ca* δ 10 and a pair of poorly resolved doublets arising from the $ArCH_2Ar$ hydrogens are present at *ca* δ 4.2 and 3.4. The latter change to a well resolved pair of doublets at lower temperatures and coalesce to a singlet at higher temperatures, a characteristic feature of calix[4]arenes. The cone conformer compound **6b**, containing β–naphthylmethyl groups, possesses a well resolved ^1H NMR spectrum similar to that of **4b**. However, compound **6a**, containing α-naphthylmethyl groups, shows a much more poorly resolved set of resonances, probably reflecting the greater degree of steric interference between the arylmethyl moieties associated with the α position of attachment.

Molecular Modeling. The ^1H NMR spectra of the perbenzylated compounds fail to reveal whether the $(ArCH_2)_2CCN$ moieties on the upper rim of the calix assume conformations in which the CN groups are oriented inward, outward, or somewhere inbetween. The definitive answer to this question must await an X-ray crystallographic structure determination, but molecular modeling studies[9] may suggest a possible candidate. The compound chosen for study was 5,11,17,23-tetra(α,α-dibenzylcyanomethyl)-25,26,27,28-tetrahydroxycalix[4]arene (**5a**) which, predictably, is found to assume the cone conformation. The energies of structures with a variety of conformational arrangements of the α,α-dibenzylcyanomethyl moieties on the upper rim were calculated. The lowest energy conformer among these, shown in Fig 3, has the cyano groups pointing somewhat into the cavity and the phenyl rings of the benzyl groups oriented away from one another. A $CHCl_3$ molecule placed in the cavity lowers the energy of the system by *ca* 5 kcal/mole and is located near the upper rim of the calix. Structures in which the phenyl ring of a benzyl group is oriented inward into the cavity have somewhat higher energies than the structure shown in Fig 3.



View of Upper Rim View of Lower Rim

Fig 3. Computer model representations of **5a**.

Experimental Section

Most reagents were purchased from Aldrich Chemical Co. and were used without further purification. Tetrahydrofuran (THF) was distilled from K-benzophenone. N,N-Dimethylformamide (DMF), acetonitrile (MeCN), and acetone (Me_2CO) were distilled and stored over molecular sieves (3Å and 4 Å Linde sieves) for at least 10 days. Flash chromatography was carried out with J. T. Baker 40 mμ silica gel, column chromatography with Aldrich 70 - 230 mesh, 60 Å silica gel. Thin layer chromatography (TLC) was performed on 250 mμ silica gel plates, and preparative thin layer chromatography (TLC) on 1000 mμ silica gel plates containing a fluorescent indicator. Melting points were taken in sealed and evacuated capillary tubes on a MEL-Temp apparatus (Laboratory Devices, Cambridge, MA) using a 500° C thermometer calibrated against a thermocouple and are uncorrected. ^1H NMR and ^{13}C NMR spectra were recorded at 20 ± 1° C on a Varian XL-300 spectrometer with chemical shifts reported as δ values (ppm). ^1H NMR spectra are referenced to tetramethylsilane (TMS) at 0.00 ppm as an internal standard, and ^{13}C NMR spectra are referenced to $CDCl_3$ (77.00 ppm), DMSO (40.0 ppm) or TMS (0.00 ppm). Crystallization solvents were carefully dried. Microanalytical samples were dried at least 72 h at 111° C (refluxing toluene) or at 140° C (refluxing xylene) at 1-2 mm[10], and the analyses were carried out by Desert Laboratories, Tucson, AZ.

5,11,17,23-Tetracyanomethyl-25,26,27,28-tetra(benzyloxy)calix[4]arene (1,3-alternate conformer) (2b). A 13.8 g (100 mmol, 10 equiv) sample of anhydrous, finely powdered K_2CO_3 and 3.0 g (20 mmol, 2 equiv) of NaI were suspended in 250 mL of anhydrous Me_2CO in a 3-necked 500 mL round-bottomed flask in an ice-bath. To this 5.81 g (10 mmol) of *p*-cyanomethylcalix[4]arene (**1b**) was added portionwise (reaction initially assumed a dark green-bluish color which later changed to a light yellow), and the reaction mixture was stirred in an atmosphere of N_2 for 30 min. A solution of 13.6 g of benzyl bromide (80 mmol, 8 equiv) in 10 mL of dry Me_2CO was added slowly from a dropping funnel. The reaction mixture was allowed warm to room temperature and then refluxed 5 h under a continuous stream of N_2. The mixture was cooled, filtered, and the residue thoroughly washed with 100 mL of anhydrous Me_2CO. The combined Me_2CO filtrate was concentrated under reduced pressure and poured into 150 mL of Et_2O to give a light yellow precipitate which was removed by filtration and washed with Et_2O. The product was stirred with MeOH (3 x 100 mL) for 30 min to remove unreacted benzyl bromides, filtered and purified by flash chromatography using $CHCl_3$ as an eluent to afford a light yellow powder. Crystallization from $CHCl_3$-hexane (1:4) gave 8.52 g (91%) of **2b**: m.p. 188-190° C; ^1H NMR (DMSO-d_6) δ 7.34 (m, 12H, ArH), 7.02 (d, 8H, J= 9.0 Hz, ArH), 6.64 (s, 8H, ArH), 4.69 (s, 8H, OCH_2Ar), 3.65 (s, 8H, $ArCH_2Ar$), 2.96 (s, 8H, CH_2CN). ^{13}C NMR (DMSO-d_6) δ 154.96 ($COCH_2Ar$), 137.74, 134.12, 129.38, 127.81, 127.10, 127.00, 123.72 (Ar), 118.68 (CH_2CN), 71.45 (OCH_2Ar), 37.27 ($ArCH_2Ar$), 21.21 (CH_2CN). Anal. Calcd for $C_{64}H_{52}N_4O_4.1/10\ CHCl_3$: C, 80.78; H, 5.51. Found: C, 80.80; H, 5.57. The presence of $CHCl_3$ in the analytical sample was verified by the appearance of a resonance at δ 7.27 in the ^1H NMR spectrum of **2b** in CH_2Cl_2.

5,11,17,23-Tetracyanomethyl-25,26,27,28-tetramethoxycalix[4]arene (Mixture of Conformers) (2a). Following the procedure described above for the preparation of **2b**, a mixture of 1.38 g (10 mmol, 10 equiv) of anhydrous K_2CO_3 and 0.3 g (2 mmol) of NaI suspended in 150 mL of anhydrous Me_2CO was

treated with 0.58 g (1 mmol) of **1b** and 3.4 g (20 mmol, 20 equiv) of MeI in 15 mL of dry Me_2CO. The crude product was purified by flash chromatography using CH_2Cl_2 as an eluent to yield 0.56 g (89%) of **2a** as a light yellow solid which was crystallized from a mixture of $CHCl_3$-hexane (1:3): m.p. 192-194° C; ^1H NMR ($CDCl_3$) δ 7.26 - 6.29 (5 lines, 8H, ArH), 4.33 - 3.01 (m, 20H, $ArCH_2Ar$, CH_2CN, and OCH_3); ^{13}C NMR ($CDCl_3$) δ 157.67 ($COCH_3$), 157.13 ($COCH_3$), 137.14, 135.38, 134.15, 134.00, 132.25, 130.32, 129.81, 128.87, 128.61, 127.80, 127.69, 124.03, 123.38, 122.64 (Ar), 118.16 (CN), 118.42 (CN), 118.35 (CN), 61.82 (OCH_3), 61.10 (OCH_3), 59.93 (OCH_3), 59.04 (OCH_3), 35.89 ($ArCH_2Ar$), 35.69 ($ArCH_2Ar$), 30.48 ($ArCH_2Ar$), (30.39 ($ArCH_2Ar$), 23.15 (CH_2CN), 23.04 (CH_2CN), 22.84 (CH_2CN). Anal. Calcd for $C_{40}H_{36}N_4O_4$: C, 75.45; H, 5.70. Found: C, 74.78; H, 5.69.

General Procedures for 5,11,17,23-Tetra-[(α,α-diarylmethyl)cyanomethyl]-25,26,27,28-tetra(arylmethyloxy)calix[4]arenes (Cone Conformer) (4) and 1,3-Alternate Conformer (3) (A) Sodium Hydride Method. A 20-40 mmol (20-40 equiv) sample of NaH (60% in oil dispersion) was placed in a 3-necked round-bottomed flask followed by 60-100 mL of a mixture of freshly distilled and dry THF-DMF (4:1 or 5:1), and the air in the flask was replaced with N_2. The flask was cooled in an ice bath to 2-3° C, 0.581 g (1 mmol) of *p*-cyanomethylcalix[4]arene (**1b**) or 0.47 g (0.5 mmol) of 5,11,17,23-tetracyanomethyl-25,26,27,28-tetrabenzyloxycalix[4]arene (**2b**) was added, the flask was allowed to warm to room temperature, and the contents were stirred for 30 min under a stream of N_2. A solution containing 15-25 equiv of arylmethyl halide in 10 mL of dry THF (with **1b** as starting material) or 11-15 equivalents (with **2b** as starting material) in 5 mL of dry THF was then added dropwise from an addition funnel to the stirred reaction mixture over a period of 30 min. The contents were refluxed 3-18 h in an oil bath and then allowed to stir at room temperature overnight (14 to 18 h). The solvent was removed under reduced pressure on a rotary evaporator, and the concentrated residue was neutralized with ice-cold 10% HCl to leave a light yellow to dark brown solid which was removed by filtration. In cases where the product was a semisolid it was extracted with CH_2Cl_2 (3 x 100 ml) and the solvent then removed under reduced pressure. The crude material from either of these operations was stirred for 30 min with 100 mL of MeOH (product from 4-*tert*-butylbenzyl bromide first stirred with hexane) to leave a white or pale yellow powder. This was purified by chromatography on a silica gel column ($CHCl_3$ or CH_2Cl_2 as eluent) followed by crystallization from the appropriate solvent to give **3b-f** and **4b-i** as crystalline compounds that were dried under vacuum for 36-72 h at 110° C.

[B] Sodium Hydroxide Method. A 20-50 mmol (20-50 equiv) sample of NaOH was crushed to a fine powder and placed in a 3-necked round-bottomed flask followed by 50-100 ml of HPLC grade Me_2CO, and the air in the flask was replaced with N_2. To the flask was added 0.29 g (0.5 mmol) of *p*-cyanomethylcalix[4]arene (**1b**) or 0.31-0.47g (0.33-0.50 mmol) of 5,11,17,23-tetracyanomethyl-25,26,27,28-tetrabenzyloxycalix[4]arene (**2b**), and the contents were stirred for 30 min at rt under a stream of N_2. A solution of 15-25 equiv of arylmethyl halide (with **1b** as starting material) or 11-15 equiv of arylmethyl halide (with **2b** as starting material) in 10 mL of dry Me_2CO was added dropwise to the stirred solution over a period of 30 min, and the reaction content was refluxed for 2-10 h. The reaction mixture was worked up in the fashion described above for the NaH procedure.

5,11,17,23-Tetra(α,α-dimethylcyanomethyl)-25,26,27,28-tetramethoxycalix[4]arene (Mixture of Conformers) (3a/4a) was prepared in 88% and 86% yield from **1b** and **2a**, respectively, using 50 equivalent

of MeI following procedure **A** (6 hr reflux). Purification by column chromatography and crystallization from $CHCl_3$/hexane (1:3) afforded a colorless solid: m.p. 247-248° C; ^1H NMR ($CDCl_3$) δ 7.37 - 6.54 (5 lines, 8H, ArH), 4.36 - 3.14 (m, 20H, $ArCH_2Ar$ and OCH_3), 1.80 - 1.41 (4 lines, 24H, $C(CH_3)_2CN$); ^{13}C NMR ($CDCl_3$) δ 157.18 ($COCH_3$), 157.10 ($COCH_3$), 156.72 ($COCH_3$), 136.59, 136.25, 134.97, 134.88, 133.88, 133.72, 133.51, 132.35, 127.74, 125.94, 125.84, 125.74, 125.34, 125.06, 124.95, 124.89, 124.85, 124.65 (Ar and CN), 60.74 (OCH_3), 59.29 (OCH_3), 58.31 (OCH_3), 56.90 (OCH_3), 36.54 ($ArCH_2Ar$), 36.31 ($ArCH_2Ar$), 30.74 ($ArCH_2Ar$), 29.44 ($ArCH_3$), 29.31 ($ArCH_3$), 28.91 ($ArCH_3$). Anal. Calcd for $C_{48}H_{52}N_4O_4$: C, 76.98; H, 7.00. Found: C, 76.45; H, 6.95.

5,11,17,23-Tetra(α,α-dibenzylcyanomethyl)-25,26,27,28-tetra(benzyloxy)calix[4]arene (3b) (1,3-alternate conformer) was prepared by treating **2b** with 15 equiv of benzyl bromide following the procedures **A** (20 equiv of NaH and 8 h reflux or 16 h at rt) and **B** (25 equiv of NaOH and 5 h reflux) and was isolated in 89% and 92% yields, respectively, after chromatography ($CHCl_3$). Crystallization from $CH_2Cl_2/CHCl_3$/hexane (1:1:4) followed by trituration with MeOH afforded a white powder: m.p.134-137° C; ^1H NMR ($CDCl_3$) δ 7.23 (shoulder, $CHCl_3$), 7.21-7.30 (m, 36H, ArH), 6.93-6.95 (m, 16H, ArH), 6.81 (d, 8H, J = 6.30 Hz, ArH), 6.63 (s, 8H, ArH), 4.57 (s, 8H, OCH_2Ar), 3.21 (s, 8H, $ArCH_2Ar$), 2.86 (d, 8H, J = 13.23 Hz, $CNC[CH_2Ar]_2$), 2.37 (d, 8H, J = 13.32 Hz, $CNC[CH_2Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 155.16 ($COCH_2Ar$), 137.15, 135.40, 133.91, 132.21, 130.70, 128.30, 128.12, 128.02, 127.89, 127.28, 127.16 (Ar), 121.18 (CN), 71.69 (OCH_2Ar), 49.09 ($CNC[CH_2Ar]_2$), 44.38 ($CNC[CH_2Ar]$), 38.33 ($ArCH_2Ar$). Anal. Calcd for $C_{120}H_{100}N_4O_4$. 1/3 $CHCl_3$: C, 84.92; H, 5.94. Found: C, 85.18; H, 5.82 .

5,11,17,23-Tetra[α,α–di(4'-methoxybenzyl)cyanomethyl]-25,26,27,28-tetra(benzyloxy)calix-[4]arene (3c) (1,3-alternate conformer) was prepared by treating **2b** with 12 equiv of 4-methoxybenzyl chloride following procedures **A** (20 equiv of NaH and 8 h reflux or 16 h at rt) and **B** (30 equiv of NaOH and 3 h reflux) and was isolated in 92% and 94% yields, respectively, after column chromatography ($CHCl_3$). Crystallization from a mixture of $CH_3CN/CHCl_3$/hexane (1:1:4) followed by trituration with MeOH afforded a white powder; m.p. 154-157° C; ^1H NMR ($CDCl_3$) δ 7.28 (m, 12H, ArH), 6.84 (d, 24H, J = 6.26 Hz, ArH), 6.75 (d, 16H, J = 8.48 Hz, ArH), 6.64 (s, 8H, ArH), 4.85 (s, 8H, OCH_2Ar), 3.79 (s, 24H, OCH_3), 3.27 (s, 8H, $ArCH_2Ar$), 2.78 (d, 8H, J = 13.13 Hz, $CNC[CH_2Ar]_2$), 2.28 (d, 8H, J = 12.77 Hz, $CNC[CH_2Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 158.84 ($COCH_3$), 155.20 ($COCH_2Ar$), 137.25, 133.88, 132.47, 131.64, 128.27, 128.08, 127.82, 127.34, 113.18 (Ar), 121.42 (CN), 71.80 (OCH_2Ar), 55.12 ($COCH_3$), 49.26 ($CNC[CH_2Ar]_2$), 43.72($CNC[CH_2Ar]$), 38.18 ($ArCH_2Ar$). Anal. Calcd for $C_{128}H_{116}N_4O_{12}$.1/6 $CHCl_3$: C, 80.08; H, 6.09. Found: C, 80.16; H, 5.74 .

5,11,17,23-Tetra[α,α-di(4'-methylbenzyl)cyanomethyl]-25,26,27,28-tetra(benzyloxy)calix[4]arene (3d) (1,3-alternate conformer) was prepared by treating **2b** with 15 equiv of 4-methylbenzyl bromide following procedures **A** (20 equiv of NaH and 8 h reflux or 16 h at rt) and **B** (25 equiv of NaOH and 5 h reflux) and was isolated in 89% and 92% yields after column chromatography ($CHCl_3$). Crystallization from $CH_3CN/CHCl_3$/hexane (1:1:4) afforded a white powder: m.p. 140-143° C; ^1H NMR ($CDCl_3$) δ 7.25-7.17 (m, 12H, ArH), 6.95 (d, 16H, J = 7.93 Hz, ArH), 6.76 (m, 8H, ArH), 6.73 (d, 16H, J = 8.05 Hz, ArH), 6.55 (s, 8H, ArH), 4.53 (s, 8H, OCH_2Ar), 3.21 (s, 8H, $ArCH_2Ar$), 2.69 (d, 8H, J = 14.30 Hz, $CNC[CH_2Ar]_2$), 2.24 (s, 24H, CH_3), 2.16 (d, 8H, J = 13.43 Hz, $CNC[CH_2Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 154.56 ($COCH_2Ar$), 137.25, 136.59, 133.81, 132.62, 132.39, 130.61, 128.52, 128.30, 127.89, 127.77, 127.23 (Ar), 121.32 (CN), 71.61

(OCH_2Ar), 49.18 ($CNC[CH_2Ar]_2$), 43.97 ($CNC[CH_2Ar]$), 38.32 ($ArCH_2Ar$), 21.11($ArCH_3$); O-Debenzylation of **3d** (*vide infra*) yielded **5c**, for which elemental analytical data are given.

5,11,17,23-Tetra[α,α-di(4'-chlorobenzyl)cyanomethyl]-25,26,27,28-tetra(benzyloxy)calix[4]arene (3e) (1,3-alternate conformer) was prepared by treating **2b** with 12 equiv of 4-chlorobenzyl chloride following procedure **A** (20 equiv of NaH; 18 h reflux) and was isolated in 83% yield after column chromatography ($CHCl_3$). Crystallization from CH_2Cl_2/$CHCl_3$/hexane (2:1:6) afforded a white powder: m.p. 168-172° C; ^1H NMR ($CDCl_3$) δ 7.30-7.23 (m, 12H, ArH), 7.21 (d, 16H, J = 7.58 Hz, ArH), 6.84 (d, 16H, J = 8.18 Hz, ArH), 6.80 (bs, 8H, ArH), 6.62 (s, 8H, ArH), 4.62 (s, 8H, OCH_2Ar), 3.31 (s, 8H, $ArCH_2Ar$), 2.74 (d, 8H, J = 13.55 Hz, $CNC[CH_2Ar]_2$), 2.19 (d, 8H, J = 12.89 Hz, $CNC[CH_2Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 155.20 ($COCH_2Ar$), 136.81, 134.00, 133.46, 133.18, 131.81, 128.42, 128.36, 128.31, 128.21, 128.03, 127.22 (Ar), 120.76 (CN), 71.80 (OCH_2Ar), 48.93($CNC[CH_2Ar]_2$), 43.64($CNC[CH_2Ar]_2$), 38.42 ($ArCH_2Ar$). Anal. Calcd for $C_{120}H_{92}N_4O_4Cl_8$: C, 74.38; H, 4.79. Found: C, 74.55; H, 4.72.

5,11,17,23-Tetra[α,α-di(4'-bromobenzyl)cyanomethyl]-25,26,27,28-tetra(benzyloxy)calix[4]arene (3f) (1,3-alternate conformer) was prepared by treating **2b** with 12 equiv of 4-bromobenzyl bromide following the procedure **A** (20 equiv of NaH; 18 h reflux) and was isolated in 81% yield after column chromatography ($CHCl_3$). Crystallization from MeCN/$CHCl_3$/hexane (1:2:4) afforded a white powder: m.p. 276-278° C; ^1H NMR ($CDCl_3$) δ 7.29 (d, 16H, J = 8.37 Hz, ArH), 7.23-7.18 (m, 12H, ArH), 6.75 (bs, 8H, ArH), 6.71 (d, 16H, J = 8.6 Hz, ArH), 6.54 (s, 8H, ArH), 4.55 (s, 8H, OCH_2Ar), 3.24 (s, 8H, $ArCH_2Ar$), 2.65 (d, 8H, J = 13.41 Hz, $CNC[CH_2Ar]_2$), 2.09 (d, 8H, J= 13.11 Hz, $CNC[CH_2Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 154.19 ($COCH_2Ar$), 136.00, 133.01, 132.94, 131.27, 130.93, 130.08, 127.38, 126.94, 126.81, 126.13, 120.51 (Ar), 119.64 (CN), 70.62 (OCH_2Ar), 47.63 ($CNC[CH_2Ar]_2$), 42.61 ($CNC[CH_2Ar]_2$), 37.26 ($ArCH_2Ar$). Anal. Calcd for $C_{120}H_{92}N_4O_4Br_8$: C, 62.85; H, 4.04. Found: C, 63.15; H, 4.04.

5,11,17,23-Tetra(α,α–dibenzylcyanomethyl)-25,26,27,28-tetra(benzyloxy)calix[4]arene (4b) (cone conformer) was prepared by treatment of **1b** with benzyl bromide (20 equiv) following procedures **A** (8 h reflux) using NaH (25 equiv) and **B** (3 h reflux) using NaOH (50 equliv) and was isolated as a white powder in yields of 88% and 90%, respectively. Further purification by crystallization from CH_2Cl_2/hexane (3:1) gave a colorless solid: mp 276-278° C; ^1H NMR ($CDCl_3$) δ 7.37 (q, 12H, J = 7.1 Hz, ArH), 7.23 (t, 8H, J = 6.5 Hz, ArH), 7.14 (t, 8H, J = 7.1 Hz, ArH), 7.02 (t, 16H, J =7.1 Hz, ArH), 6.92 (s, 8H, ArH), 6.77 (d, 16H, J = 7.5 Hz, ArH), 4.89 (s, 8H, OCH_2Ar), 3.96 (d, 4H, J = 12.36 Hz, $ArCH_2Ar$), 2.98 (d, 8H, J = 13.56 Hz, $CNCCH_2Ar$), 2.76 (d, 8H, J = 13.44 Hz, $CNCCH_2Ar$), 2.65 (d, 4H, J = 12.36 Hz, $ArCH_2Ar$); ^{13}C NMR ($CDCl_3$) δ 153.73 ($COCH_2Ar$), 137.19, 135.66, 135.22, 133.01, 130.46, 129.12, 128.12, 127.06, 126.36 (Ar), 121.24 (CN), 77.06(OCH_2Ar), 50.14 ($CNC[CH_2Ar]_2$), 45.54 ($CNC[CH_2Ar]_2$), 30.59 ($ArCH_2Ar$). The $ArCH_2Ar$ and $ArCH_2O$ protons are well resolved in pyridine-d_5 [δ 4.18 (d, 4H, J = 12.6 Hz, $ArCH_2Ar$), 3.28(d, 8H, J = 12.6 Hz, $CNC[CH_2Ar]_2$), 3.12 (d, 8H, J = 12.6 Hz, $CNC[CH_2Ar]_2$), 2.72 (d, 4H, J = 12.6 Hz, $ArCH_2Ar$)]. Anal. Calcd for $C_{120}H_{100}N_4O_4$: C, 86.71; H, 6.06; N, 3.37. Found: C, 87.03; H, 5.90; N, 3.16.

5,11,17,23-Tetra[α,α-di(4'-methoxybenzyl)cyanomethyl]-25,26,27,28-tetra(4'-methoxybenzyloxy)calix[4]arene (4c) (cone conformer) was prepared from **1b** following procedures **A** using 25 equiv of NaH (3h at rt) and **B** using 25 equiv of NaOH (2 h at rt) with 20 equiv of 4-methoxybenzyl chloride and was isolated as a white powder in yields of 92% and 94% yields, respectively. Further purification by crystallization from CH_2Cl_2/hexane (4:1) gave a colorless solid: m.p. 136-138° C; ^1H NMR ($CDCl_3$) δ 7.13

(d, 8H, J = 7.64 Hz, ArH), 6.85 (m, 16H, ArH), 6.75 (d, 16H, J = 8.0 Hz, ArH), 6.59 (d, 16H, J = 7.64 Hz, ArH), 4.86 (s, 8H, OCH_2Ar), 3.98 (d, 4H, J = 12.89 Hz, $ArCH_2Ar$), 3.84 (s, 12H, OCH_3), 3.69 (s, 24H, OCH_3), 2.89 (d, 8H, J = 13.43 Hz, CNC $[CH_2Ar]_2$), 2.74 (d, 8H, J = 13.96 Hz, $CNC[CH_2Ar]_2$), 2.67 (d, 4H, J = 12.89 Hz, $ArCH_2Ar$); ^{13}C NMR ($CDCl_3$) δ 159.49 ($COCH_3$), 158.52($COCH_3$), 153.64 ($COCH_2Ar$), 135.47, 133.07, 131.50, 131.18, 129.52, 127.45, 126.16, 113.31, 113.26 (Ar), 121.61 (CN), 76.37 (OCH_2Ar), 55.22($ArOCH_3$), 55.02($ArOCH_3$), 50.48 ($CNC[CH_2Ar]_2$), 44.73 ($CNC[CH_2Ar]_2$), 30.86 ($ArCH_2Ar$). The $ArCH_2Ar$ and $ArCH_2O$ protons are well resolved in pyridine-d_5 [δ 4.39 (d, 4H, J = 12.19 Hz, $ArCH_2Ar$), 3.29 (d, 8H, J = 13.55 Hz, $CNC[CH_2Ar]_2$), 3.17 (d, 8H, J = 14.38 Hz, $CNC[CH_2Ar]_2$), 2.93 (d, 4H, J = 12.35 Hz, $ArCH_2Ar$)]. Anal. Calcd. for $C_{132}H_{124}N_4O_{16}$: C, 78.39; H, 6.18. Found: C, 78.04; H, 6.12.

5,11,17,23-Tetra[α,α-di(4'-methylbenzyl)cyanomethyl]-25,26,27,28-tetra(4'-methylbenzyloxy)-calix[4]arene (4d) (cone conformer) was prepared following procedures **A** (30 equiv of NaH; 3 h reflux) and **B** (40 equiv of NaOH, 3 h reflux) using 20 equiv of 4-methylbenzyl bromide and was isolated as a pale yellow powder in yields of 85% and 87% yields, respectively. Purification by column chromatography ($CHCl_3$-CH_2Cl_2) and crystallization from $CHCl_3$/hexane (3:5) gave a pale yellow solid: m.p. 112-114° C; ^1H NMR ($CDCl_3$) δ 7.04 (bs, 16H, ArH), 6.80 (d, 16H, J = 7.94 Hz, ArH), 6.74 (s, 8H, ArH), 6.67 (d, 16H, J = 7.76 Hz, ArH), 4.82 (s, 8H, OCH_2Ar), 3.91 (d, 4H, J = 12.77 Hz, $ArCH_2Ar$), 2.81 (d, 8H, J = 13.55 Hz, $CNC[CH_2Ar]_2$), 2.68 (d, 8H, J = 13.84 Hz, $CNC[CH_2Ar]_2$), 2.56 (d, 4H, $ArCH_2Ar$), 2.33 (s, 12H, CH_3), 2.18 (s, 24H, CH_3). ^{13}C NMR ($CDCl_3$) δ 153.41 ($COCH_2Ar$), 136.72, 135.33, 134.15, 133.24, 131.98, 131.20, 129.37, 129.02, 127.69, 127.56, 125.19 (Ar), 120.48 (CN), 75.57 (OCH_2Ar), 48.98 ($CNC[CH_2Ar]_2$), 44.12 ($CNC[CH_2Ar]_2$), 28.68 ($ArCH_2Ar$), 20.36 ($ArCH_3$), 20.05 ($ArCH_3$). The $ArCH_2Ar$ amd $ArCH_2O$ protons are well resolved in pyridine-d_5 [δ 4.35 (d, 4H, J = 12.78 Hz, $ArCH_2Ar$), 3.26 (d, 8H, J = 13.53 Hz, $CNC[CH_2Ar]_2$), 3.15 (d, 8H, J = 13.44 Hz, $CNC[CH_2Ar]_2$), 2.85 (d, 4H, J = 12.72 Hz, $ArCH_2Ar$)]; O-Debenzylation (*vide infra*) yielded **5c**, for which elemental analytical data are given.

5,11,17,23-Tetra[α,α-di(4'-*tert*-butylbenzyl)cyanomethyl]-25,26,27,28-tetra(4'-*tert*-butylbenzyloxy)calix[4]arene (4e) (cone conformer) was prepared following procedures **A** (40 equiv of NaH and 8 h reflux) and **B** (25 equiv of NaOH; 6 h reflux) using 25 equiv of *4-tert*-butylbenzyl bromide and was isolated as a white powder in yields of 34% and 78% yields, respectively. In procedure **A**, a second compound of unknown structure was isolated as the major product when the crude material was stirred with hexane before subjecting it to column chromatography. The unknown compound and **4e** were purified by column chromatography ($CHCl_3$) and crystallization from $CHCl_3$/hexane (1:4). The ^1H NMR and ^{13}C NMR spectra of the unknown compound indicate it to be derived from *p-tert*-butylbenzyl bromide and DMF, but its elemental analysis (C, 52.07, H, 6.33, N, 2.52) is not easily reconciled with the spectral data. Compound **4e**: m.p. 216-218° C, ^1H NMR ($CDCl_3$) δ 7.34 (d, 8H, J = 8.4 Hz, ArH), 7.19 (d, 8H, J = 8.0 Hz, ArH), 7.12 (d, 16H, J = 6.94 Hz, ArH), 6.85 (d, 16H, J = 8.0 Hz, ArH), 6.76 (s, 8H, ArH), 4.84 (s, 8H, OCH_2Ar), 4.01 (d, 4H, J = 12.98 Hz, $ArCH_2Ar$), 2.96 (d, 8H, J = 13.89 Hz, $CNC[CH_2Ar]_2$), 2.80 (d, 8H, J = 13.54 Hz, $CNC[CH_2Ar]_2$), 2.65 (d, 4H, J = 13.07 Hz, $ArCH_2Ar$), 1.27 (s, 72H, $C(CH_3)_3$, 1.25 (s, 36H, $C(CH_3)_3$, 0.76 (m, hexane); ^{13}C NMR ($CDCl_3$) δ 154.31 ($COCH_2Ar$), 151.08 (CBu^t), 149.55 (CBu^t), 134.79, 134.64, 133.03, 132.37, 130.33, 129.52, 126.36, 124.95, 124.75 (ArC), 121.80 (CN), 76.71 (OCH_2Ar), 49.56 ($CNC[CH_2Ar]_2$), 44.93 ($CNC[CH_2Ar]_2$), 34.64 ($C(CH_3)_3$), 34.41 ($C(CH_3)_3$), 31.44 ($C(CH_3)_3$), 29.73 ($ArCH_2Ar$). The $ArCH_2Ar$ protons are well resolved in pyridine-d_5 [δ 4.21 (d, 4H, J = 12.7 Hz, $ArCH_2Ar$),

3.28 (d, 8H, J = 12.9 Hz, CNC[$CH_2Ar]_2$), 3.18 (d, 8H, J = 12.9 Hz, CNC[$CH_2Ar]_2$), 2.86 (d, 4H, J = 12.7 Hz, $ArCH_2$ Ar). Anal. Calcd. for $C_{168}H_{196}N_4O_4 \cdot 2C_6H_{14}$: C, 86.21; H, 9.00. Found: C, 85.84; H, 9.16.

5,11,17,23-Tetra[α,α-di(4'-fluorobenzyl)cyanomethyl]-25,26,27,28-tetra(4'-fluorobenzyloxy)-calix[4]arene (4f) (cone conformer) was prepared following procedure A (30 equiv of NaH; 18 h reflux) using 25 equiv 4-fluorobenzyl bromide and obtained in 83% yield as a white powder. An analytical sample was obtained by recrystallization from a mixture of CH_2Cl_2/$CHCl_3$/hexane (1:1:4): m.p. 124-127° C; ^1H NMR ($CDCl_3$) δ 7.14 (t, 8H, J = 7.0 and 6.5 Hz, ArH), 7.04 (t, 8H, J = 8.6 and 8.5 Hz, ArH), 7.69 (bs, 8H, ArH), 6.75 (s, 16H, ArH), 6.63 (s, 16H, ArH), 4.83 (s, 8H, OCH_2Ar), 3.96 (d, 4H, J = 11.8 Hz, $ArCH_2Ar$), 2.96 (d, 8H, J = 13.56 Hz, CNC[$CH_2Ar]_2$), 2.75 (d, 4H, J = 11.7 Hz, $ArCH_2Ar$), 2.71 (d, 8H, J = 13.71 Hz, CNC[CH_2 $Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 164.46 (CF), 163.71 (CF), 161.17 (CF), 160.44 (CF), 153.62 (CCH_2Ar), 135.65, 133.04, 132.74, 132.70, 131.95, 131.84, 131.21, 131.10, 130.72, 126.47, 115.31, 115.04, 114.77 (Ar), 121.03 (CN), 77.08 (OCH_2Ar), 50.15 (CNC[$CH_2Ar]_2$), 44.53 (CNC[CH_2Ar]), 30.56 ($ArCH_2Ar$). The $ArCH_2Ar$ protons are well resolved in pyridine-d_5 [δ 4.16 (d, 4H, J = 11.63 Hz, $ArCH_2Ar$), 3.36 (d, 8H, J = 13.43 Hz, CNC[$CH_2Ar]_2$), 3.20 (d, 8H, J = 13.13 Hz, CNC[$CH_2Ar]_2$), 2.89 (d, 4H, J = 11.44 Hz, $ArCH_2Ar$). Anal. Calcd. for $C_{120}H_{88}N_4O_4F_{12}$: C, 76.75 H, 4.70. Found: C, 76.41; H, 4.55.

5,11,17,23-Tetra[α,α-di(4'-chlorobenzyl)cyano)methyl]-25,26,27,28-tetra(4'-chlorobenzyloxy)-calix[4]arene (4g) (cone conformer) was prepared in 75% and 79% yields, respectively, by following the procedures A (30 equiv of NaH; 8 h reflux) and B (35 equiv of NaOH; 7 h reflux) using 20 equiv of 4-chlorobenzyl chloride. The product was purified by column chromatography ($CHCl_3$) and crystallized from CH_2Cl_2/hexane (1:5) to give a white powder: m.p. 135-138° C; ^1H NMR ($CDCl_3$) δ 7.34 (d, 8H, J = 8.37 Hz, ArH), 7.08 (m, 24H, ArH), 6.77 (t, 24H, J = 8.19 and 8.34 Hz, ArH), 5.09 (CH_2Cl_2), 4.82 (s, 8H, OCH_2Arl), 3.96 (d, 4H, J = 12.84 Hz, $ArCH_2Ar$), 2.93 (d, 8H, J = 13.56 Hz, CNC[$CH_2Arl]_2$), 2.72 (d, 4H, J = 12.90 Hz, $ArCH_2Ar$), 2.70 (d, 8H, J = 13.44 Hz, CNC[$CH_2Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 153.76 ($COCH_2ArCl$), 135.23, 135.08, 134.62, 133.46, 133.28, 132.83, 131.72, 130.90, 128.55, 128.28, 126.46 (Ar), 120.95 (CN), 76.38 (OCH_2Ar), 49.54 (CNC[$CH_2Ar]_2$), 44.60 (CNC[CH_2Ar]), 30.81 ($ArCH_2Ar$). The CH_2 protons are well resolved in pyridine-d_5 [δ 4.19 (d, 4H, J = 12.89 Hz, $ArCH_2Ar$), 3.29 (d, 8H, J = 13.01 Hz, CNC[$CH_2Ar]_2$), 3.11 (d, 8H, J = 13.44 Hz, CNC[$CH_2Ar]_2$), 2.86 (d, 4H, J = 12.23 Hz, $ArCH_2Ar$)]. Anal. Calcd for $C_{120}H_{88}N_4O_4Cl_{12}$. 1/4 CH_2Cl_2: C, 68.89; H, 4.25 . Found: C, 68.87; H, 3.92 .

5,11,17,23-Tetra[α,α-di(4'-bromobenzyl)cyanomethyl]-25,26,27,28-tetra(4'-bromobenzyloxy)-calix[4]arene (4h) (cone conformer) was prepared following procedure A (30 equiv of NaH and 13 h reflux) using 4-bromobenzyl bromide and was isolated as white powder in 80% after column chromatography ($CHCl_3$). The product was further purified by crystallization from CH_2Cl_2/hexane (4:1) to give a white solid: m.p. 149-151° C; ^1H NMR ($CDCl_3$) δ 7.49 (d, 8H, J = 8.1 Hz, ArH), 7.25 (d, 16H, J = 8.2 Hz, ArH), 7.03 (d, 8H, J = 8.3 Hz, ArH), 6.72 (t, 24H, J = 3.6 and 4.7 Hz, ArH), 4.82 (s, 8H, OCH_2Ar), 3.95 (d, 4H, J = 13.0 Hz, $ArCH_2Ar$), 2.92 (d, 8H, J = 13.5 Hz, CNC[$CH_2Ar]_2$), 2.70 (d, 12H, J = 14.4 Hz, $ArCH_2Ar$ and CNC[CH_2 $Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 153.76 ($COCH_2Ar$), 135.49, 134.99, 133.73, 132.73, 132.20, 132.10, 131.53, 131.25, 126.44, 122.81, 120.94 (Ar), 121.67 (CN), 76.37 (OCH_2ArBr), 49.20 (CNC[$CH_2Ar]_2$), 44.56 (CNC[CH_2Ar]), 30.87 ($ArCH_2Ar$). The $ArCH_2Ar$ protons are well resolved in pyridine-d_5 [δ 4.20 (d, 4H, J = 12.36 Hz, $ArCH_2Ar$), 3.28(d, 8H, J = 13.44 Hz, CNC[$CH_2Ar]_2$), 3.09 (d, 8H, J = 13.41 Hz, CNC[$CH_2Ar]_2$),

2.86 (d, 4H, J = 12.33 Hz, $ArCH_2Ar$)]. Anal. Calcd for $C_{120}H_{88}N_4O_4Br_{12}$: C, 55.25; H, 3.46. Found: C, 55.60 H, 3.36 .

5,11,17,23-Tetra[α,α-di(3'-chlorobenzyl)cyanomethyl]-25,26,27,28-tetra(3'-chlorobenzyloxy)-calix[4]arene (4i) (cone conformer) was prepared in 80% yield using 20 equiv of 3-chlorobenzyl bromide with 30 equiv of NaH and 18 h reflux following procedure A. Crystallization from CH_2Cl_2/hexane (5:2) gave a colorless solid: m.p. 168-171° C; ^1H NMR ($CDCl_3$) δ 7.39 (m, 4H, ArH), 7.33 (bs, 4H, ArH), 7.26 (t, 8H, J = 7.5 Hz, ArH), 7.15 (d, 8H, J = 8.0 Hz, ArH), 7.04 (m, 12H, ArH), 6.87 (bs, 8H, ArH), 6.73 (bs, 4H, ArH), 6.70 (bs, 8H, ArH), 4.87 (s, 8H, OCH_2Ar), 3.97 (d, 4H, J = 12.3 Hz, $ArCH_2Ar$), 2.95 (d, 8H, J = 13.5 Hz, $CNC[CH_2Ar_2)$, 2.74 (d, 12H, J = 13.4 Hz, $ArCH_2Ar$ and CNC $[CH_2Ar]_2$); ^{13}C NMR ($CDCl_3$) δ 153.03 ($COCH_2ArCl$), 137.87, 135.82, 134.40, 133.14, 132.74, 131.62, 129.37, 128.56, 128.45, 128.36, 127.57, 127.53, 126.55, 125.61 (Ar), 119.69 (CN), 75.71 (OCH_2Ar), 48.52 ($CNC[CH_2Ar]_2$), 43.73 ($CNC[CH_2Ar]$), 28.67 ($ArCH_2Ar$). Anal. Calcd for $C_{120}H_{88}N_4O_4Cl_{12}$: C, 69.45; H, 4.27. Found: C, 69.84; H, 4.77 .

5,11,17,23-Tetra-[α,α-di(1-naphthylmethyl)cyanomethyl]-25,26,27,28-tetra-(1-naphthylmethoxy)-calix[4]arene (6a) (cone conformer) was prepared from *p*-cyanomethylcalix[4]arene **1b** and 1-chloromethylnaphthalene following procedure A (reflux 3 h or rt for 18 h) and was isolated as a white powder in 84 % yield when eluted with CH_2Cl_2: m.p. 170° C (softening) and 190-192° C (liquid); ^1H NMR ($CDCl_3$) δ 7.93-7.70 (m, 16H, ArH), 7.67-7.57 (m, 24H, ArH), 7.50-7.42 (m, 8H, ArH), 7.32-7.12 (m, 24H, ArH), 7.20-7.14 (m, 12H, ArH), 6.98-6.87 (m, 8H, ArH), 5.06 (s, 8H, OCH_2Ar), 4.02 (d, 4H, J = 13.20 Hz, $ArCH_2Ar$), 3.58 (d, 8H, J = 15.0 Hz, $ArCH_2$), 3.26 (d, 8H, J = 15.20 Hz, $ArCH_2$), 2.39 (d, 4H, J = 12.90 Hz, $ArCH_2Ar$); ^{13}C NMR ($CDCl_3$) δ 154.46 ($COCH_2$), 135.43, 133.82, 133.60, 133.56, 133.01, 132.68, 131.68, 131.46, 129.11 128.82, 128.69, 128.57, 128.03, 127.86, 126.42, 126.23, 125.79, 125.53, 125.27, 125.08, 124.93, 123.87, 123.61 (Ar), 121.93 (CN), 74.78 ($COCH_2Ar$), 50.38 ($CNC[CH_2Ar]_2$), 40.93 ($CNC[CH_2Ar]_2$) 30.26 ($ArCH_2Ar$). Anal Calcd. for $C_{168}H_{124}N_4O_4$: C, 89.17; H, 5.52; Found: C, 88.92, H, 5.33.

5,11,17,23-Tetra[α,α-di-(2-naphthylmethyl)cyanomethyl]-25,26,27,28-tetra(2-naphthylmethoxy) calix[4]arene (6b) (cone conformer) was prepared from **1b** following procedure A (rt for 16 h) using 2-bromomethylnaphthalene and was isolated as a white powder in 90% yield after column chromatography ($CHCl_3$): m.p. 148-150° C; ^1H NMR ($CDCl_3$) δ 7.18 (d, 4H, J =8.40 Hz, ArH), 7.67 (d, 8H, J =8.10 Hz, ArH), 7.48-7.56 (m, 16H, ArH), 7.36-7.45 (m, 32H, ArH), 7.24-7.33 (m, 16H, ArH), 6.94 (bs, 16H, ArH), 5.09 (s, 8H, OCH_2Ar) 4.15 (d, 4H, J= 12.36 Hz, $ArCH_2Ar$), 3.21(d, 8H, J = 13.86 Hz, $CNCCH_2Ar$), 3.06 (d, 8H, J = 13.29 Hz, $CNCCH_2Ar$), 2.69 (d, 4H, J= 12.48 Hz, $ArCH_2Ar$); ^{13}C NMR ($CDCl_3$) δ 154.28 ($COCH_2Ar$), 135.16, 134.94, 133.19, 132.83, 132.56, 129.75, 128.66, 128.56, 128.14, 128.00, 127.89, 127.77, 127.52, 126.62, 126.34, 125.83, 125.75 (Ar), 121.78 (CN), 77.43 (OCH_2Ar), 50.09 ($CNC[CH_2Ar]_2$), 45.86 ($CNC[CH_2Ar]_2$), 31.26 ($ArCH_2Ar$). Anal. Calcd for $C_{168}H_{124}N_4O_4$: C, 89.17; H, 5.51;N, 2.48. Found: C, 89.12; H, 5.65; N, 2.28.

5,11,17,23-Tetra[α,α-(di-*trans*-cinnamyl)cyanomethyl]-25,26,27,28-tetra(*trans*-cinnamyloxy)-calix[4]arene (6c) (cone conformer) was prepared from **1b** following procedure A using *trans*-cinnamyl bromide and was isolated as a white powder in 91% yield after column chromatography ($CHCl_3$): m.p.115-117° C; ^1H NMR ($CDCl_3$) δ 7.15-7.26 (m, 60H, ArH), 6.98 (s, 8H, ArH), 6.68 (m, 4H, HC=CH), 6.46 (t, 3H, HC=CH), 6.05 (m, 8H, HC=CH), 4.72 (d, 8H, J =6.87 Hz, OCH-CH=CH-Ar), 4.57 (d, 4H, J = 12.72 Hz, $ArCH_2Ar$), 3.26 (d, 4H, J = 12.60 Hz, $ArCH_2Ar$), 2.72, 2.67, 2.58 and 2.53 (d,d,d,d, 16H, J= 5.61, 7.74,

6.15 and 5.34 Hz, $CNCCH_2$-cinnamyl); ^{13}C NMR ($CDCl_3$) δ 155.05 (C-O-cinnamyl), 136.82, 136.60, 135.34, 135.13, 133.47, 133.39, 128.74, 128.52, 127.94, 127.51, 126.66, 126.52, 126.07, 123.42 (Ar), 121.89 (CN), 75.99 (OCH_2-cinnamyl), 47.19 ($CNC[CH_2$-cinnamyl$]_2$), 43.07 ($CNC[CH_2$-cinnamyl]), 31.86 ($ArCH_2Ar$). Anal. Calcd for $C_{144}H_{124}N_4O_4$: C, 87.59; H, 6.33; N, 2.84. Found: C, 87.35; H, 6.09; N, 2.81.

5,11,17,23-Tetra[(α,α-di-*trans*-cinnamyl)cyanomethyl]-25,26,27,28-tetra(benzyloxy)calix[4]arene (6d) (1,3-alternate conformer) was prepared from **2b** following procedure A using *trans*-cinnamyl bromide and was isolated as a white powder in 85% yield when eluted with $CHCl_3$ in column chromatography: m.p.122-125° C; ^1H NMR ($CDCl_3$) δ 7.31-7.16 (m, 60H, ArH), 7.04-7.00 (m, 4H, ArH), 6.90 (s, 4H, ArH), 6.38(d, 8H, J = 15.99Hz, CH=CH), 6.02-5.92 (m, 8H, CH=CH), 4.71 (s, 8H, $ArCH_2O$), 3.46 (s, 8H, $ArCH_2Ar$), 2.48 and 2.43 (dd, 8H, J = 9.54 and 8.04 Hz, $ArCH_2$), 2.09 and 2.04 (dd, 8H, J = 8.81 and 7.83 Hz, $ArCH_2$); ^{13}C NMR ($CDCl_3$) δ 154.07(COH), 135.02, 134.82, 134.14, 132.65, 128.62, 128.45, 128.06, 127.92, 127.61, 127.42, 126.35, 123.78 (Ar), 122.20(CN), 72.75 (OCH_2Ar), 46.35 ($CNC[CH_2$-cinnamyl$]_2$), 41.61 ($CNC[CH_2$-cinnamyl$]_2$), 38.04 ($ArCH_2Ar$). Anal. Calcd. for $C_{136}H_{116}N_4O_4$: C, 87.33; H, 6.25. Found: C, 87.54; H, 6.09.

General Procedures for 5,11,17,23-Tetra(α,α-dibenzylcyanomethyl)-25,26,27,28-tetrahydroxycalix[4]arenes (5a-g) (Cone Conformer). (A') Trimethylsilyl Bromide Method. A 0.1 mmol of sample of **3b-f** or **4b-i** in 20 mL of anhydrous $CHCl_3$ containing some molecular sieve was placed in a 150 mL 3-necked, round-bottomed flask. The reaction mixture was heated for 10 min in an oil bath at 50-55° C, and a solution of 10-30 equiv of Me_3SiBr in $CHCl_3$ was added dropwise with stirring. The reaction mixture was refluxed and stirred 24-78 h in an atmosphere of N_2. The progress of the reaction was monitored by TLC, and when it was complete the solvent was removed under reduced pressure and the concentrate poured into 30 mL of MeOH. The white to light yellow precipitate was separated by filtration and washed throughly with MeOH to remove unreacted Me_3SiBr and benzyl bromide or benzyl alcohal formed in the reaction. The product was dried and purified by column chromatography.

(B') Aluminum Chloride Method. Anhydrous white $AlCl_3$ (10-30 equiv) and carefully dried toluene (molecular sieve for 10 d) were placed in a 100 mL 3-necked, round-bottomed flask and stirred 5 min at rt. A slurry of 0.1 mmol of **3b-f** or **4b-i** in 10 mL of toluene was added with stirring. The reaction mixture was stirred 10-30 min in an atmosphere of N_2, completion of reaction being assessed by TLC. The reaction mixture was poured into 50 mL of ice cold water, and unreacted $AlCl_3$ was neutralized with 10% dilute HCl. The organic layer and aqueous layers were separated, and the water layer was extracted with 100 mL of CH_2Cl_2. The organic layer combined with the extract was concentrated on a rotary evaporator, and the concentrate was poured into MeOH to give a white to pale yellow solid which was removed by filtration, washed with MeOH and subjected to column chromatography.

5,11,17,23-Tetra(α,α-dibenzylcyanomethyl)-25,26,27,28-tetrahydroxycalix[4]arene (5a) (cone conformer) was prepared in 90% and 85% yields by the reaction of **4b** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively. Crystallization from CH_2Cl_2/hexane (1:1) afforded **5b** as grannular white crystals which were triturated with MeOH to obtain the analytical sample: m.p. 184-186° C; ^1H NMR ($CDCl_3$) δ 9.85 (s, 4H, ArOH), 7.03 (d, 8H, J = 7.59 Hz, ArH), 6.98 (s, 8H, ArH), 6.91 (t, 16H, J = 7.62 and 7.41 Hz, ArH), 6.78 (d, 4H, J = 7.29 Hz, ArH), 4.22 (b, 4H, $ArCH_2Ar$), 3.42 (b, 4H, $ArCH_2Ar$), 3.04 (d, 8H, J

= 13.47 Hz, CH_2Ar), 2.86 (d, 8H, J = 13.50 Hz, CH_2Ar); ^{13}C NMR ($CDCl_3$) δ 148.17 (COH), 134.81, 131.91, 130.31, 128.29, 127.89, 127.30, 127.17 (Ar), 120.94 (CN), 50.21 ($CNC[CH_2Ar]_2$), 45.71 ($CNC[CH_2Ar]_2$), 31.70 ($ArCH_2Ar$). Anal. Calcd for $C_{92}H_{76}N_4O_4$: C, 84.89; H, 5.89, N, 4.30. Found: C, 84.94; H, 5.79; N, 3.93. In similar fashion **5a** was obtained in 90% and 92% yield by the reaction of **3b** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively.

5,11,17,23-Tetra[α,α-di(4'-methoxybenzyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (5b) (cone conformer) was prepared in 95% and 93% yields by the reaction of **4c** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively. An analytical sample was obtained by crystallization from CH_2Cl_2/hexane (1:5) to give a white powder: m.p. 218-219° C, ^1H NMR ($CDCl_3$) δ 9.96 (s, 4H, ArOH), 7.04 (s, 8H, ArH), 6.72 (d, 16H, J = 8.58 Hz, ArH), 6.52 (d, 16H, J = 8.6 Hz, ArH), 4.26 (b, 4H, $ArCH_2Ar$), 3.68 (b, 4H, $ArCH_2Ar$), 3.64 (s, 24H, OCH_3), 2.95 (d, 8H, J = 13.98 Hz, CH_2Ar), 2.84 (d, 8H, J = 13.56 Hz, CH_2Ar); ^{13}C NMR ($CDCl_3$) δ 158.60 ($COCH_3$), 148.01 (COH), 132.35, 131.33, 128.42, 127.28, 127.14, 113.33 (Ar), 121.18 (CN), 55.11 (OCH_3), 50.69 ($CNC[CH_2Ar]_2$), 44.85 ($CNC[CH_2Ar]_2$), 31.81 ($ArCH_2Ar$). Anal. Calcd for $C_{100}H_{92}N_4O_{12}$. 1/3 CH_2Cl_2: C, 76.75; H, 5.95. Found: C, 76.82; H, 5.91. In similar fashion **5b** was obtained in 93% and 94% yield by the reaction of **3c** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively.

5,11,17,23-Tetra[α,α-di(4'-methylbenzyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (5c) (cone conformer) was prepared in 91% and 90% yields by the reaction of **4c** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively. Crystallization from CH_2Cl_2/$CHCl_3$/hexane (2:1:6) afforded **5c** as a white powder: m.p. 250-253° C; ^1H NMR ($CDCl_3$) δ 10.12 (s, 4H, ArOH), 7.03 (s, 8H, ArH), 6.81 (d, 16H, J = 7.77 Hz, ArH), 6.70 (d, 16H, J = 7.86 Hz, ArH), 4.22 (b, 4H, $ArCH_2Ar$), 3.48 (b, 4H, $ArCH_2Ar$), 2.18 (s, 24H, CH_3), 2.98 (d, 8H, J = 13.53 Hz, CH_2Ar), 2.84 (d, 8H, J = 13.53 Hz, CH_2Ar); ^{13}C NMR ($CDCl_3$ δ 148.09 (COH), 136.66, 132.32, 131.86, 130.23, 128.66, 128.31, 127.36 (Ar), 121.02 (CN), 50.34 ($CNC[CH_2Ar]_2$), 45.27 ($CNC[CH_2Ar]_2$), 31.90 ($ArCH_2Ar$), 21.12 (CH_3). Anal. Calcd for $C_{100}H_{92}N_4O_4$·1/4 $CHCl_3$: C, 83.40; H, 6.44. Found: C, 83.48; H, 6.34. In similar fashion **4c** was also obtained in 91% and 87% yield from **3d** following procedures **A** and **B**, respectively.

5,11,17,23-Tetra[α,α-di(4'-*tert*-butylbenzyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (5d) (cone conformer) was prepared in 94% yield by the reaction of **4e** with Me_3SiBr using procedure **A'**. Crystallization from CH_2Cl_2/hexane (1:4) afforded **5b** as grannular white crystals: m.p. 175-177° C; ^1H NMR ($CDCl_3$) δ 10.30 (s, 4H, ArOH), 7.18 (d, 16H, J = 8.31 Hz, ArH), 7.05 (s, 8H, ArH), 6.92 (d, 16H, J = 8.31 Hz, ArH), 4.24 (b, 4H, $ArCH_2Ar$), 3.38 (b, 4H, $ArCH_2Ar$), 3.10 (d, 8H, J = 13.53 Hz, CH_2Ar), 2.96 (d, 8H, J = 13.56 Hz, CH_2Ar), 1.26 (s, 72H, $C[CH_3]_3$); ^{13}C NMR ($CDCl_3$) δ 149.96 ($CC[CH_3]_3$), 148.27 (COH), 132.82, 132.01, 130.27, 128.01, 127.56, 125.03 (Ar), 121.30 (CN), 49.89 ($CNC[CH_2Ar]_2$), 44.93 ($CNC[CH_2Ar]$), 34.45 ($C[CH_3]_3$), 32.01 ($ArCH_2Ar$), 21.12 (CH_3), 31.37 ($C[CH_3]_3$). Anal. Calcd for $C_{124}H_{140}N_4O_4$: C, 85.08; H, 8.06. Found: C, 84.80; H, 8.06. When compound **4e** was treated with $AlCl_3$ in toluene the de-*tert*-butylated product **5a** was obtained in 85% yield.

5,11,17,23-Tetra[α,α-di(4'-flourobenzyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (5e) (cone conformer) was prepared in 89% and 92% yields by the reaction of **4b** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively, and triturating the product with MeOH: m.p. 148-151° C; ^1H NMR ($CDCl_3$) δ 9.88 (s, 4H, ArOH), 6.97 (s, 8H, ArH), 6.72 (t, 16H, J = 7.2 and 10.8Hz, ArH), 6.61 (t, 16H, J =

11.2 Hz, ArH), 4.24 (b, 4H, $ArCH_2Ar$), 3.45 (b, 4H, $ArCH_2Ar$), 3.01 (d, 8H, J = 13.80 Hz, CH_2Ar), 2.82 (d, 8H, J = 13.80 Hz, CH_2Ar); ^{13}C NMR ($CDCl_3$) δ 163.59 (CF), 160.33 (CF), 148.29 (COH), 131.85, 131.75, 131.45, 130.42, 128.43, 127.30, 114.99, 114.83, 114.71 (Ar), 120.65 (CN), 50.42 ($CNC[CH_2Ar]_2$), 44.72 ($CNC[CH_2Ar]_2$), 31.73 ($ArCH_2Ar$).

5,11,17,23-Tetra[α,α-di(4'-chlorobenzyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (5f) (cone conformer) was prepared in 87% and 85% yields by the reaction of **4b** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively. Trituration with MeOH and crystallization from $CHCl_3$ afforded **5b** as a colorless solid: m.p. 197-200° C; ^1H NMR ($CDCl_3$) δ 9.94 (b, 4H, ArOH), 6.98 (s, 8H, ArH), 6.92 (d, 16H, J = 7.74 Hz, ArH), 6.68 (d, 16H, J = 7.82 Hz, ArH), 4.26 (b, 4H, $ArCH_2Ar$), 3.48 (b, 4H, $ArCH_2Ar$), 3.01 (d, 8H, J = 13.51 Hz, $CNC[CH_2Ar]_2$), 2.84 (d, 8H, J = 13.48 Hz, $CNC[CH_2Ar]_2$).

5,11,17,23-Tetra[α,α-di-(4'-bromobenzyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (5g) (cone conformer) was prepared in 78% and 80% yields by the reaction of **4b** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively. Crystallization from MeCN/$CHCl_3$/hexane (1:2:5) afforded **5g** as a white powder: m.p. 207-210° C; ^1H NMR ($CDCl_3$) δ 9.97 (s, 4H, ArOH), 7.12 (d, 16H, J = 8.31 Hz, ArH), 7.01 (s, 8H, ArH), 6.66 (d, 16H, J= 8.43 Hz, ArH), 4.27 (b, 4H, $ArCH_2Ar$), 3.48 (b, 4H, $ArCH_2Ar$), 2.97 (d, 8H, J = 13.44 Hz, CH_2Ar), 2.85 (d, 8H, J = 13.53 Hz, CH_2Ar); ^{13}C NMR ($CDCl_3$) δ 148.35 (COH), 133.58, 131.96, 131.18, 128.53, 127.33, 127.22, 121.61 (Ar), 120.39 (CN), 49.97 ($CNC[CH_2Ar]_2$), 44.98 ($CNC[CH_2Ar]_2$), 31.84 ($ArCH_2Ar$). Anal. Calcd for $C_{92}H_{68}N_4O_4Br_8$: C, 57.17; H, 3.55 .Found: C, 57.64; H, 3.79. In similar fashion **5g** was obtained in 82% yield by the reaction of **3f** following procedure **B'**.

5,11,17,23-Tetra-[α,α-di(1-naphthylmethyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (7a) (cone conformer) was prepared in 91% and 87% yields by the reaction of **6b** with Me_3SiBr (36 h reflux) or $AlCl_3$ (5 min at rt) using procedures **A'** and **B'**, respectively, followed by crystallization from a mixture of $CHCl_3$ and hexane which yielded a light yellow powder. An analytical sample was obtained by stirring the crystallized compound with MeOH: m.p. 204-206° C; ^1H NMR ($CDCl_3$) δ 10.02 (bs, 4H, ArOH), 7.65 (d, 8H, J = 7.53 Hz, ArH), 7.56 (d, 8H, J = 7.38 Hz, ArH), 7.44 (d, 8H, J = 8.49 Hz, ArH), 7.18-7.13 (m, 24H, ArH) 6.98-6.90 (m, 12H, ArH), 4.24 (bs, 4H, $ArCH_2Ar$), 3.63 (d, 8H, J = 13.98 Hz, $ArCH_2$), 3.48 (bs, 4H, $ArCH_2Ar$) 3.34 (d, 8H, J = 13.98 Hz, $ArCH_2$); ^{13}C NMR ($CDCl_3$, δ 148.42 (C-OH), 133.52, 132.97, 132.50, 131.03 128.83, 128.52, 128.04, 127.86, 127.49, 125.68, 125.34, 124.79, 123.56 (Ar), 121.57 (CN), 49.49 ($CNC[CH_2Ar]_2$), 41.34 ($CNC[CH_2Ar]_2$), 31.71 ($ArCH_2Ar$). Anal. Calcd for $C_{124}H_{92}N_4O_4$: C, 87.50; H, 5.45 Found: C, 87.40, H, 5.54.

5,11,17,23-Tetra[α,α-di(2-naphthylmethyl)cyanomethyl]-25,26,27,28-tetrahydroxycalix[4]arene (7b) (cone conformer) was obtained in 94% and 90% yields by the reaction of **6b** with Me_3SiBr or $AlCl_3$ using procedures **A'** and **B'**, respectively, and was crystallized from $CHCl_3$/hexane to give a white powder which was triturated with MeOH: m.p. 172-174°C (softening) and 187° C (liquid); ^1H NMR ($CDCl_3$) δ 10.02 (s, 4H, ArOH), 7.65 (d, 8H, J = 8.07 Hz, ArH), 7.34-7.41 (m, 24H, ArH), 7.27-7.22 (m, 8H, ArH), 7.19 (s, 8H, ArH), 7.10 (s, 8H, ArH), 6.78(d, 8H, J =8.41 Hz, ArH), 4.30 (bs, 4H, $ArCH_2Ar$), 3.46 (bs, 4H, $ArCH_2Ar$), 3.05 (d, 8H, J = 13.44 Hz, CH_2Ar), 2.78 (d, 8H, J = 13.11 Hz, CH_2Ar); ^{13}C NMR ($CDCl_3$) δ 148.40 (COH), 132.98, 132.50, 132.40, 132.31, 129.47, 128.46, 128.28, 127.70, 127.60, 127.51, 127.34, 125.84 (Ar), 120.80 (CN), 50.25 ($CNC[CH_2Ar]_2$), 45.62 ($CNC[CH_2Ar]_2$), 31.85 ($ArCH_2Ar$). Anal. Calcd for $C_{124}H_{92}N_4O_4$. 1/3$CHCl_3$: C, 85.73; H, 5.34; N, 3.22. Found: C, 85.55; H, 5.38; N, 3.12. The presence of

$CHCl_3$ of crystallization was verified by the appearance of a resonance line at δ 7.26 in the ^1H NMR spectrum of the analytical sample obtained in CH_2Cl_2 solution.

5,11,17,23-Tetra(α,α-dibenzylcyanomethyl)-25,26,27-trihydroxy-28-benzyloxycalix[4]arene (8) (Cone Conformer). A 0.16 g (0.1 mmol) sample of **4b** in 20 mL of anhydrous $CHCl_3$ was treated with 0.15 g (1 mmol, 10 equiv) of Me_3SiBr. The reaction mixture was stirred at rt for 7 d in an atmosphere of N_2, during which time the progress was monitored by TLC. The solvent was removed under reduced pressure (no heating) and the concentrate poured into 40 mL of MeOH to give a white precipitate. This was removed by filtration and the filtrate washed with MeOH to remove unreacted Me_3SiBr, benzyl bromide and/or benzyl alcohol. The crude product was purified by column chromatography ($CHCl_3$), crystallization from CH_2Cl_2/hexane (1:5) and trituration with MeOH (to remove residual CH_2Cl_2). It was dried by heating to *ca* 75° C at 1 mm pressure for 72 h and obtained as 0.133 g (89%) of a colorless solid: m.p. 212-214° C; ^1H NMR ($CDCl_3$) δ 9.48 (s, 1H, ArOH), 9.18 (s, 2H, ArOH), 5.19 (s, 2H, $ArCH_2O$), 5.08 (CH_2Cl_2), 4.24 (d, 2H, J = 13.02 Hz, $ArCH_2Ar$), 4.21 (d, 2H, J = 13.98 Hz, $ArCH_2Ar$), 3.35 (d, 2H, J = 13.95 Hz, $ArCH_2Ar$), 3.28 (d, 2H, J = 13.14 Hz, $ArCH_2Ar$), 2.91-3.08 (m, 8H, CH_2Ar), 2.77-2.91 (m, 8H, CH_2Ar), 7.63 (dd, 2H, ArH), 7.55 (d, 1H, ArH), 7.53 (d, 2H, ArH), 6.92-6.09 (m, 26H, ArH), 6.72-6.86 (m, 18H, ArH); ^{13}C NMR ($CDCl_3$) δ 150.30 (COH), 150.12 (COH), 148.80 ($COCH_2Ar$), 135.69, 135.05, 134.99, 134.92, 134.88, 134.68, 134.62, 130.61, 130.55, 130.45, 130.37, 130.18, 129.45, 129.16, 129.09, 128.96, 128.44, 128.24, 127.92, 127.80, 127.72, 127.17, 127.11, 126.86 (Ar), 121.23 (CN), 120.96 (CN), 120.64 (CN), 79.56 (OCH_2Ar), 50.75 ($CNC[CH_2Ar]_2$), 50.09 ($CNC[CH_2Ar]_2$), 45.89 ($CNC[CH_2Ar]_2$), 45.66 ($CNC[CH_2Ar]_2$), 45.52 ($CNC[CH_2Ar]_2$), 32.16 and 31.59 ($ArCH_2Ar$). Anal. Calcd for $C_{99}H_{82}N_4O_4$. 1/4 CH_2Cl_2: C, 84.31; H, 5.89, N, 3.95; Found: C, 84.31, H, 6.07, N, 3.92.

5,11,17,23-Tetra(α,α-dibenzylcyanomethyl)-25,26,27-tribenzyloxy-28-hydroxycalix[4]arene (9) (Cone Conformer), A solution of 0.166 g (0.1 mmol) of **4b** in 20 mL of anhydrous $CHCl_3$ was treated with 0.15 g (1 mmol, 10 equiv) of Me_3SiBr in $CHCl_3$. The reaction mixture was stirred 2 min, and the solvent was then removed under reduced pressure at rt. The concentrate was poured into MeOH, and the white precipitate was removed by filtration, washed with MeOH, dried, and subjected to column chromatography ($CHCl_3$) to give a white powder: m.p. 165-166° C; ^1H NMR ($CDCl_3$) δ 9.24 (s, 1H, ArOH), 7.46 (bs, 8H, ArH), 7.12-6.94 (m, 26H, ArH), 6.90-6.84 (m, 12H, ArH), 6.81-6.76 (m, 10H, ArH), 6.48 (d, 2H, ArH), 6.09 (m, 5H, ArH), 5.08 - 4.87 (m, 6H, $ArCH_2O$), 5.35 (d, 2H, J = 12.90 Hz, $ArCH_2Ar$), 4.08 (d, 2H, J = 12.90 Hz, $ArCH_2Ar$), 3.15 - 2.70 (m, 20H, $ArCH_2$, $ArCH_2Ar$ and $ArCH_2O$); ^{13}C NMR ($CDCl_3$) δ 151.94 (COH), 150.62 ($COCH_2Ar$), 135.82, 135.14, 135.08, 134.99, 134.78, 134.49, 134.39, 130.48, 130.36, 130.14, 129.05, 128.92, 128.77, 127.97, 127.90, 127.70, 127.20, 127.10 (Ar), 121.29 (CN), 120.80 (CN), 78.75 (OCH_2Ar), 50.70 ($CNC[CH_2Ar]_2$), 49.92 ($CNC[CH_2Ar]_2$), 45.88, 45.67, 45.56 and 45.28 ($CNC[CH_2Ar]_2$), 32.31, 31.89 and 30.14 ($ArCH_2Ar$). Anal. Calcd for $C_{113}H_{94}N_4O_4$: C, 86.34; H, 6.03. Found: C, 85.89, H, 5.90.

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9 Molecular modeling studies were carried out on a Silicon Graphics IRIS-4D/210VGX terminal using the QUANTA and CHARMm programs. The structures were energy minimized using the Adopted Basis Newton Raphson procedure. It should be noted that application of the full Newton Raphson procedure failed to give an energy-minimized structure, the energy instead increasing with each iteration and the molecule ultimately "exploding". This, along with the fact that the Adopted Basis Newton Raphson ceased iterations before the rms values had fallen below *ca* 0.4 suggests that these results should be viewed with some caution.

10 Calixarenes often hold small molecules very tenaciously, and this is true for several of the compounds herein reported which, in spite of very strenuous drying, retain certain amounts of the crystallizating solvent. In most instances the presence of solvent of crystallization has been substantiated by ^{1}H NMR spectral evidence; in others it is assumed as the most logical explanation for the divergences between the calculated and experimental elemental analytical values. The excellent agreement that is generally observed when certain amounts of solvent are included in the calculation of the elemental analytical values provides inferental assurance that the reported compounds are analytically pure.

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