Synthesis and conformations of novel diamide-bridged homooxacalix[3]arenes

Shilan Liu, Shuling Gong, Qin Zheng, Yuanyin Chen* and Xiaojun Wu

Department of Chemistry, Wuhan University, Wuhan 430072 P. R. China

A series of novel di-*O*-bridged homooxacalix[3]arenes and their esters and acylamides have been synthesised. A full account of the synthesis, conformational features of these compounds is provided.

Keywords: bridged homooxacalix[3]arenes, amide-bridged, calixarene, conformation

The first member of homooxacalixarene family, 7, 15, 23-tri-tert-butyl-25, 26, 27-tri-hydroxy-2, 3, 10, 11, 18, 19-hexa-homo -3, 11, 19-trioxacalix[3]arene (homooxacalix[3]arene) was reported by Dhawan and Gutsche in 1983.[1] Tri-*O*-alkylated homooxacalix[3]arenes were firstly reported by Shinkai *et al*. in 1993.[2] Since then, studies have concentrated on their tri-*O*-substituted derivatives.[2-11] It is well known that capping and bridging is an effective route to reduce the conformational mobility.[12] Only two capped homooxacalix[3]arenes with a fixed conformation have been reported,[13,14] but bridged homooxacalix[3]arenes have not been reported to the best of our knowledge. In this paper we report a series of di-*O*-bridged homooxacalix[3]arenes **2a**, **3a** and **4a** (Scheme 1), and their ester and amide derivatives..

Synthesis

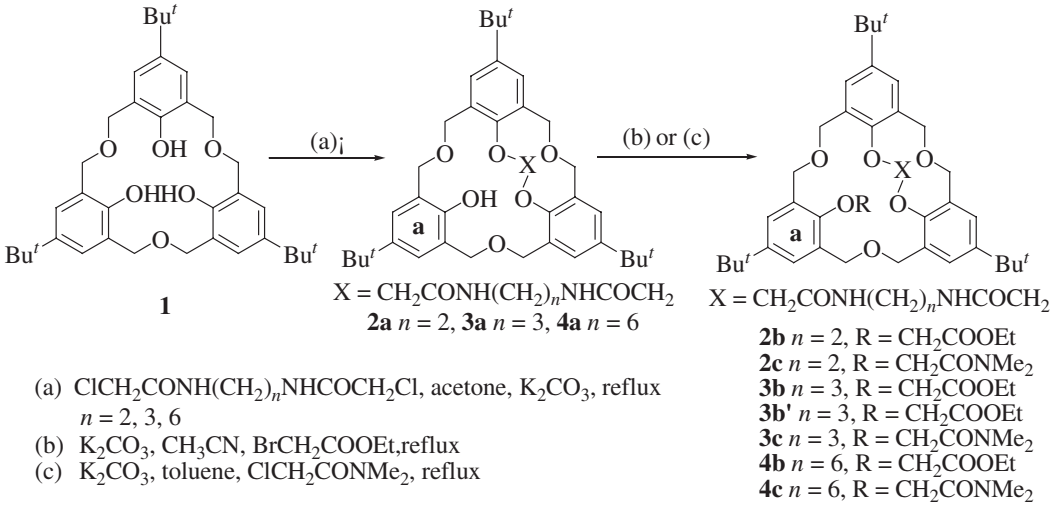
Bridged homooxacalix[3]arenes **2a**, **3a** and **4a** were prepared by the reaction of *p-tert*-butylhomooxacalix[3]arene **1** with *N*,*N* -bis(chloroacetyl)diamine in refluxing acetone in the presence of a base (Scheme 1). The reaction proceeded until **1** could not be detected by TLC. The results are listed in Table 1. It was found that the strength of the base has a remarkable influence on the yield and reaction velocity. Among the bases used, K_2CO_3 was the best. The basicity of Na_2CO_3 is too weak to promote the reaction. The basicity of Cs_2CO_3 is too strong resulting in the formation of more by-products and decrease in the yield of the desired product. The template effect of the K^+ cation can not be excluded. The length of the spacers in the bridging reagent also influenced the yield. It is obvious that the yield decreased with increasing length of the bridging reagents especially from **3a** to **4a**. This can be attributed to the fact that increasing the length of the bridging reagent is unfavourable in matching the two ends with the two hydroxyl groups in the homooxacalix[3]arene.

Table 1 The influence of base on the synthesis of bridged homooxacalix[3]arene

Compound	Base (equiv for **1**)	Reaction time /day[c]	Yield[a] /%
2a	Na_2CO_3(10)	7	–[b]
2a	K_2CO_3(10)	5	81
2a	Cs_2CO_3(10)	2	52
3a	Na_2CO_3(10)	7	–[b]
3a	K_2CO_3(10)	5	78
3a	Cs_2CO_3(10)	2	47
4a	Na_2CO_3(10)	7	–[b]
4a	K_2CO_3(10)	6	22
4a	Cs_2CO_3(10)	2	14

[a]Isolated yield.
[b]Not isolated because the yield was very low according to TLC analysis.
[c]The yield did not increase with the increase of reaction time.

The functionalisation of the bridged homooxacalix[3]arenes was carried out as shown in Scheme 1, and the results are listed in Table 2. It is well known that the exhaustive alkylation of homooxacalix[3]arenes can produce cone and/or partial-cone conformational products.[2,4,5,7,10] This is also the case for the bridged homooxacalix[3]arenes. The conformation of the alkylation products were dependent on the nature of the alkylating reagent. With $ClCH_2CONMe_2$ as an alkylating reagent and K_2CO_3 as a base in toluene, only an alkylation product with cone conformation was obtained. With $BrCH_2CO_2Et$, the conformation of product was dependent



(a) $ClCH_2CONH(CH_2)_nNHCOCH_2Cl$, acetone, K_2CO_3, reflux $n = 2, 3, 6$
(b) K_2CO_3, CH_3CN, $BrCH_2COOEt$,reflux
(c) K_2CO_3, toluene, $ClCH_2CONMe_2$, reflux

Scheme 1 Synthesis of bridged homooxacalix[3]arenes 2a, 3a, 4a and their derivatives.

* Correspondent. E-mail: yychen@whu.edu.cn

Table 2 Functionalisation of bridged homooxacalix[3]arenes

Product	Solvent	Time /h	Yield/%[a]	Conformation
2b	CH_3CN	10	60	Cone
2c	Toluene	96	34	Cone
3b	CH_3CN	10	62	Cone
3b′	CH_3CN	10	5	Partial-cone
3c	toluene	96	31	Cone
4b	CH_3CN	10	45	Partial-cone
4c	toluene	96	28	Cone

[a]Isolated yield.

on the length of spacer in the bridged homooxacalix[3]arene. When the spacer is ethylene (n =2 in Scheme 1), the product with cone conformation was obtained selectively. When the spacer is 1,3-propylene (n =3 in Scheme 1), however, a partial-cone conformational product was obtained as a by-product besides the cone product. In the case of the spacer being hexamethylene (n =6 in Scheme 1), the only isolated product was the partial-cone conformer.

Conformational features

(a) *Conformations of bridged homooxacalix[3]arenes*

In the ^{1}H NMR spectra**,** the ArOCH_2 of **2a** and **3a** give rise to three AX systems, which indicated that the backbone of annulus is stable at room temperature in chloroform on the NMR time scale. The similar spectra of **2a** and **3a** indicated that they adopt the same conformation. However, there was not enough evidence to assign **2a** and **3a** to a cone or partial-cone conformation. It was reported that di-*O*-substituted homooxacalix[3]arenes adopt partial cone conformation to satisfy the requirement of thermodynamic stability.[4,8,10] Their low coalescence temperature (T_c= 50 °C and 45 °C) which were obtained with the aid of VT-^{1}H NMR, indicated that they were not stable at elevated temperature on the NMR time scale.[15] The signals of the ArOCH_2 of **4a** appeared as two AX systems and a singlet that belonged to the methylene connected with 'isolated' aryl ring (labelled **a** in Scheme 1), suggesting that the conformation of **4a** is not rigid at room temperature.

(b) *Conformations of the derivatives of the bridged homooxacalix[3]arenes*

3b and **3b'** are the ester derivatives of **3a** which were obtained in one reaction as conformational isomers. In the ^{1}H NMR spectra of **3b** and **3b'**, it could be seen that the resonance for the methylene protons of OCH_2COOEt appeared at upper field in **3b'** (δ 3.12) than that in **3b** (δ 4.32). The chemical shift difference of the ester group can be used to distinguish the conformation of the isomers. In the partial cone conformation (Figure 1), the methylene of OCH_2COOEt is shielded by two adjacent phenolic units, which caused its signal the shift upfield. Therefore, it can be concluded that **3b** exists in cone conformation and **3b'** exists in partial-cone conformation. Similar phenomena were also observed for other conformers of homooxacalix[3]arene triesters.[3]

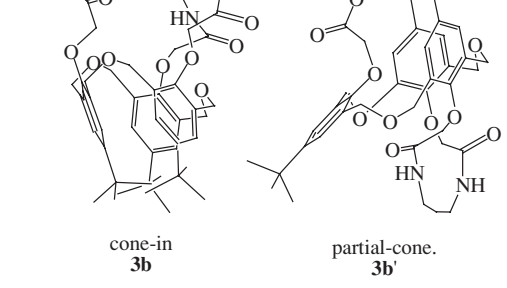


Fig. 1 CS Chem3D molecular models of derivatives 3b and 3b' with ^{1}H NMR spectrum of 3b (300MHz, $CDCl_3$).

In the ^{1}H NMR spectrum of **3b**, upfield singlets were observed for the *t*-Bu (δ 0.71) and aromatic hydrogens (δ 6.42) of the isolated aryl ring. These can by no means be explained by the effect of substituent of OCH_2OOEt, because such upfield signals have never been observed in the case of cone and partial cone tri-*O*-substituted homooxacalix[3] arenes.[3,7] In the literature, this kind of phenomena were explained by the deformation of cone conformation.[3,16,17] The distorted conformation (cone-in conformation) of **3b** is shown in Fig. 1, in which the *p-tert*-butyl phenyl moiety of the isolated aryl ring leans into the cavity of homooxacalix[3] arene, whereas its substituent at the lower rim moves away from the amide bridge caused by the steric repulsion.

2b adopts a cone-in conformation, which is revealed by its ^{1}H NMR spectrum with similar character to that of **3b** as indicated by the resonance appeared at δ 4.23 for methylene of OCH_2COOEt, at δ 0.63 for *t*-Bu and at δ 6.41 for aromatic protons of the isolated phenolic unit.The partial cone conformation of **4b** was deduced similarly. The singlet of OCH_2COOEt appeared at δ 3.00, as compared with that appeared at δ 3.23 for **3b'**.

The cone conformation of bridged homooxacalix[3]arenes **2c**, **3c** and **4c** were similarly deduced, by comparison with the assignment for the conformation of **2b** and **3b**. The signals of methylene protons of OCH_2CONMe_2 all appear at δ 3.9–4.2, indicating that **2c**, **3c** and **4c** adopt a cone conformation. Among them, **2c** and **3c** adopt cone-in conformation, because high-field signals of *t*-Bu (δ 0.69–0.71 ppm) and aromatic hydrogens (δ 6.23–6.31 ppm) of isolated phenolic unit were observed. The signals of *t*-Bu (δ 1.28 ppm) and aromatic hydrogens (δ 7.18 ppm) of isolated phenolic moiety of **4c** suggested that its cone conformation was not apparently distorted. This might be attributed to weak steric repulsion between the bridge and substituted group.

Experimental

General details: The ^{1}H NMR and ^{13}C NMR spectra were recorded at 300 MHz and 75 MHz, respectively, on Varian Mercury-VX300 spectrometer. The chemical shifts were recorded in parts per million (ppm) with TMS as the internal reference. ESI Mass spectra were determined using Finnigan LCQ Advantage mass spectrometer. UV spectral analysis was performed with a Perkin Elmer Lambda 35 UV/VIS spectrophotometer. Melting points (uncorrected) were obtained from X6 microscopic melting point detector. Elemental analysis were performed with Yanaco MT-5.

Materials: homooxacalix[3]arenes (**1**) was prepared according to a literature procedure.

Diacetylamidoethylene bridged homooxacalix[3]arene **2a**. **2a** were obtained by treatment of **1** (1.15g, 2 mmol), respectively, with anhydrous K_2CO_3 (2.76g, 20mmol) and *N,N′*-bis (chloroacetyl) propanediamine (426mg, 2mmol) in dry acetone (400ml), under reflux, for 5 days. Progress of the reaction was monitored (TLC) by following the disappearance of the starting **1**. The excess of base and KCl formed were filtered off and washed with CH_2Cl_2, and the combined organic layers were concentrated to dryness. The residue was dissolved in CH_2Cl_2. The solution was washed with aqueous 1M HCl and water and dried over $MgSO_4$. After filtration, the filtrate was concentrated to dryness. The residue (slight yellow oil) was subject to a preparative TLC separation (silicagel, CH_2Cl_2:Me_2CO = 4:1, v/v): mp 248.6–249.8 °C. ^{1}H NMR (300MH_2, $CDCl_3$, 16°C) δ 1.26 (s, 9 H, *t*-Bu), 1.29 (s, 18 H, *t*-Bu), 2.85 (q, 2 H, NCH_2), 4.00 (m, 2 H, NCH_2), 4.27 and 4.54 (AX, J = 14.4 Hz, OCH_2CO), 4.37 and 4.86, 4.40 and 4.80, 4.46 and 4.53 (AX × 3, J = 11.1, 8.7, 6.9 Hz, ArCH_2O, 1:1:1, 12H), 7.09 (s, 2 H, Ar*H*), 7.20 and 7.29 (AX, J = 2.4 Hz, Ar*H*, 1:1, 4 H), 7.42 (s, 1 H, ArO*H*), 7.94 (br s, 2 H, CON*H*) ppm. ^{13}C NMR (75M, $CDCl_3$, 16°C) δ = 32.22 (×2), 32.32 (C(*C*H_3)$_3$), 34.84, 35.20 (×2) (*C*(CH_3)$_3$), 37.82 (*C*H_2NH), 70.19, 71.29, 73.65 (Ar*C*H_2O), 73.64 (*C*H_2CO), 124.00, 127.34, 131.11 (*m*-Ar), 129.38,

129.50, 129.65 (*o*-Ar), 142.71, 147.49 (×2) (*p*-Ar), 152.63, 153.55 (×2) (*ipso*-Ar), 168.78 (*C*O) ppm; MS-ESI *m/z* = 717.3 [MH$^+$]. $C_{42}H_{56}N_2O_8$ (716.4): calcd. C 70.37, H 7.87, N 3.91. Found C 70.10, H 7.88, N 3.90%.

Diacetylamide-1, 3-propylene bridged homooxacalix[3]arene **3a**. **3a** Was obtained with the same procedure as **2a**: m.p. 235.4–236.8 °C. ^{1}H NMR (300MH$_2$, CDCl$_3$, 16°C) δ 1.28 (s, 9H, *t*-Bu), 1.29 (s, 18H, *t*-Bu), 1.63 (m, 2H, CH$_2$C*H*$_2$CH$_2$), 2.85 (d, 2H, NC*H*$_2$), 3.94 (t, 2H, NC*H*$_2$), 4.11 and 4.90 (AX, *J* = 14.4 Hz, C*H*$_2$CO, 4H), 4.12 and 4.53, 4.27 and 4.95, 4.41 and 4.88 (AX×3, *J* = 9.3, 12.3, 9.0 Hz, ArC*H*$_2$, 1:1:1, 12H), 6.72 (s, 1H, ArO*H*), 7.17 (s, 2H, Ar*H*), 7.19 and 7.29 (AX, *J* = 2.1Hz, Ar*H*, 4H), 8.22(d, 2H, CON*H*) ppm; ^{13}C NMR (75M, CDCl$_3$, 16°C) δ 28.30 (CH$_2$*C*H$_2$CH$_2$), 31.80 (×2), 31.90 (C(*C*H$_3$)$_3$), 34.44, 34.70 (×2) (*C*(CH$_3$)$_3$), 39.53 (*C*H$_2$CH$_2$*C*H$_2$), 68.79, 70.90, 71.57 (Ar*C*H$_2$O), 72.78(*C*H$_2$CO), 128.30, 129.54, 129.67 (*m*-Ar), 124.88, 129.40, 130.54 (*o*-Ar), 143.09, 147.21 (×2) (*p*-Ar), 152.73, 155.43 (×2) (*ipso*-Ar), 168.75(*C*O) ppm; ESI-MS *m/z* = 731.2[MH$^+$]. $C_{43}H_{58}N_2O_8$ (730.42): calcd. C 70.66, H 8.00, N 3.83. Found C 70.40, H 8.03, N 3.82%.

Diacetylamidehexamethylene bridged homooxacalix[3]-arene **4a. 4a** was obtained with the same procedure as **2a**. m.p. 204.7–205.8 °C. ^{1}H NMR (300MH$_2$, CDCl$_3$, 25°C) δ 1.14 (s, 18H, *t*-Bu), 1.29 (s, 9H, *t*-Bu), 1.25, 1.35 (CH$_2$C*H*$_2$CH$_2$C*H*$_2$CH$_2$C*H*$_2$CH$_2$, s and m, 4H and 4H), 3.24 (m, 2H, NC*H*$_2$), 3.48 (m, 2H, NC*H*$_2$), 4.30 and 4.41 (AX, *J* = 2.1 Hz, C*H*$_2$CO, 4H), 4.25 and 4.84, 4.42 and 4.88 (AX × 2, *J* = 2.1, 2.7 Hz, ArC*H*$_2$, 1:1. 8H), 4.42 (s, 4H, ArC*H*$_2$) 6.72 (s, 1H, ArO*H*), 6.90 and 6.98 (AX, *J* = 2.4Hz, Ar*H*, 4H), 7.07 (s, 2H, Ar*H*), 7.88 (d, 2H, N*H*) ppm; ^{13}C NMR (75M, CDCl$_3$, 25°C) δ 26.31, 27.98 (CH$_2$*C*H$_2$CH$_2$*C*H$_2$CH$_2$*C*H$_2$CH$_2$), 31.63 (×2), 31.88 (C(*C*H$_3$)$_3$), 34.28 (×2), 34.49 (*C*(CH$_3$)$_3$), 39.24 (NH*C*H$_2$), 70.03, 70.13 (×2) (Ar*C*H$_2$O), 73.03 (*C*H$_2$CO), 123.89, 127.41, 130.15 (*m*-Ar), 128.01, 128.22, 130.79 (*o*-Ar), 141.12, 147.18 (×2) (*p*-Ar), 152.98, 153.99 (×2) (*ipso*-Ar), 168.99(*C*O) ppm; ESI-MS *m/z* = 773.2[MH$^+$]. $C_{46}H_{64}N_2O_8$ (772.47): calcd. C 71.47, H 8.35, N 3.62. Found C 71.20, H 8.36, N 3.61%.

Exhaustive derivatives of bridged homooxacalix[3]arenes general procedure. Derivatives **2b**, **2c**, **3b**, **3b'**, **3c**, **4b** and **4c** were obtained by treatment of bridged homooxacalix[3]arenes **2a**, **3a** and **4a**, with anhydrous K_2CO_3 (5 equiv) and the appropriate electrophile (3 equiv) in dry CH_3CN or toluene under reflux. Progress of the reaction was monitored (TLC) by following the disappearance of the starting material. The excess of base and salt formed were filtered off and washed with CH_2Cl_2, and the combined organic layers were concentrated to dryness. The residue was dissolved in CH_2Cl_2. The solution was washed with aqueous 1M HCl and water and dried over $MgSO_4$. After filtration, the filtrate was concentrated to dryness. The residue was subject to a preparative TLC separation (silicagel, CH_2Cl_2:Me_2CO = 6:1–1:1, v/v). Further details are given for the individual compounds.

Diacetylamidoethylene bridged homooxacalix[3]arene ester **2b**. **2b** was obtained from **2a** with BrCH$_2$COOEt in refluxing acetonitrile in 60% yield. m.p. 145.4–146.8 °C. ^{1}H NMR (300MH$_2$, CDCl$_3$, 25°C) δ 0.63 (s, 9H, *t*-Bu), 1.29 (s, 18H, *t*-Bu), 1.30 (t, 3H, CH$_2$C*H*$_3$), 3.55(m, 2H, NHC*H*$_2$), 3.92 (m, 2H, NHC*H*$_2$), 4.05 and 4.27 (AX, *J* = 7.8 Hz, C*H*$_2$CONH, 4H), 4.26 (q, 2H, C*H*$_2$CH$_3$), 4.23 (s, 2H, OC*H*$_2$COOEt), 4.00 and 4.26, 4.68 and 4.98 (AX × 2, *J* = 6.6, 7.5 Hz, 1:1, ArC*H*$_2$O, 8H), 4.63 and 4.65 (AB, *J* = 6.3, ArC*H*$_2$O, 4H), 6.41 (s, 2H, Ar*H*), 7.25 and 7.33 (AX, *J* = 1.5, Ar*H*, 4H), 7.45 (s, 2H, CON*H*); ^{13}C NMR (75M, CDCl$_3$, 25°C) δ 14.42 (CH$_2$*C*H$_3$), 31.50, 31.66 (×2) (C(*C*H$_3$)$_3$), 34.29, 34.79 (×2) (*C*Me$_3$), 37.48 (NH*C*H$_2$), 61.66 (*C*H$_2$CH$_3$), 66.01, 71.10, 71.32 (Ar*C*H$_2$O), 70.10 (*C*H$_2$COOEt), 73.68 (*C*H$_2$CONH), 128.77, 130.09, 131.15 (*m*-Ar), 122.87, 127.63, 130.55 (*o*-Ar), 146.93, 148.60 (×2) (*p*-Ar), 148.74, 131.56 (×2) (*ispo*-Ar), 168.59 (*C*ONH, *C*OOEt); ESI-MS, *m/z* = 825.5 [M+Na$^+$]. $C_{46}H_{62}N_2O_{10}$ (802.44): calcd. C 68.80, H 7.78, N 3.49. Found C 68.53, H 8.05, N 3.48%.

Diacetylamidoethylene bridged homooxacalix[3]arene acetylamide **2c**. **2c** was obtained from **2a** with ClCH$_2$CONMe$_2$ in refluxing toluene in 34% yield. m.p. 142.3–143.1 °C. ^{1}H NMR (300MH$_2$, CDCl$_3$, 25°C) δ 0.71 (s, 9H, *t*-Bu), 1.27 (s, 3H, NC*H*$_3$), 1.29 (s, 3H, NC*H*$_3$) 1.34 (s, 18H, *t*-Bu), 3.32 (m, 2H, NHC*H*$_2$), 4.01 (m, 2H, NHC*H*$_2$), 4.11 and 4.27, 4.44 and 4.93, 4.47 and 4.87 (AX × 3, *J* = 6.3, 6.9, 6.3 Hz, ArC*H*$_2$O, 1:1:1, 12H), 3.99 and 4.18 (AX, *J* = 1.8 Hz, C*H*$_2$CONMe$_2$, 4H), 4.16 and 4.20 (AB, *J* = 7.5 Hz, C*H*$_2$CONH, 4H), 6.23 (s, 2H, Ar*H*), 7.25 and 7.27 (AB, *J* = 1.2 Hz, Ar*H*, 4H), 7.52 (s, 2H, CON*H*); ^{13}C NMR (75M, CDCl$_3$, 25°C) δ 22.83, 22.95 (N(*C*H$_3$)), 31.44, 31.70 (×2) (C(*C*H$_3$)$_3$), 34.10, 34.78 (×2) (*C*Me$_3$), 37.32 (NH*C*H$_2$), 66.80, 70.41, 72.08 (Ar*C*H$_2$O), 73.01 (*C*H$_2$CONH, *C*H$_2$CONMe$_2$), 125.14, 127.71, 128.40 (*m*-Ar), 130.06, 130.73 (*o*-Ar), 146.94, 148.09 (×2) (*p*-Ar), 151.71, 152.42 (×2) (*ispo*-Ar), 168.06 (*C*ONMe$_2$), 168.85 (*C*ONH); ESI-MS, *m/z* = 840.5 [M+K$^+$]. $C_{46}H_{63}N_3O_9$ (801.46): calcd. C 68.89, H 7.92, N 5.24. Found C 69.15, H 7.94, N 5.25%.

Diacetylamide-1, 3-propylene bridged homooxacalix[3]arene ester **3b**. **3b** was obtained from **3a** with BrCH$_2$COOEt in refluxing acetonitrile in 62% yield. m.p. 137.4–138.5 °C. ^{1}H NMR (300MH$_2$, CDCl$_3$, 25°C) δ 0.71 (s, 9H, *t*-Bu), 1.25 (m, 2H, CH$_2$C*H*$_2$CH$_2$), 1.30 (s, 18H, *t*-Bu), 1.30 (t, 3H, CH$_2$C*H*$_3$), 3.48 (m, 2H, NHC*H*$_2$), 3.84 (m, 2H, NHC*H*$_2$), 3.96 and 4.31 (AX, *J* = 7.5 Hz, 4H, C*H*$_2$CONH), 4.26 (q, 2H, C*H*$_2$CH$_3$), 4.24 and 4.64, 4.50 and 4.66, 4.57 and 5.01 (AX × 3, *J* = 8.4, 6.6, 6.9 Hz, ArC*H*$_2$O, 1:1:1, 12H), 4.32 (s, 2H, OC*H*$_2$COOEt), 6.42 (s, 2H, Ar*H*), 7.19 and 7.28 (AX, *J* = 2.1, Ar*H*, 4H), 7.60 (s, 2H, CON*H*); ^{13}C NMR (75M, CDCl$_3$, 25°C) δ 14.55 (CH$_2$*C*H$_3$), 28.93 (CH$_2$*C*H$_2$CH$_2$), 31.61, 31.81 (×2) (C(*C*H$_3$)$_3$), 34.26, 34.80 (×2) (*C*Me$_3$), 39.94 (CONH*C*H$_2$), 61.68 (*C*H$_2$CH$_3$), 67.49, 70.64, 71.48 (Ar*C*H$_2$O), 71.11 (*C*H$_2$COOEt), 73.29 (*C*H$_2$CONH), 125.43, 127.32,128.10 (*m*-Ar), 130.50, 130.73, 130.87 (*o*-Ar), 146.78, 147.81 (×2) (*p*-Ar), 151.40, 152.64 (×2) (*ispo*-Ar), 168.59 (*C*OOEt), 168.79 (CH$_2$CONH); ESI-MS, *m/z* = 817.7 [MH$^+$]. $C_{47}H_{64}N_2O_{10}$ (816.46): calcd. C 69.09, H 7.90, N 3.43. Found C 68.82, H 7.92, N 3.42%.

Diacetylamide-1, 3-propylene bridged homooxacalix[3]arene ester **3b'**. **3b'** was obtained from **3a** with BrCH$_2$COOEt in refluxing acetonitrile in 5% yield. m.p. 148.5–149.2 °C. ^{1}H NMR δ 1.01 (t, 3H, CH$_2$C*H*$_3$), 1.25 (m, 2H, CH$_2$C*H*$_2$CH$_2$), 1.29 (s, 27H, *t*-Bu), 2.87 (m, 2H, NHC*H*$_2$), 3.72 (m, 2H, NHC*H*$_2$), 3.32 (s, 2H, CH$_2$COOEt), 3.76 (q, 2H, C*H*$_2$CH$_3$), 4.03 and 4.09 (AB, *J* = 6.6 Hz, C*H*$_2$CONH, 4H), 4.10 and 4.56, 4.36 and 4.72 (AX × 2, *J* = 14.7, 9.6 Hz, ArC*H*$_2$O, 1:1, 8H), 4.36 and 4.72 (AB, *J* = 9.3 Hz, ArC*H*$_2$O, 4H), 7.23 (s, 4H, Ar*H*), 7.31 (s, 2H, Ar*H*), 7.55 (br s, 2H, CON*H*); ^{13}C NMR δ 14.66 (CH$_2$*C*H$_3$), 30.87 (CH$_2$*C*H$_2$CH$_2$), 33.66, 33.84 (×2) (C(*C*H$_3$)$_3$), 36.55, 36.98 (×2) (*C*Me$_3$), 42.00 (NH*C*H$_2$), 62.95 (*C*H$_2$CH$_3$), 66.45, 69.54, 72.43 (Ar*C*H$_2$O), 71.56 (*C*H$_2$CONH), 72.31 (*C*H$_2$COOEt), 127.73, 129.35, 129.65 (*m*-Ar), 131.55, 133.43, 135.03 (*o*-Ar), 148.42, 151.41 (×2) (*p*-Ar), 155.85, 156.54 (×2) (*ispo*-Ar), 168.31(*C*ONH), 169.38 (*C*OOEt); ESI-MS, *m/z* = 817.7 [MH$^+$]. $C_{47}H_{64}N_2O_{10}$ (816.46): calcd. C 69.09, H 7.90, N 3.43. Found C 68.81, H 7.93, N 3.42%.

Diacetylamide-1, 3-propylene bridged homooxacalix[3]arene acetylamide **3c**. **3c** was obtained from **3a** with ClCH$_2$CONMe$_2$ in refluxing toluene in 31% yield. m.p. 135.5–136.4 °C. ^{1}H NMR (300MH$_2$, CDCl$_3$, 25°C) δ 0.69 (s, 9H, *t*-Bu), 1.26 (m, 2H, CH$_2$C*H*$_2$CH$_2$), 1.27 (s, 3H, NC*H*$_3$), 1.29 (s, 3H, NC*H*$_3$), 1.36 (s, 18H, *t*-Bu), 3.45 (m, 2H, NHC*H*$_2$), 3.93 (m, 2H, NHC*H*$_2$), 4.15 and 4.32, 4.49 and 4.90, 4.52 and 4.81 (AX × 3, *J* = 5.9, 6.3, 6.0 Hz, ArC*H*$_2$O, 1:1:1, 12H), 3.97 and 4.18 (AX, *J* = 1.5 Hz, C*H*$_2$CONMe$_2$, 4H), 4.12 and 4.16 (AB, *J* = 7.5 Hz, C*H*$_2$CONH, 4H), 6.31 (s, 2H, Ar*H*), 7.20 and 7.26 (AB, *J* = 1.2 Hz, Ar*H*, 4H), 7.67 (s, 2H, CON*H*); ^{13}C NMR (75M, CDCl$_3$, 25°C) δ 21.82, 21.94 (N*C*H$_3$), 28.85 (CH$_2$*C*H$_2$CH$_2$), 31.45, 31.87 (×2) (C(*C*H$_3$)$_3$), 34.16, 34.79 (×2) (*C*Me$_3$), 39.62 (NH*C*H$_2$), 67.09, 70.55, 71.28 (Ar*C*H$_2$O), 72.98 (*C*H$_2$CONH), 73.09 (*C*H$_2$CONMe$_2$) 120.44, 124.35,131.13 (*m*-Ar), 130.23, 130.44, 130.68 (*o*-Ar), 146.78, 147.81 (×2) (*p*-Ar), 154.45, 155.67 (×2) (*ispo*-Ar), 168.47 (*C*ONH), 168.77 (CONMe$_2$); ESI-MS, *m/z* = 854.5 [M+K$^+$]. $C_{48}H_{65}N_3O_9$ (815.47): calcd. C 69.18, H 8.03, N 5.15. Found C 69.44, H 8.05, N 5.27%.

Diacetylamidehexamethylene bridged homooxacalix[3]arene ester **4b**. **4b** was obtained from **4a** with BrCH$_2$COOEt in refluxing acetonitrile in 45% yield. m.p. 149.1–150.2 °C. ^{1}H NMR (300MH$_2$, CDCl$_3$, 25°C) δ 1.02 (t, 3H, CH$_2$C*H*$_3$), 1.16, 1.43 (m, m, 5H, 3H, CH$_2$(C*H*$_2$)$_4$CH$_2$), 1.27 (s, 27H, *t*-Bu), 3.00 (s, 2H, C*H*$_2$COOEt), 3.16 (m, 2H, NHC*H*$_2$), 3.29(m, 2H, NHC*H*$_2$), 3.79 (q, 2H, C*H*$_2$CH$_3$), 4.17 and 4.32 (AX, *J* = 7.2 Hz, 4H, C*H*$_2$CONH), 4.33 and 4.70, 4.34 and 4.60 (AX × 2, *J* = 6.0, 4.5 Hz, ArC*H*$_2$, 1:1, 8H), 4.64 and 4.66 (AB, *J* =6.3 Hz, ArC*H*$_2$, 4H), 7.10 (t, 2H, CON*H*), 7.22 and 7.45 (AX, *J* = 2.4 Hz, Ar*H*, 4H), 7.29 (s, 2H, Ar*H*); ^{13}C NMR δ 14.28 (CH$_2$*C*H$_3$), 25.89, 29.91 (CH$_2$(*C*H$_2$)$_4$CH$_2$), 31.53, 31.66 (×2) (C(*C*H$_3$)$_3$), 34.45, 34.57 (×2) (*C*Me$_3$), 37.86 (NH*C*H$_2$), 60.37(*C*H$_2$CH$_3$), 66.68, 66.98, 73.26 (Ar*C*H$_2$O), 69.03 (*C*H$_2$CONH), 69.32 (*C*H$_2$COOEt), 127.39, 129.57, 129.86 (*m*-Ar), 126.88, 129.91, 131.62 (*o*-Ar), 146.70, 148.00 (×2) (*p*-Ar), 153.29, 154.99 (×2) (*ispo*-Ar), 168.68 (*C*ONH), 169.11 (*C*OOEt); ESI-MS, *m/z* = 859.7 [MH$^+$]. $C_{50}H_{70}N_2O_{10}$ (858.50): calcd. C 69.90, H 8.21, N 3.26. Found C 69.63, H 8.24, N 3.25%.

Diacetylamidehexamethylene bridged homooxacalix[3]arene acetylamide **4c**. **4c** was obtained from **4a** with ClCH$_2$CONMe$_2$ in refluxing toluene in 34% yield. m.p. 155.9–160.4 °C. ^{1}H NMR δ 1.01 (s, 18H, *t*-Bu), 1.28 (s, 3H, NMe$_2$), 1.29 (s, 3H, NMe$_2$), 1.28 (s, 9H, *t*-Bu), 1.76, 1.97 (br s, br s, 5H, 3H, CH$_2$(C*H*$_2$)$_4$CH$_2$), 3.25 (m, 2H, NHC*H*$_2$), 3.70 (m, 2H, NHC*H*$_2$), 3.91 and 4.37 (AX, *J* = 14.4

Hz, CH_2CONH, 4H), 4.00 (s, 2H, OCH_2CONMe$_2$), 4.21 and 4.25, 4.67 and 4.72 (AB × 2, J = 3.6, 3.6 Hz, ArCH_2O, 1:1, 8H), 4.66 and 4.91 (AX, J = 13.5 Hz, ArCH_2O, 4H), 6.77 and 6.89 (AX, J = 2.4 Hz, ArH, 4H), 7.18 (s, 2H, ArH), 7.26 (s, 2H, CONH); ^{13}C NMR δ 20.50 (NCH_3), 20.61 (NCH_3) 23.24, 26.47 (CH$_2$(CH_2)$_4$CH$_2$), 29.21 (×3) (C(CH_3)$_3$), 31.96, 32.07 (×2) (CMe_3), 35.78 (NHCH_2), 67.48, 68.08 (×2) (ArCH_2O), 71.05 (CH_2CONH, CH_2CNMe$_2$), 124.51, 128.89, 129.04 (*m*-Ar), 125.19, 126.07, 127.79 (*o*-Ar), 144.34, 144.76 (×2) (*p*-Ar), 149.80, 150.82 (×2) (*ispo*-Ar), 166.46 (CONH), 167.65 (CONMe$_2$); ESI-MS, *m/z* = 858.5 [MH$^+$]. $C_{50}H_{71}N_3O_9$ (857.52): calcd. C 69.98, H 8.34, N 4.90. Found C 70.25, H 8.36, N 4.92%.

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