Electronic Supplementary Information for

Multi-stimuli responsive poly(amidoamine) dendrimers with peripheral *N*-dialkylaminoethyl carbamate moieties

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Synthesis of 2-dipropylamino ethanol (DPEA)

Ethanolamine (6.1000 g, 0.1 mol) and Na_2CO_3 (31.8000 g, 0.3 mol) were dissolved in 100 mL acetonitrile, to which bromopropane (24.6000 g, 0.2 mol) in 50 mL acetonitrile was added dropwise. The reaction mixture was stirred at 40 °C for 120 h. The viscous solution was filtered to remove the precipitates including NaBr and unreacted Na_2CO_3. Acetonitrile was removed by rotary evaporation. The residual was dissolved by dichloromethane, and washed with saturated saline solution three times to remove unreacted ethanolamine. The organic layer was collected, dried over $MgSO_4$, and filtered. After removal of dichloromethane, the residue was distilled under vacuo as a colorless liquid to obtain DPEA. Yield: 48%. ^{1}H NMR (TMS, $CDCl_3$, ppm): 3.55 (t, 2H, -OC*H*$_2$CH$_2$N-), 2.60 (t, 2H, -OCH$_2$C*H*$_2$N-), 2.40 (t, 4H, -N(C*H*$_2$CH$_2$CH$_3$)$_2$), 1.45 (m, 4H, -N(CH$_2$C*H*$_2$CH$_3$)$_2$), 0.93 (t, 6H, -N(CH$_2$CH$_2$C*H*$_3$)$_2$).

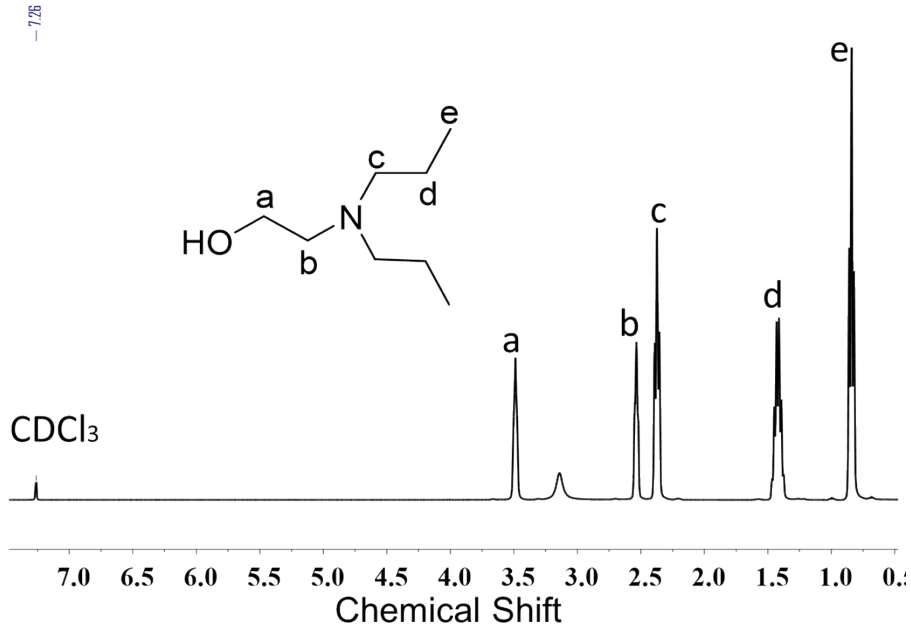


Figure S1. ^{1}H NMR spectrum of DPEA in $CDCl_3$.

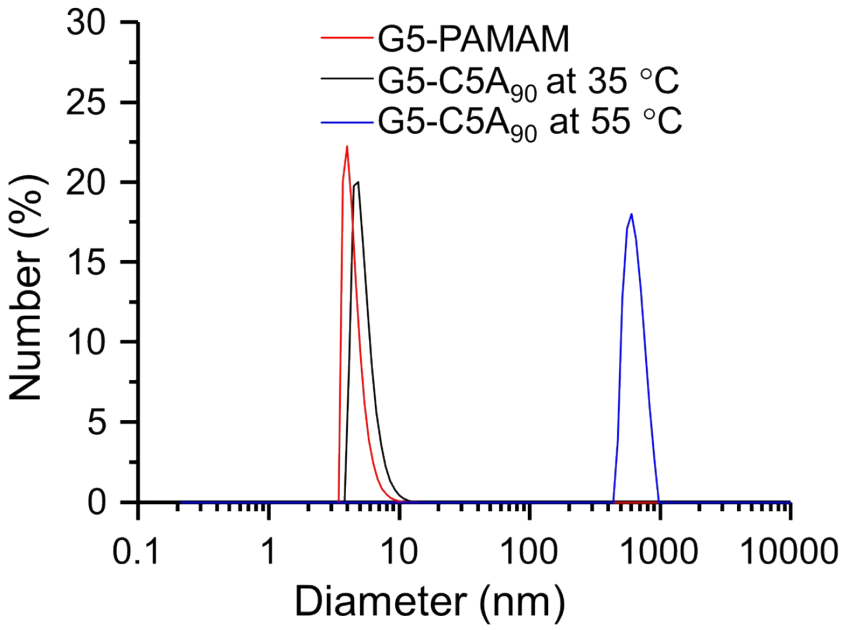


Figure S2. Dynamic light scattering (DLS) measurement of G5-PAMAM, and its derivative G5-C5A$_{90}$ at 35 °C (below LCST) and at 55 °C (above LCST).

Synthesis of *N*-Dialkylaminoethyl Carbamate (DMEA-CDI, DEPA-CDI, and C5A-CDI)

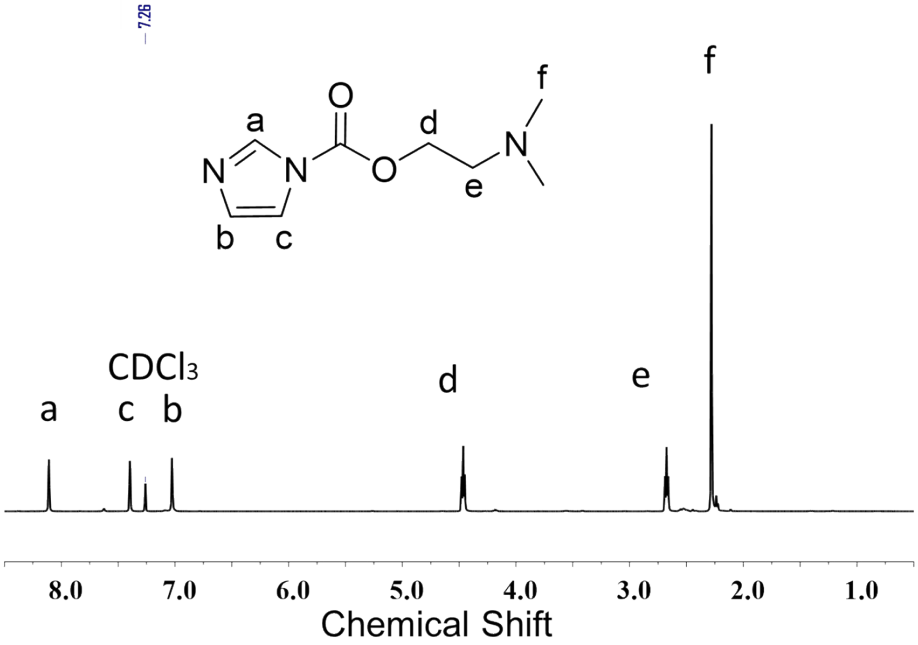
DMEA-CDI, DPEA-CDI, and C5A-CDI were synthesized following similar procedures as the synthesis of C6A-CDI. Their structures were verified by ^{1}H NMR as follows.

DMEA-CDI: Yield 48%. ^{1}H NMR (TMS, $CDCl_3$, ppm): 8.15 (s, 1H, -NC*H*N-), 7.38 (s, 1H, -NCH$_2$C*H*$_2$N-), 7.02 (s, 1H, -NC*H*$_2$CH$_2$N-), 4.50 (t, 2H, -OC*H*$_2$CH$_2$N-), 2.72 (t, 2H, -OCH$_2$C*H*$_2$N-), 2.28 (s, 6H, -N(C*H*$_3$)$_2$).

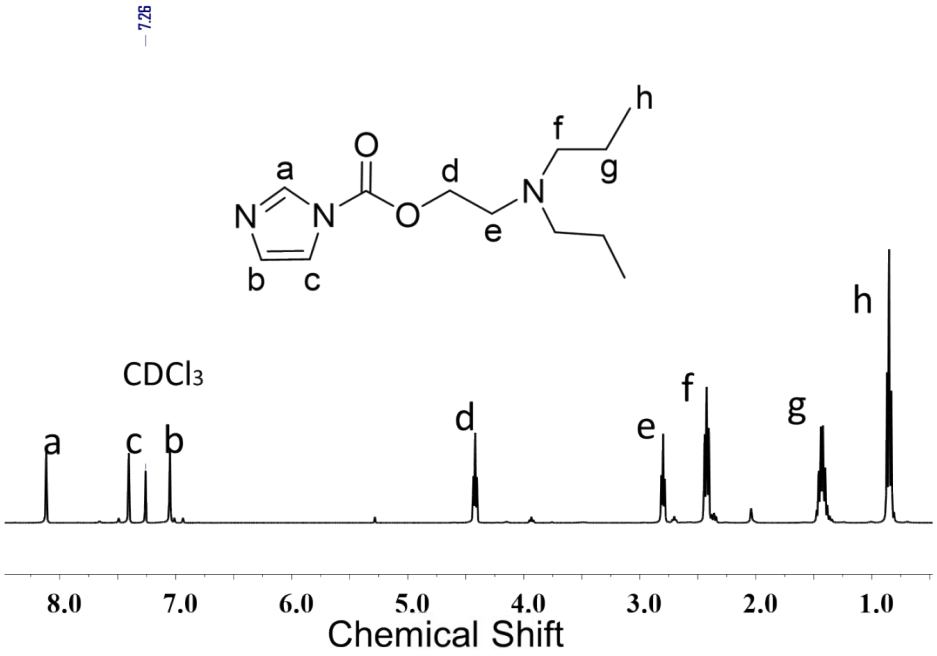
DPEA-CDI: Yield 90%. ^{1}H NMR (TMS, $CDCl_3$, ppm): 8.15 (s, 1H, -NC*H*N-), 7.38 (s, 1H, -NCH$_2$C*H*$_2$N-),7.02 (s, 1H, -NC*H*$_2$CH$_2$N-), 4.45 (t, 2H, -OC*H*$_2$CH$_2$N-), 2.83 (t, 2H, -OCH$_2$C*H*$_2$N-), 2.45 (t, 4H, -N(C*H*$_2$CH$_2$CH$_3$)$_2$), 1.45 (m, 4H, -N(CH$_2$C*H*$_2$CH$_3$)$_2$), 0.90 (t, 6H, -N(CH$_2$CH$_2$C*H*$_3$)$_2$).

C5A-CDI: Yield 85%. ^{1}H NMR (TMS, $CDCl_3$, ppm): 8.15 (s, 1H, -NC*H*N-), 7.38 (s, 1H, -NCH_2CH_2N-),7.02 (s, 1H, -NCH_2CH_2N-), 4.55 (t, 2H, -OCH_2CH_2N-), 2.90 (t, 2H, -OCH_2CH_2N-), 2.62 (t, 4H, -$N(CH_2CH_2)_2$),1.80 (m, 4H, -$N(CH_2CH_2)_2$).

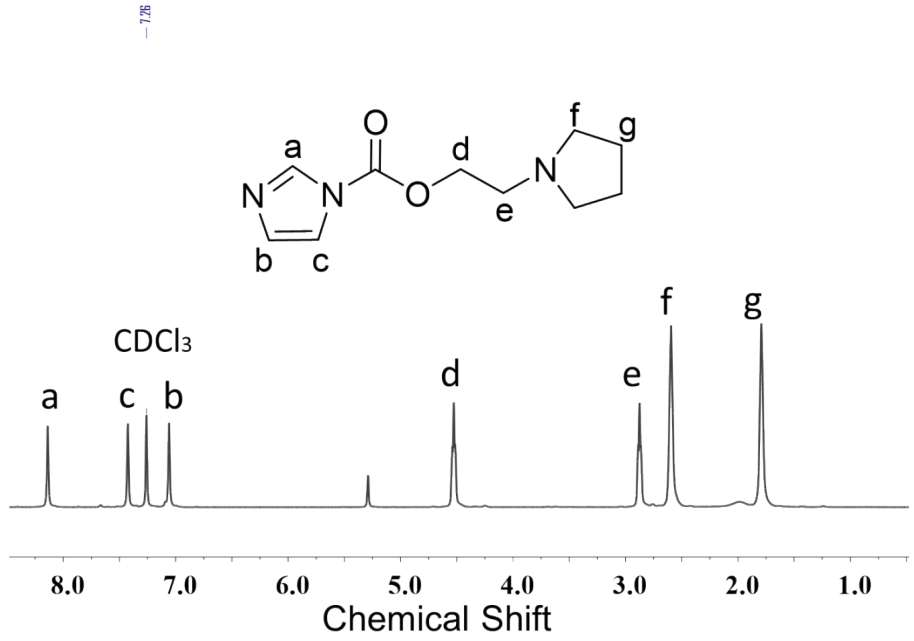
DMEA-CDI



DPEA-CDI



C5A-CDI



Synthesis of *N*-dialkylaminoethyl carbamate modified dendrimers

All other modified dendrimers such as G4-DMEA$_{45}$, G4-DPEA$_{45}$, G4-C5A$_{45}$, G4-C6A$_{21}$, G4-C6A$_{45}$, G5-DEEA$_{90}$, G5-C5A$_{90}$, G5-C6A$_{90}$, and G5-C6A$_{45}$ were prepared following similar procedure of G4-DEEA$_{45}$, and their substitution numbers were calculated using the same method according to their ^{1}H NMR spectra shown below.

G4-DMEA$_{45}$: Yield 90%. ^{1}H NMR (TMS, $CDCl_3$, ppm): 4.10 (-COOC*H*$_2$CH$_2$N-), 3.25 (-CONHC*H*$_2$CH$_2$-), 2.20-3.00 (-OCH$_2$C*H*$_2$N-, and all other protons from PAMAM), 2.20 (-N(C*H*$_3$)$_2$).

G4-DPEA$_{45}$: Yield 95%. ^{1}H NMR (TMS, $CDCl_3$, ppm): 4.05 (-COOC*H*$_2$CH$_2$N-), 3.25 (-CONHC*H*$_2$CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$C*H*$_2$N-, -N(C*H*$_2$CH$_2$CH$_3$)$_2$, and all other protons from PAMAM), 1.45 (-N(CH$_2$C*H*$_2$CH$_3$)$_2$), 0.90 (-N(CH$_2$CH$_2$C*H*$_3$)$_2$)

G4-C5A$_{45}$: Yield 92%. ^{1}H NMR (TMS, $CDCl_3$, ppm): 4.15 (-COOC*H*$_2$CH$_2$N-), 3.25

(-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_2$)$_2$, and all other protons from PAMAM), 1.75(-N(CH$_2$CH_2)$_2$).

G4-C5A$_{64}$: Yield 83%. ^{1}H NMR (TMS, CDCl$_3$, ppm): 4.15 (-COOCH_2CH$_2$N-), 3.25 (-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_2$)$_2$, and all other protons from PAMAM), 1.75(-N(CH$_2$CH_2)$_2$).

G4-DEEA$_{64}$: Yield 84%. ^{1}H NMR (TMS, CDCl$_3$, ppm): 4.10 (-COOCH_2CH$_2$N-), 3.25(-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_3$)$_2$, and all other protons from PAMAM), 1.02 (-N(CH$_2$CH_3)$_2$).

G4-C6A$_{45}$: Yield 90%. ^{1}H NMR (TMS, CDCl$_3$, ppm): 4.15 (-COOCH_2CH$_2$N-), 3.25 (-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_2$CH$_2$)$_2$, and all other protons from PAMAM), 1.40-1.60 (-(CH$_2$CH_2)$_2$CH_2).

G4-C6A$_{21}$: Yield 90%. ^{1}H NMR (TMS, D$_2$O, ppm): 4.15 (-COOCH_2CH$_2$N-), 3.25 (-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_2$CH$_2$)$_2$, and all other protons from PAMAM), 1.40-1.60 (-(CH$_2$CH_2)$_2$CH_2).

G5-DEEA$_{90}$: Yield 80%. ^{1}H NMR (TMS, CDCl$_3$, ppm): 4.10 (-COOCH_2CH$_2$N-), 3.25 (-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_3$)$_2$, and all other protons from PAMAM), 1.02 (-N(CH$_2$CH_3)$_2$).

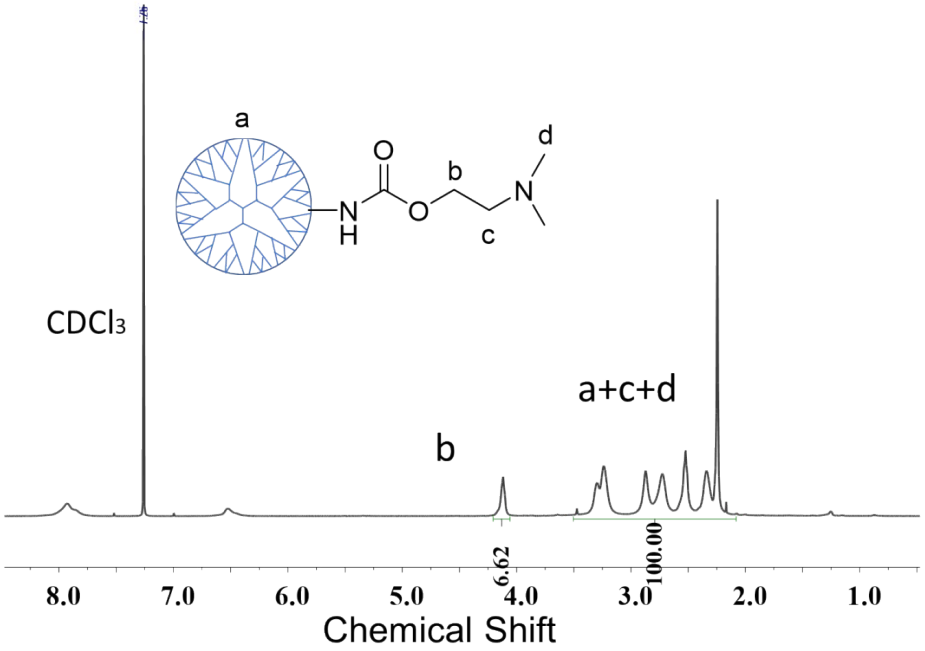
G5-C5A$_{90}$: Yield 87%. ^{1}H NMR (TMS, CDCl$_3$, ppm): 4.15 (-COOCH_2CH$_2$N-), 3.25 (-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_2$)$_2$, and all other protons from PAMAM), 1.75(-N(CH$_2$CH_2)$_2$).

G5-C6A$_{90}$: Yield 85%. ^{1}H NMR (TMS, CDCl$_3$, ppm): 4.15 (-COOCH_2CH$_2$N-), 3.25

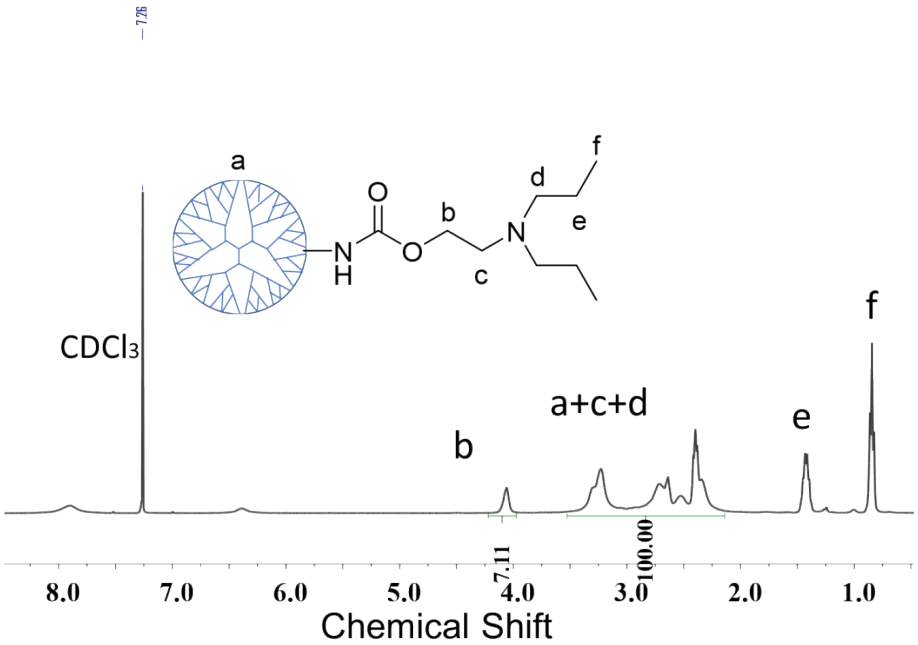
(-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_2$CH$_2$)$_2$, and all other protons from PAMAM), 1.40-1.60 (-(CH$_2$CH_2)$_2$CH_2).

G5-C6A$_{45}$: Yield 90%. ^{1}H NMR (TMS, CDCl$_3$, ppm): 4.15 (-COOCH_2CH$_2$N-), 3.25 (-CONHCH_2CH$_2$- from PAMAM), 2.20-3.00 (-OCH$_2$CH_2N-, -N(CH_2CH$_2$CH$_2$)$_2$, and all other protons from PAMAM), 1.40-1.60 (-(CH$_2$CH_2)$_2$CH_2).

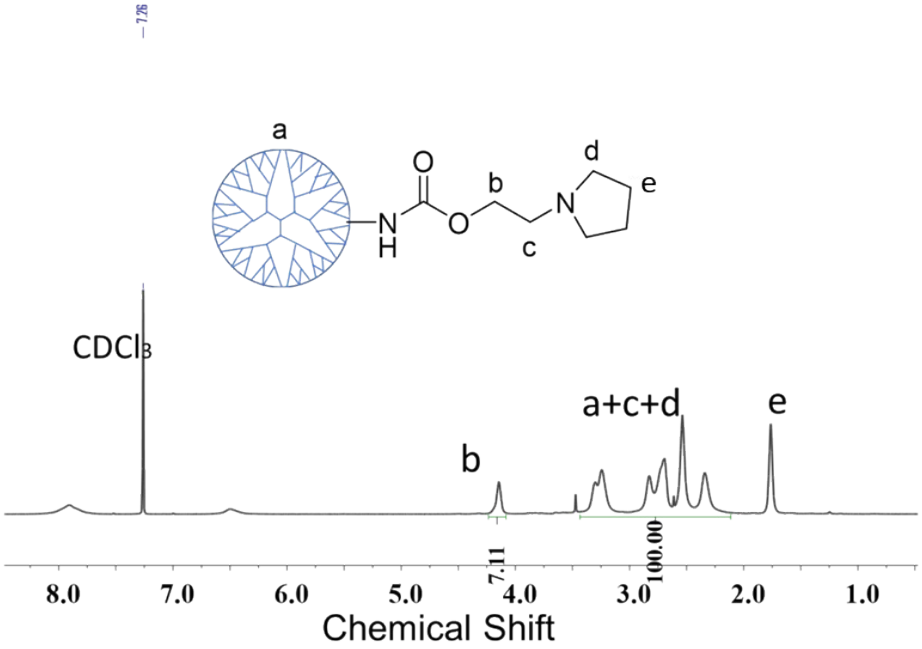
G4-DMEA$_{45}$



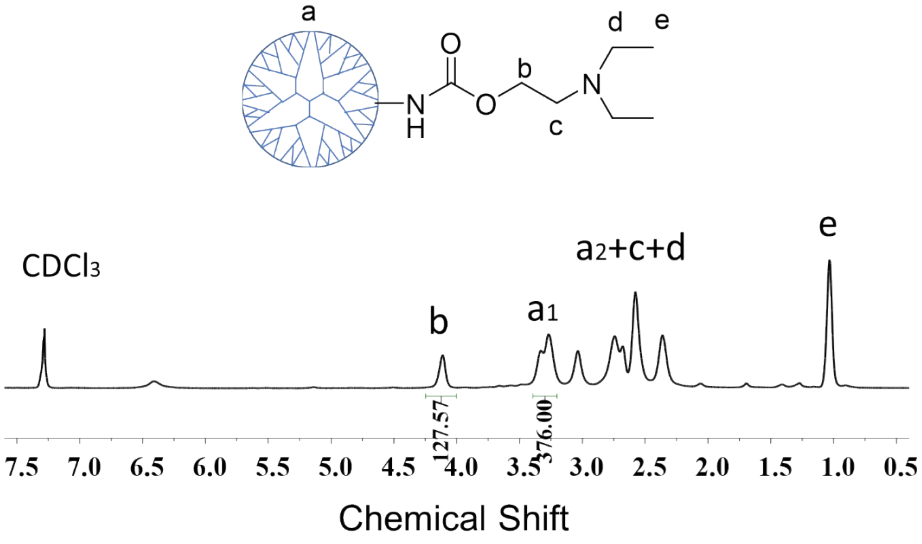
G4-DPEA$_{45}$



G4-C5A$_{45}$



G4-DEEA$_{64}$



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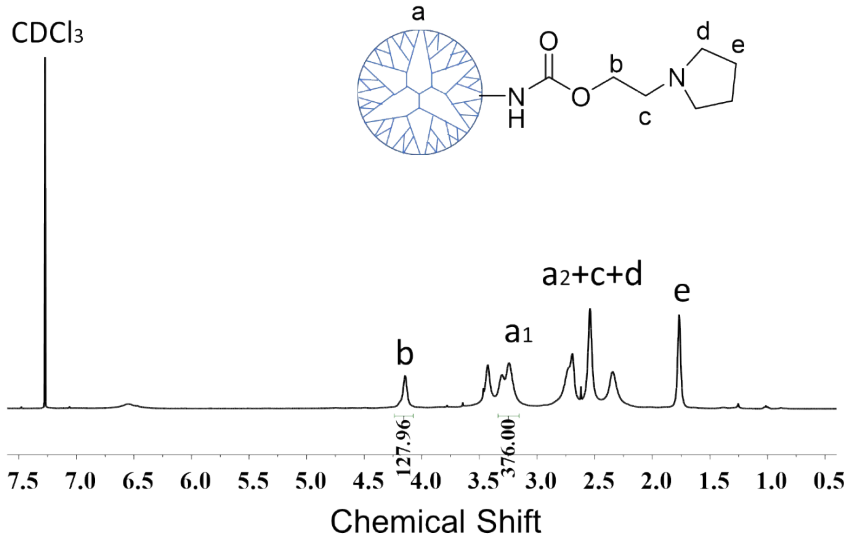
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b
d
e
N
H
O
N
c
a2+c+d
e
a1
b
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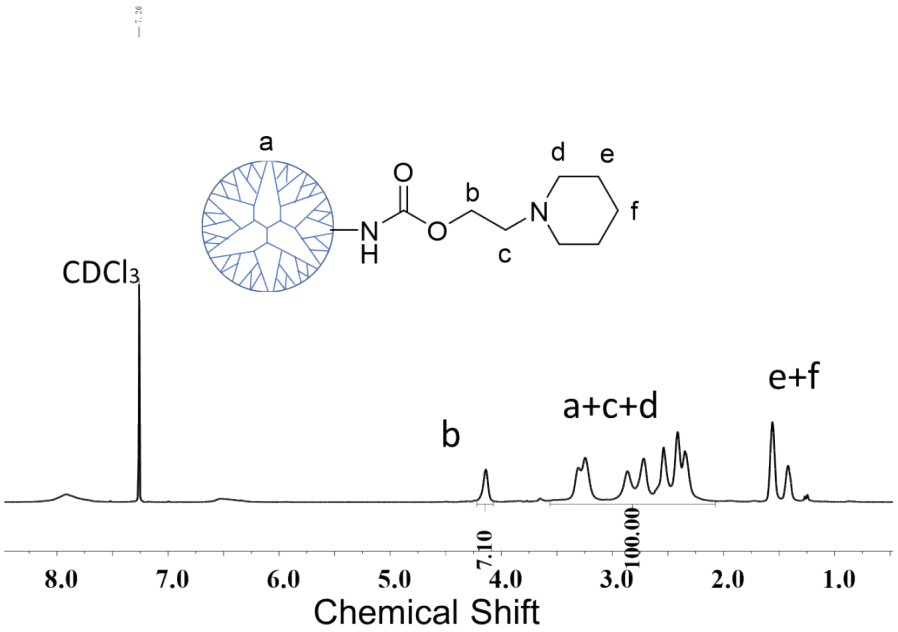
376.00
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
Chemical Shift

G4-C6A$_{45}$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O
b
d
e
N
f
N
H
O
c
CDCl3
e+f
a+c+d
b
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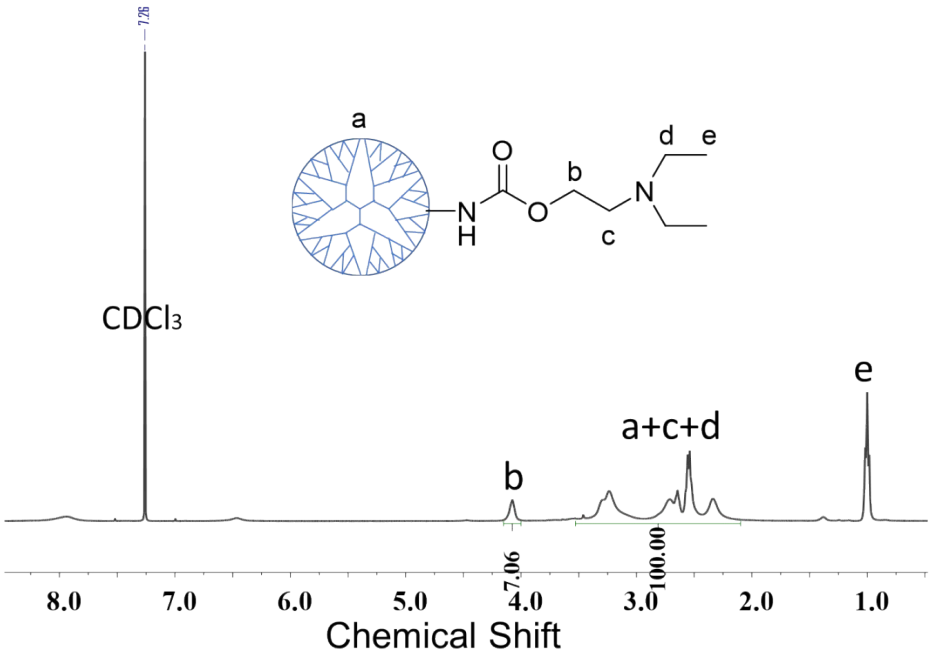
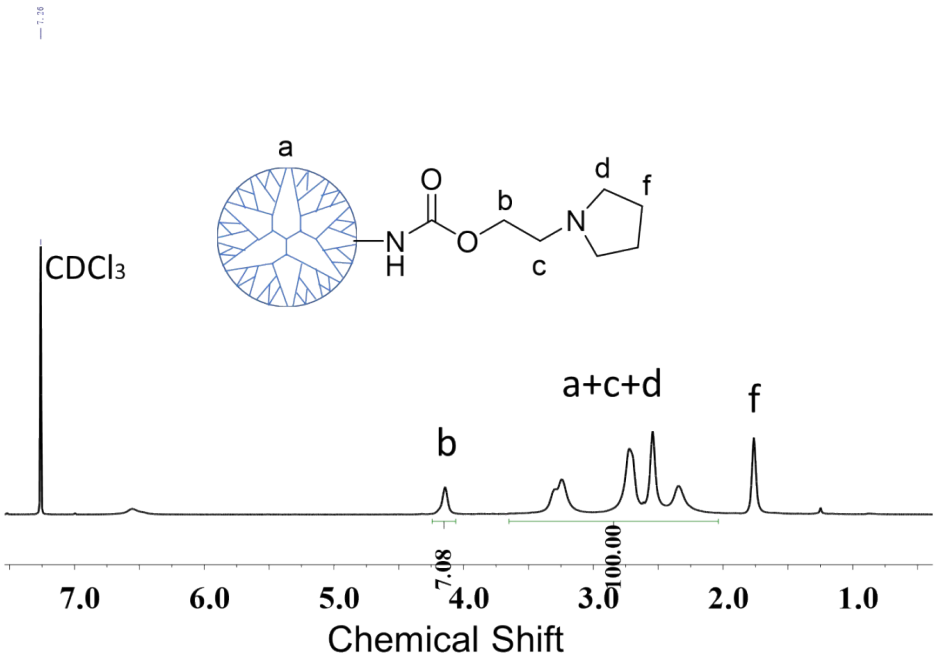
100.00
8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0
Chemical Shift

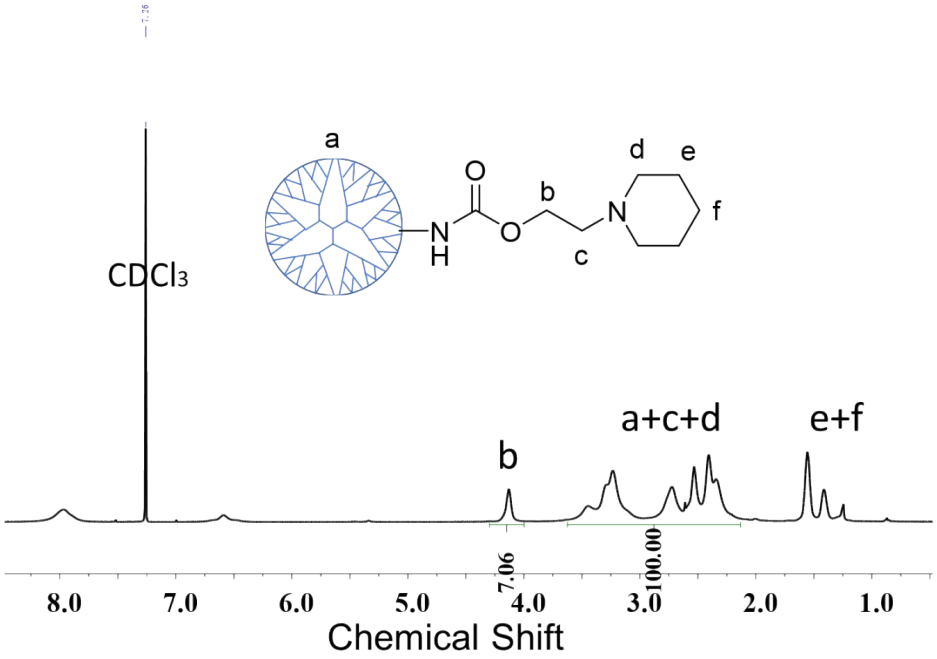
G5-DEEA$_{90}$



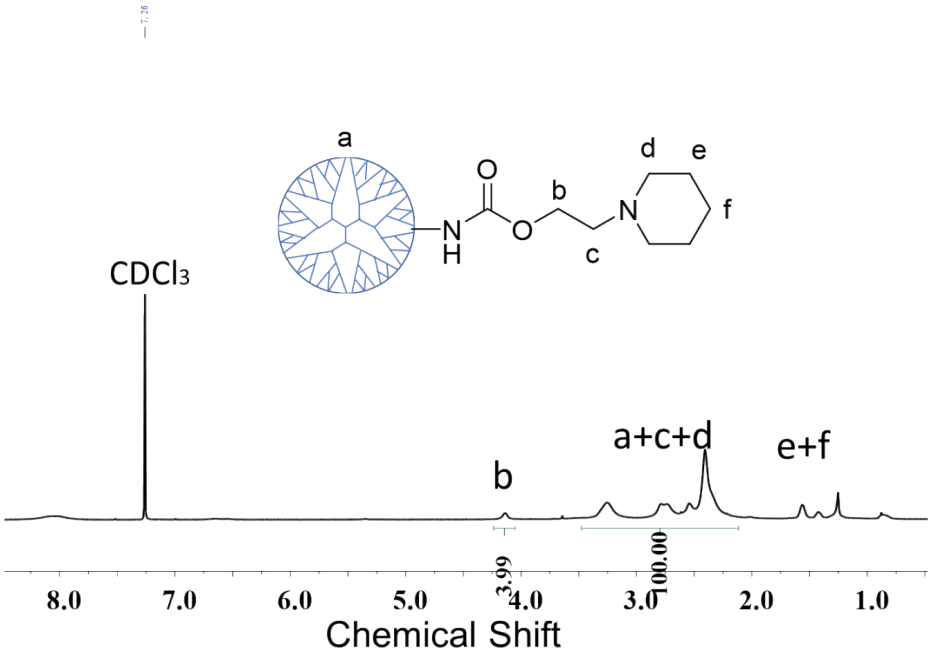
G5-C5A$_{90}$



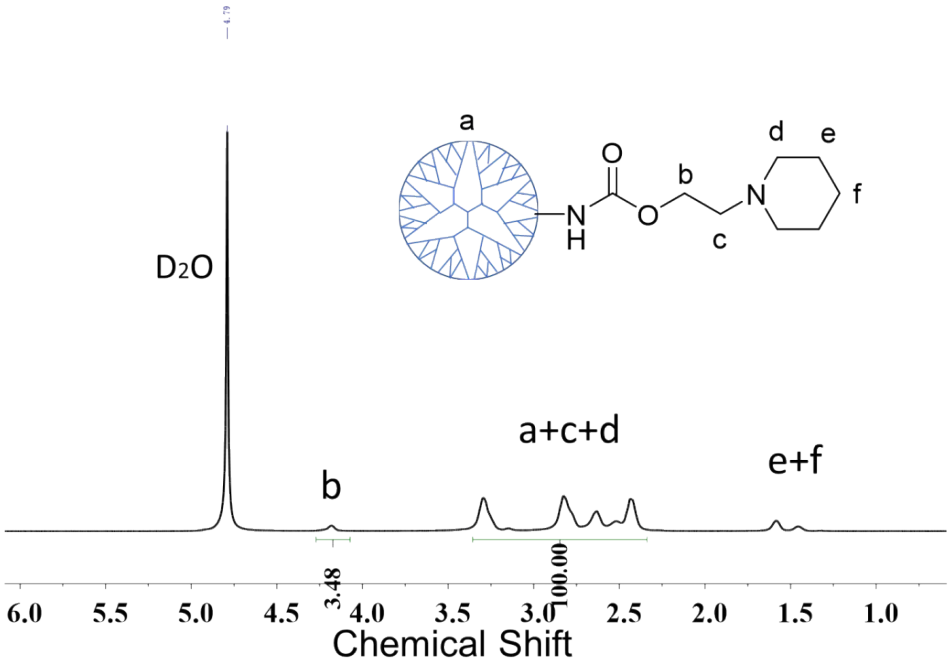
G5-C6A$_{90}$



G5-C6A$_{45}$



G4-C6A$_{21}$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O
b
N
f
N
H
O
c
D2O
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e+f
b
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6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Chemical Shift

Table S1. Structural information and thermoresponsive properties of the modified PAMAM dendrimers.

Sample	PAMAM Generation	Substitution Number of *N*-dialkylaminoethyl moieties [a]	T_{cp} (°C)[b]
G4-DMEA$_{45}$	4	45	-
G4-DEEA$_{45}$	4	45	65
G4-DEEA$_{64}$	4	64	38
G4-DPEA$_{45}$	4	45	-
G4-C5A$_{45}$	4	45	68
G4-C5A$_{64}$	4	64	44
G4-C6A$_{21}$	4	21	-
G4-C6A$_{45}$	4	45	21
G4-C6A$_{64}$	4	64	9
G5-C6A$_{45}$	5	45	-
G5-C6A$_{70}$	5	70	44
G5-DEEA$_{90}$	5	90	68
G5-C5A$_{90}$	5	90	53
G5-C6A$_{90}$	5	90	20

[a] Determined from ^{1}H NMR; [b] Determined from UV measurement.