Electronic Supplementary Information

Bis(ammonium) ionic liquids with herbicidal anions

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Figure S1. ^{1}H NMR spectrum of **1a** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propioniate]).

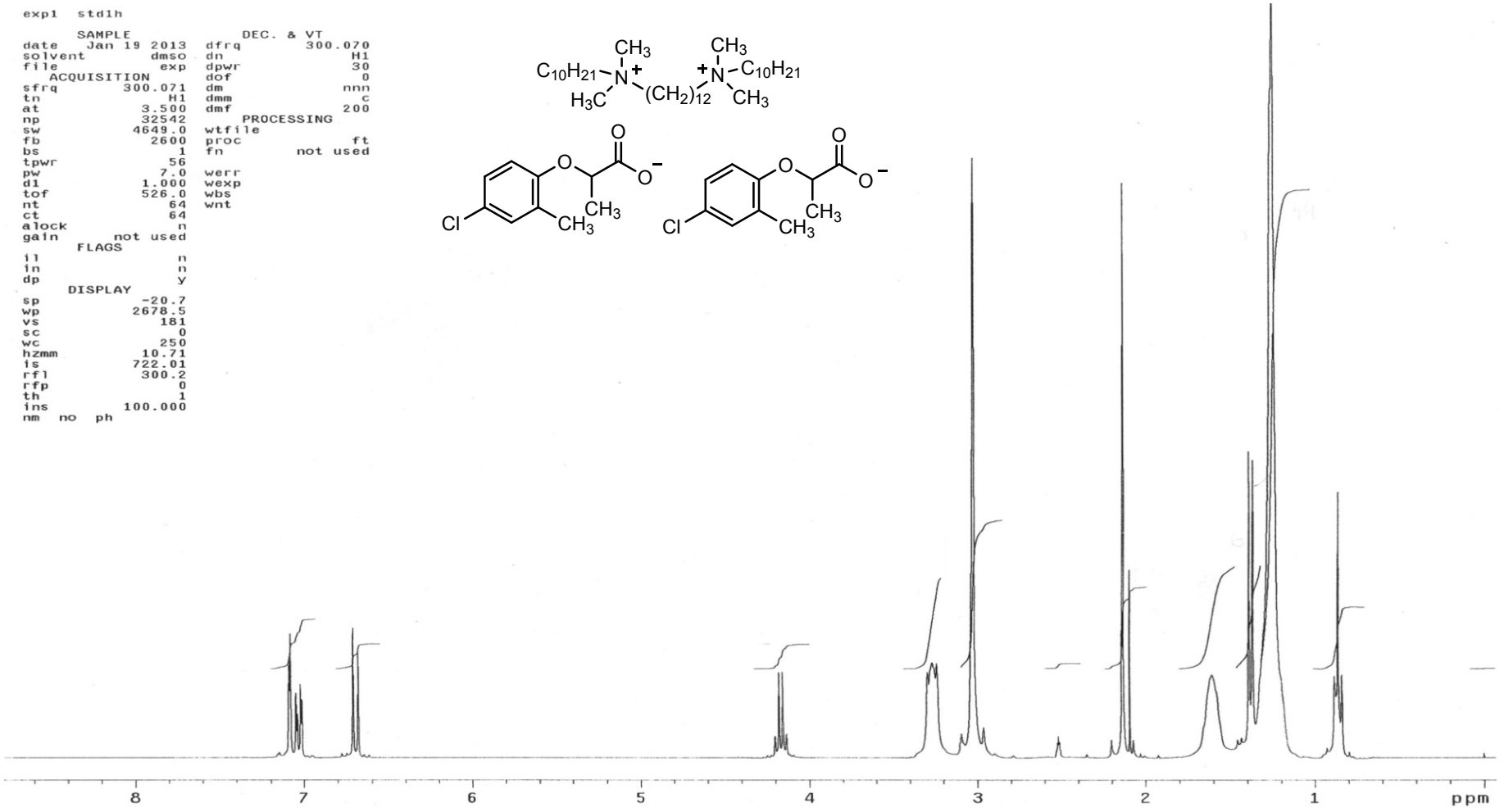

Figure S2. ^{13}C NMR spectrum of **1a** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propioniate]).

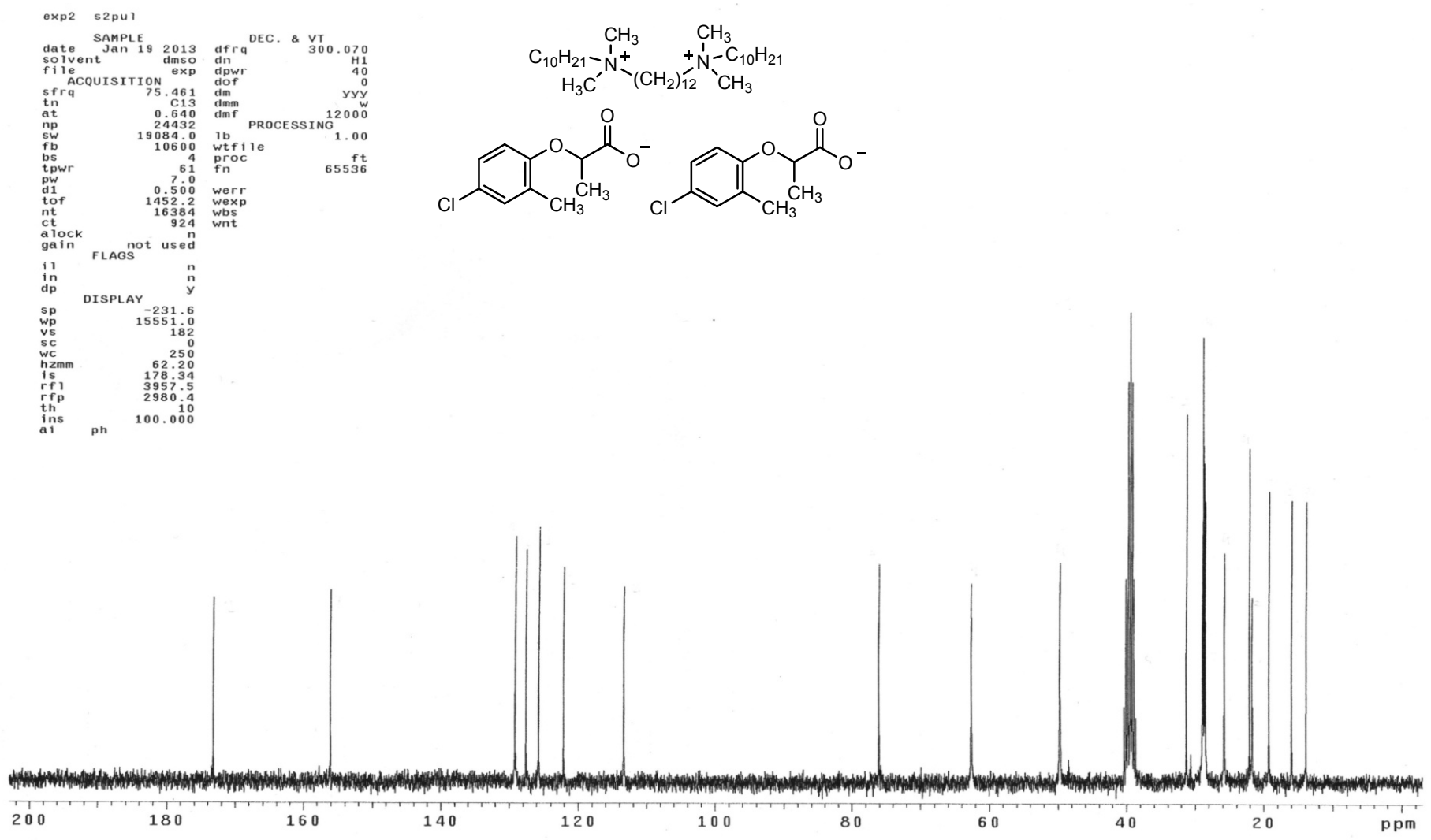

Figure S3. ^{1}H NMR spectrum of **1b** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[3.6-dichloro-2-methoxybenzoate]).

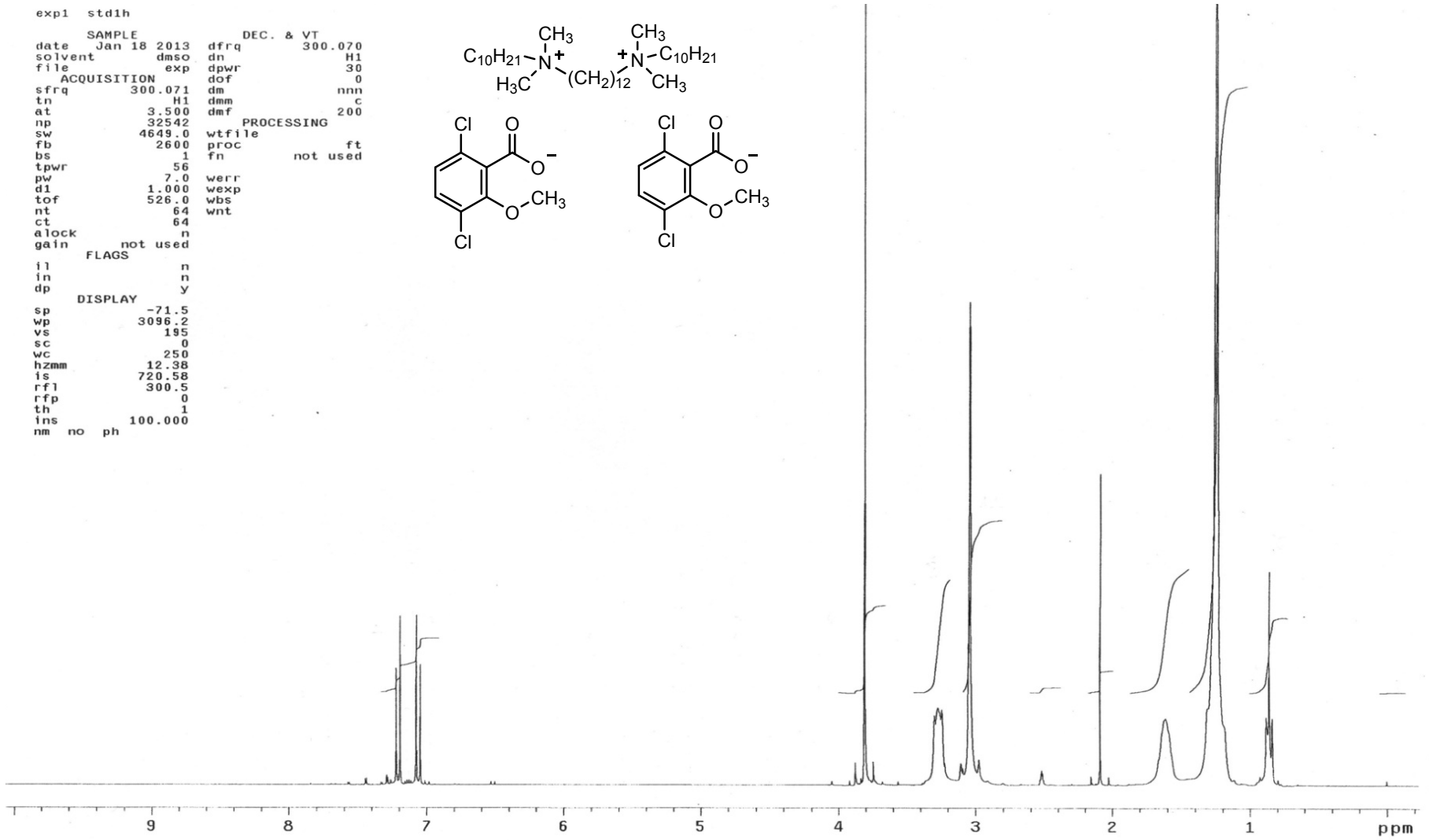

Figure S4. ^{13}C NMR spectrum of **1b** (dodecamethylene-1,12-bis(dimethyldecylammonium) di[3.6-dichloro-2-methoxybenzoate]).

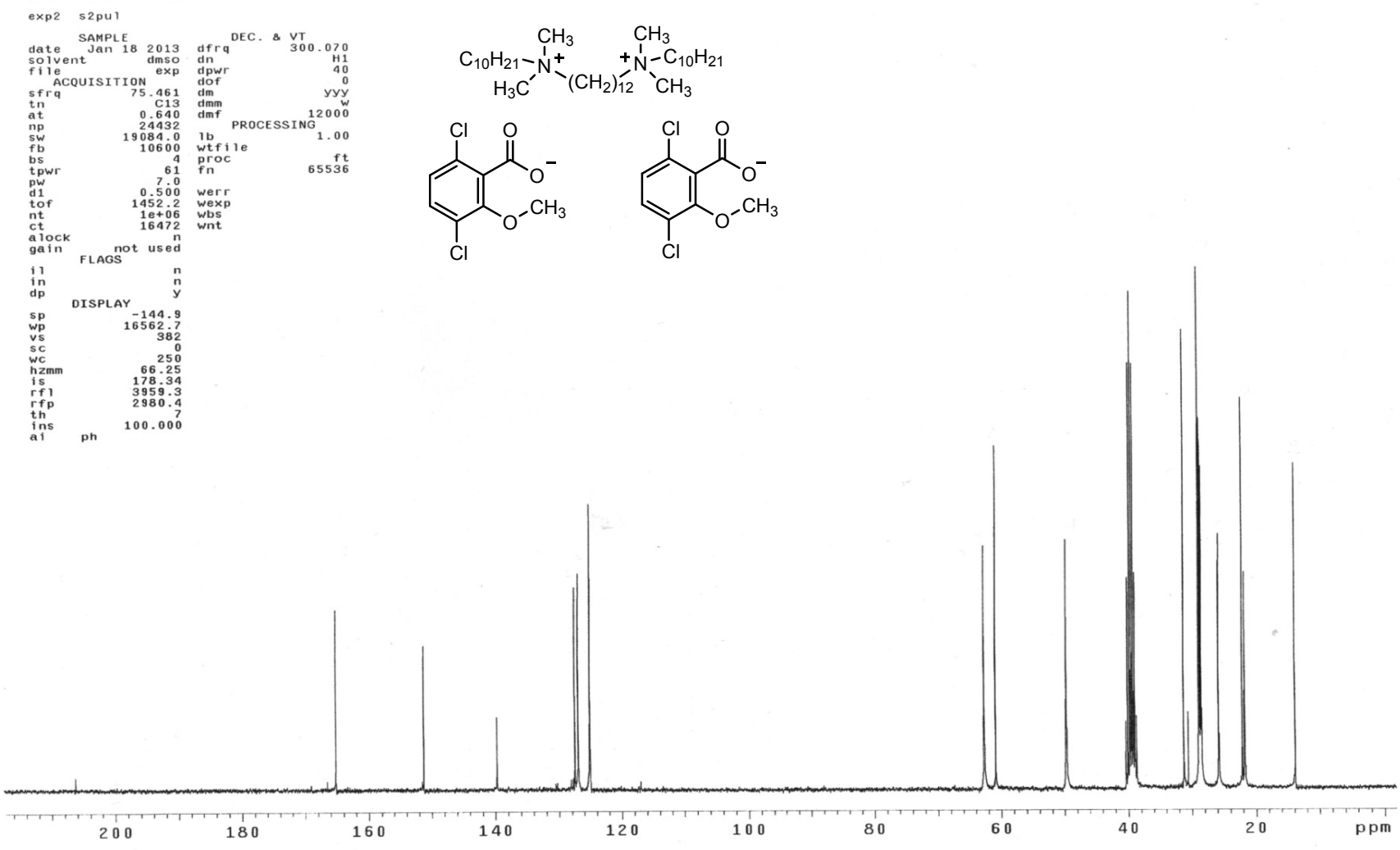

Figure S5. ^{1}H NMR spectrum of **2a** (oxybis(ethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propioniate]).

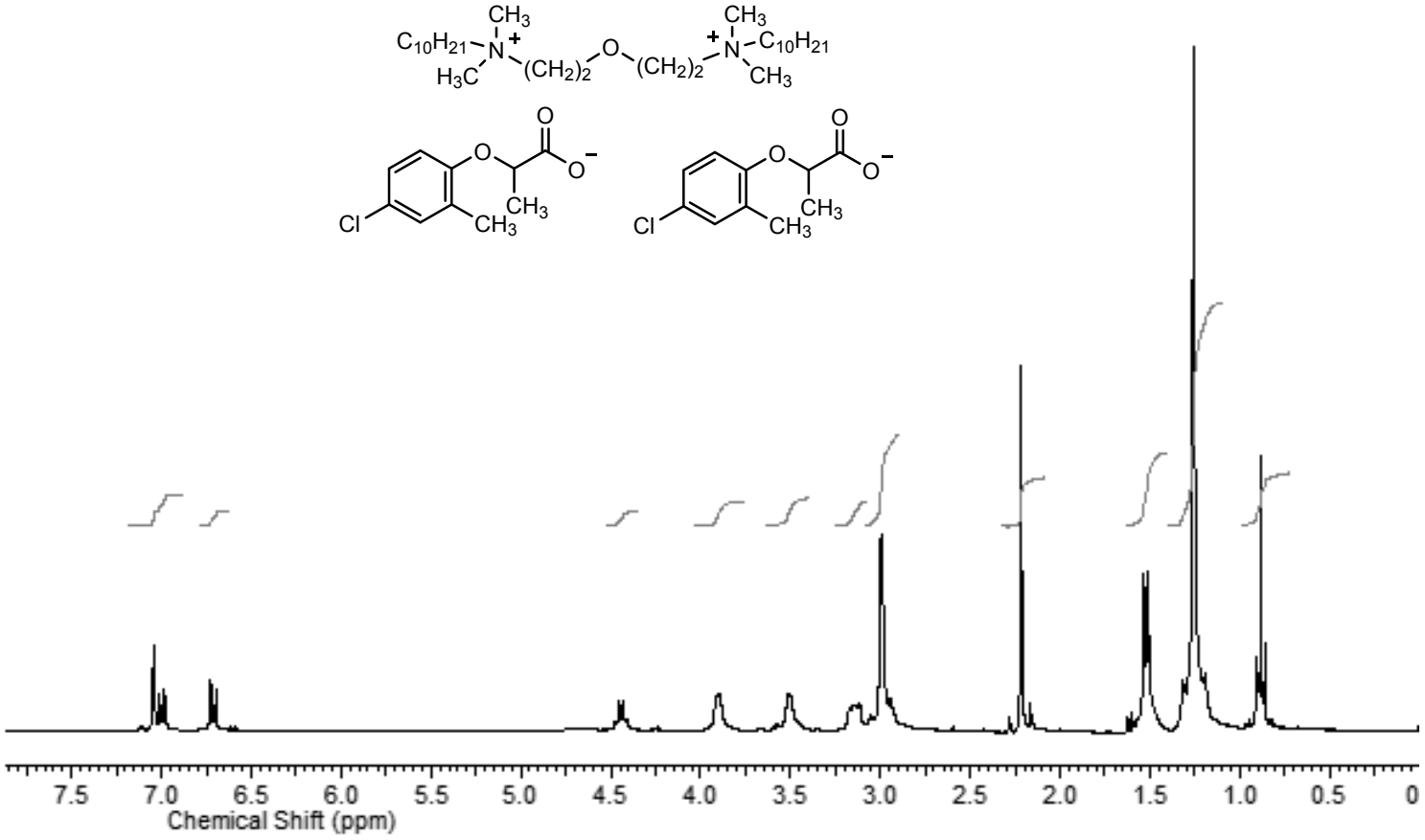

Figure S6. ^{13}C NMR spectrum of **2a** (oxybis(ethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propioniate]).

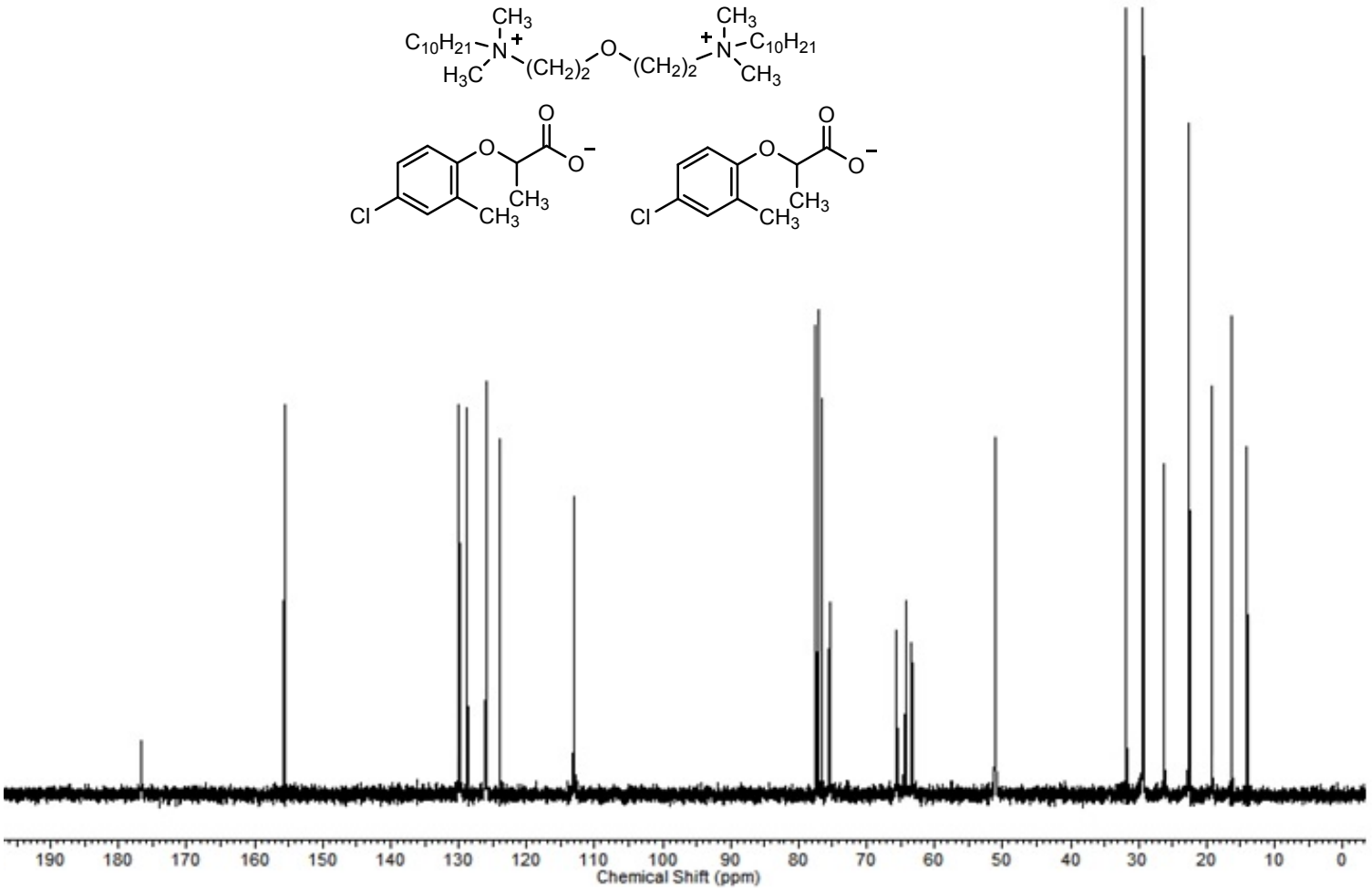

Figure S7. ^{1}H NMR spectrum of **2b** (oxybis(ethylene)bis(dimethyldecylammonium) di[3.6-dichloro-2-methoxybenzoate]).

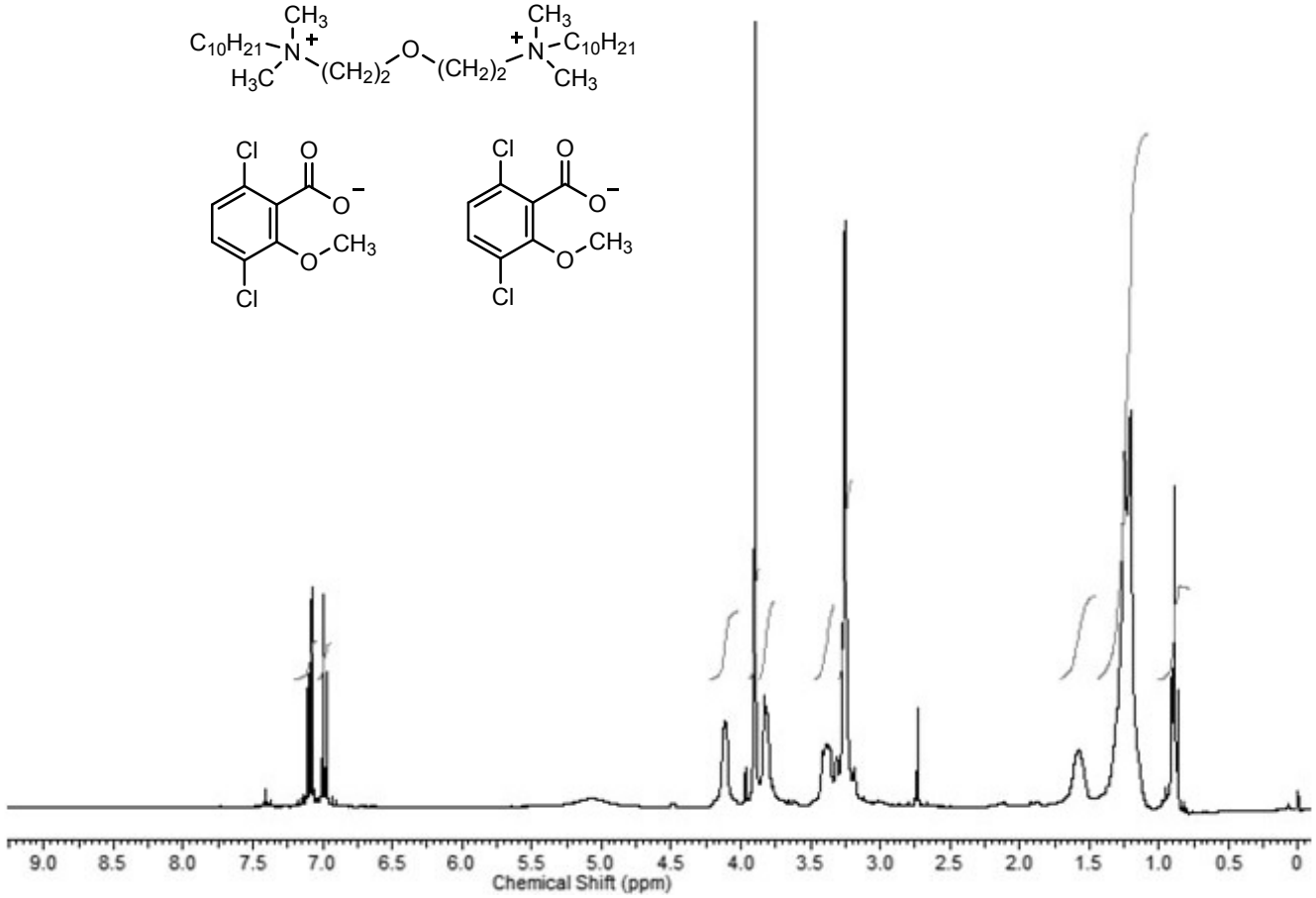

Figure S8. ^{13}C NMR spectrum of **2b** (oxybis(ethylene)bis(dimethyldecylammonium) di[3.6-dichloro-2-methoxybenzoate]).

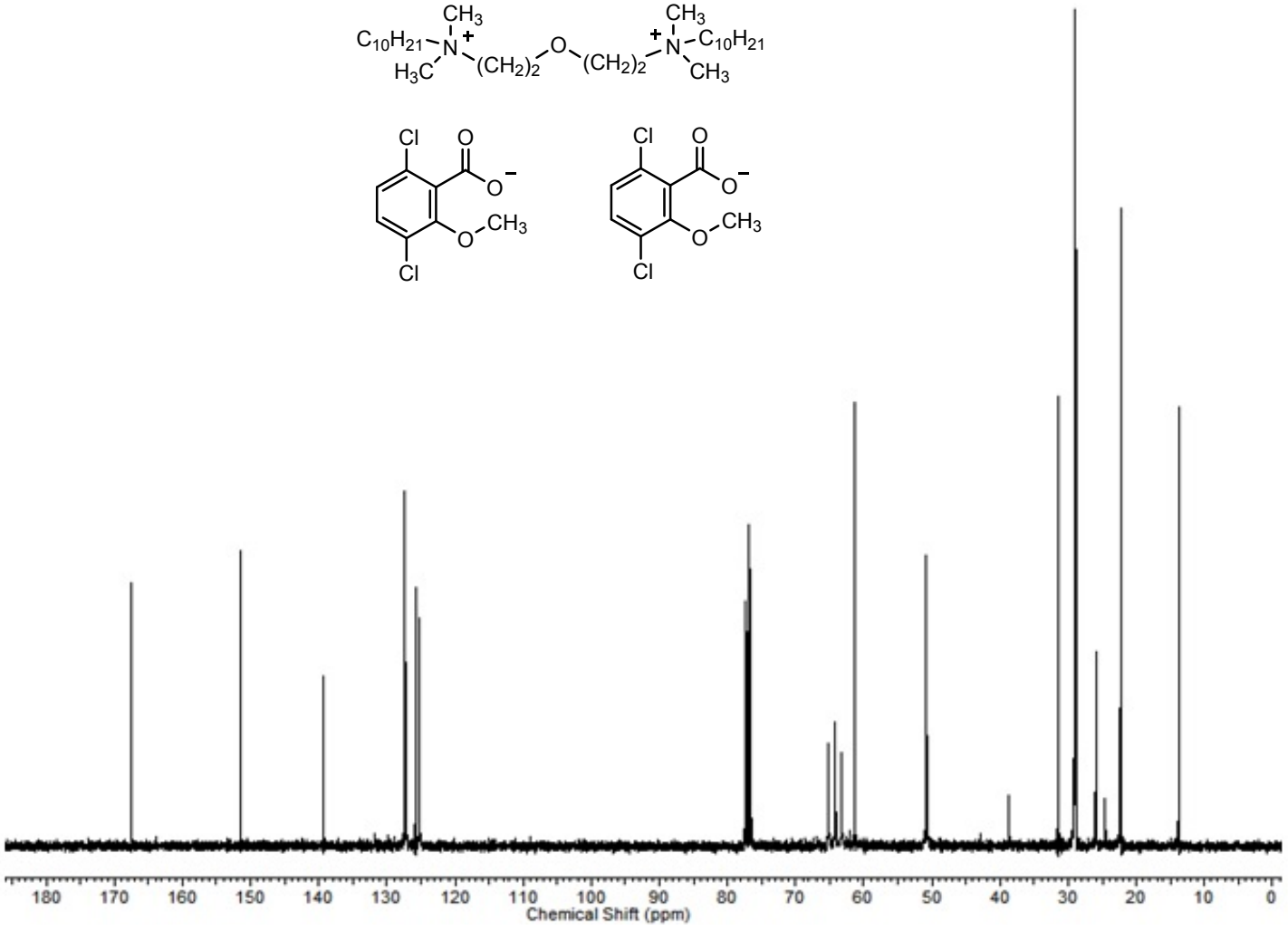

Figure S9. ^{1}H NMR spectrum of **2c** (oxybis(ethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

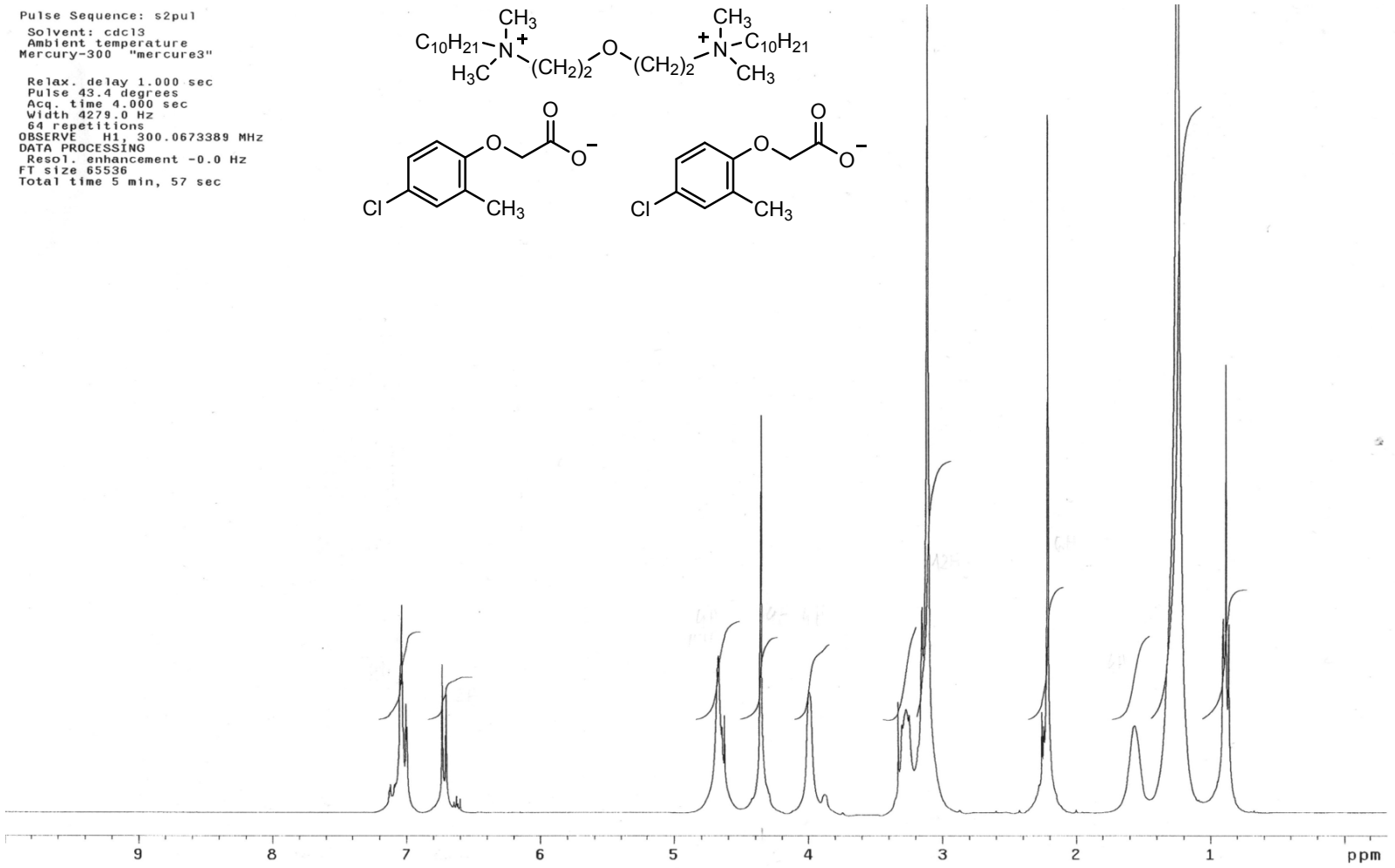

Figure S10. ^{13}C NMR spectrum of **2c** (oxybis(ethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

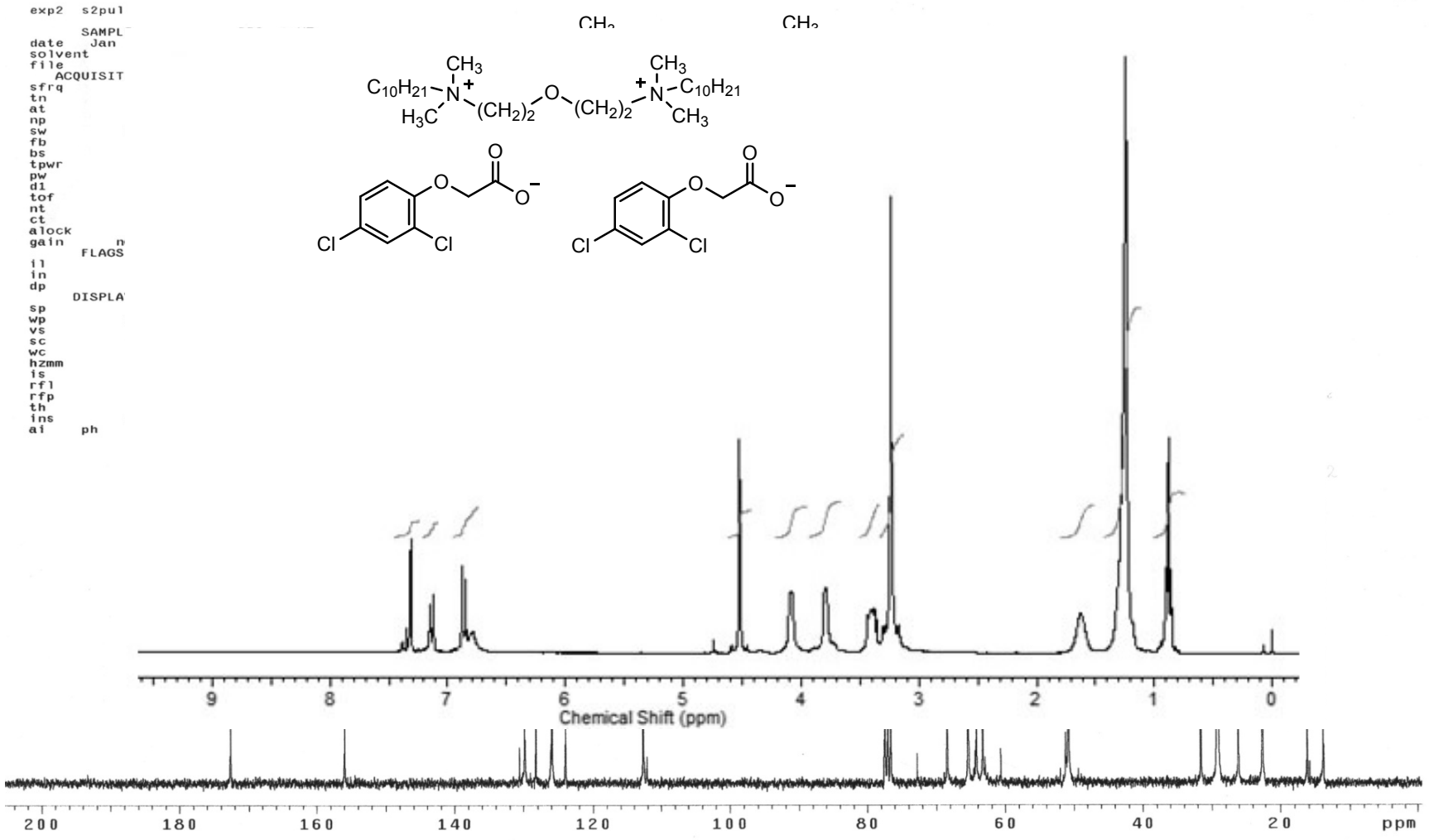

Figure S11. ^{1}H NMR spectrum of **2d** (oxybis(ethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

Figure S12. ^{13}C NMR spectrum of **2d** (oxybis(ethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

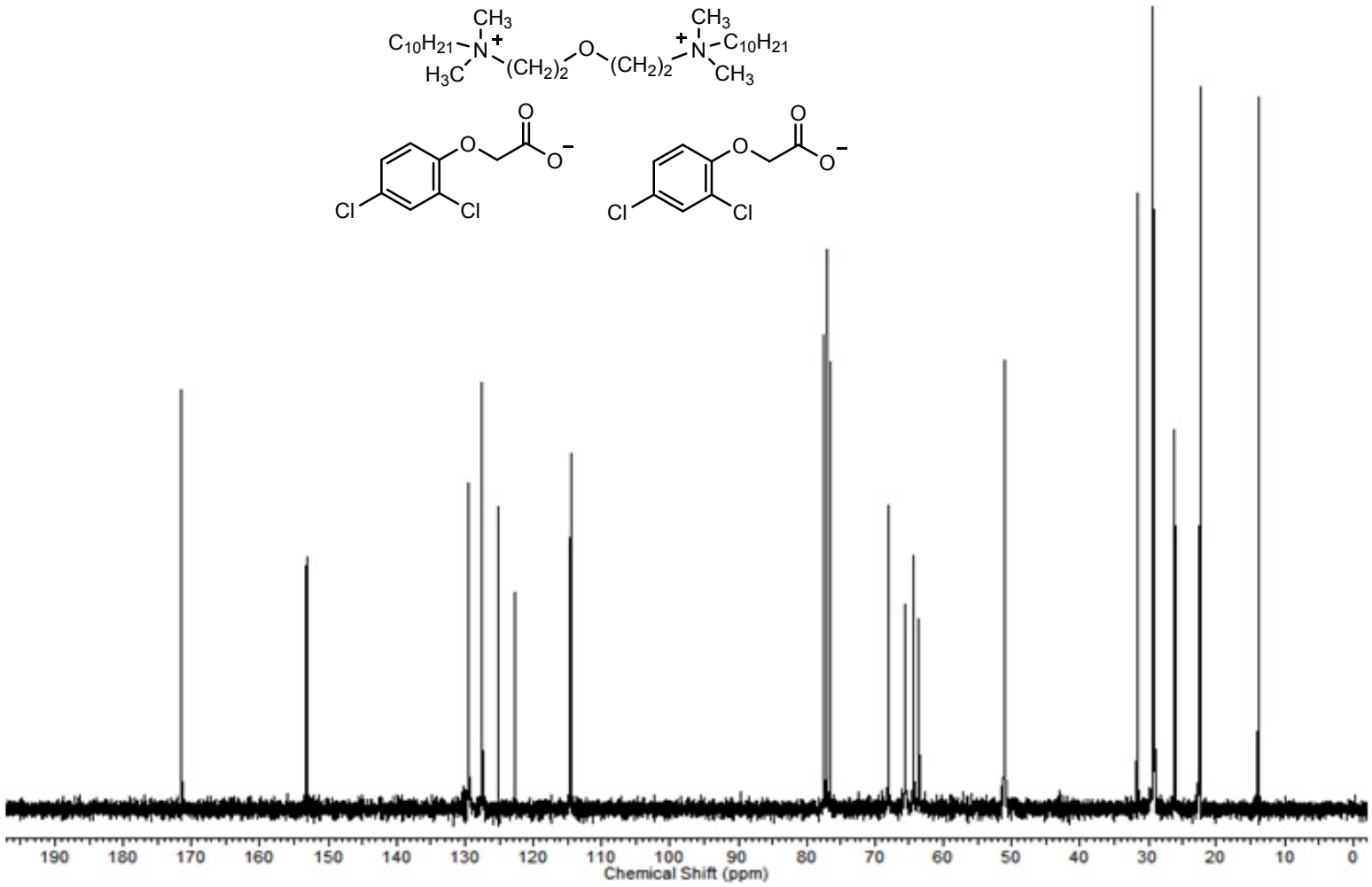

Figure S13. ^{1}H NMR spectrum of **3a** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propioniate]).

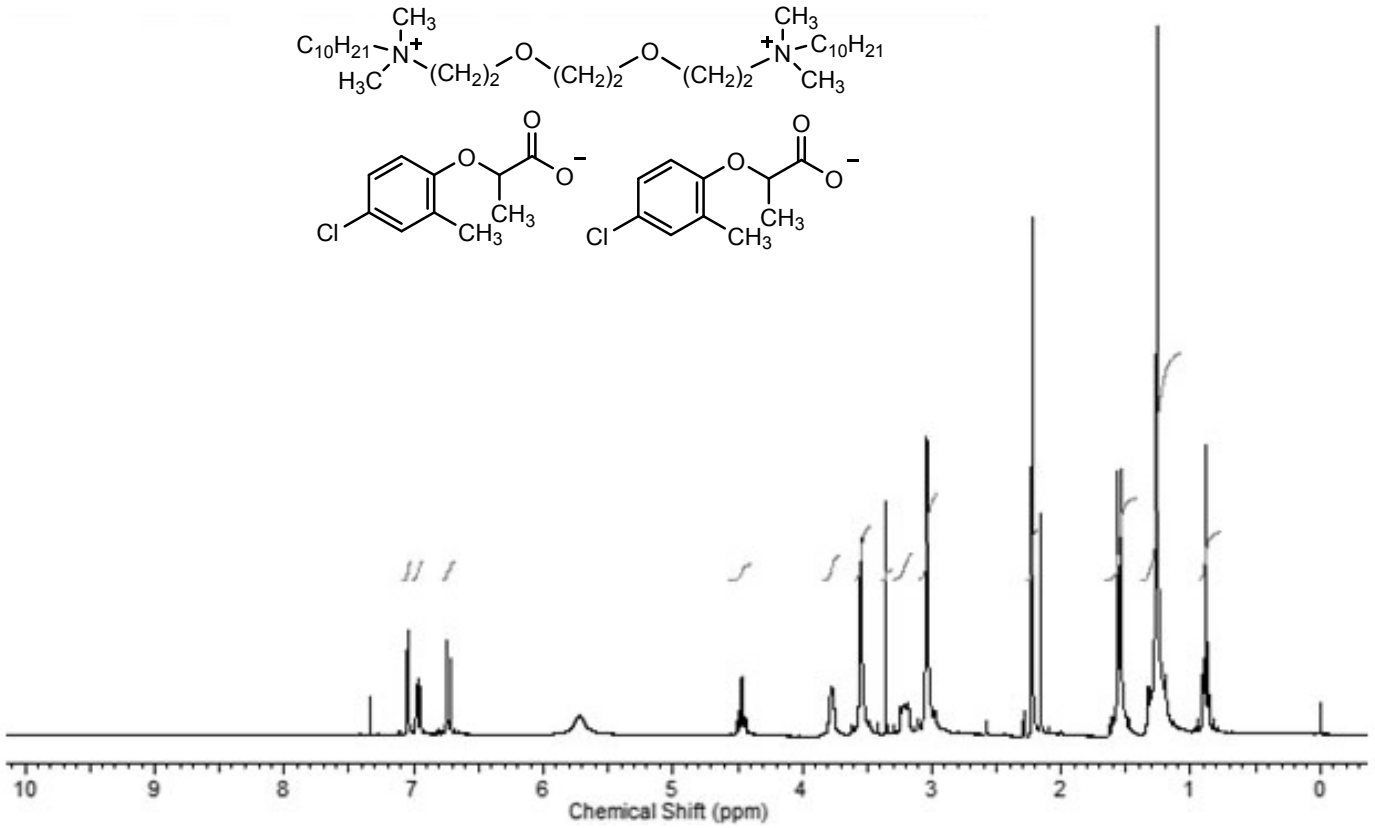

Figure S14. ^{13}C NMR spectrum of **3a** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[2-(4-chloro-2-methylphenoxy)propioniate]).

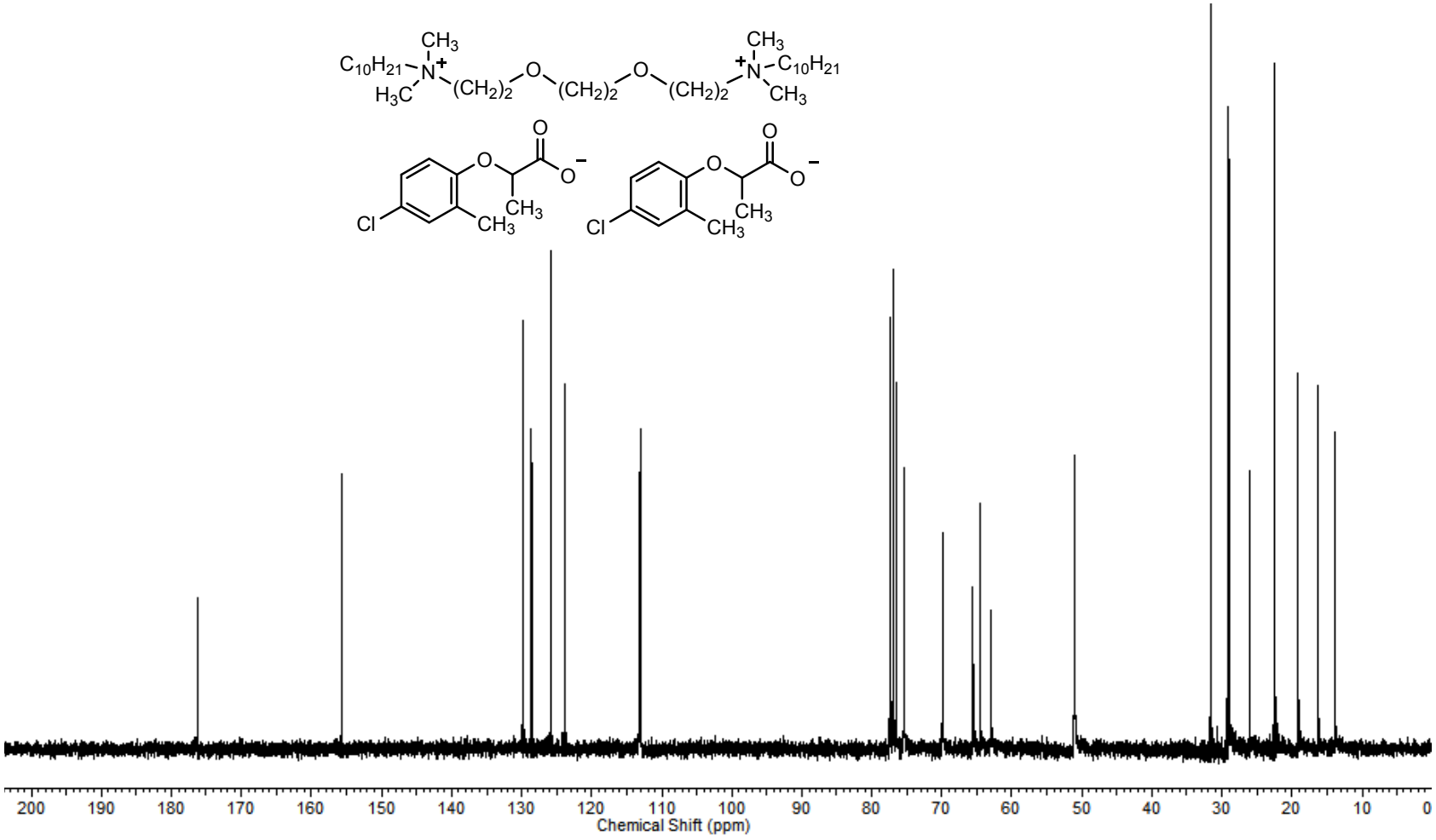

Figure S15. ^{1}H NMR spectrum of **3b** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[3.6-dichloro-2-methoxybenzoate]).

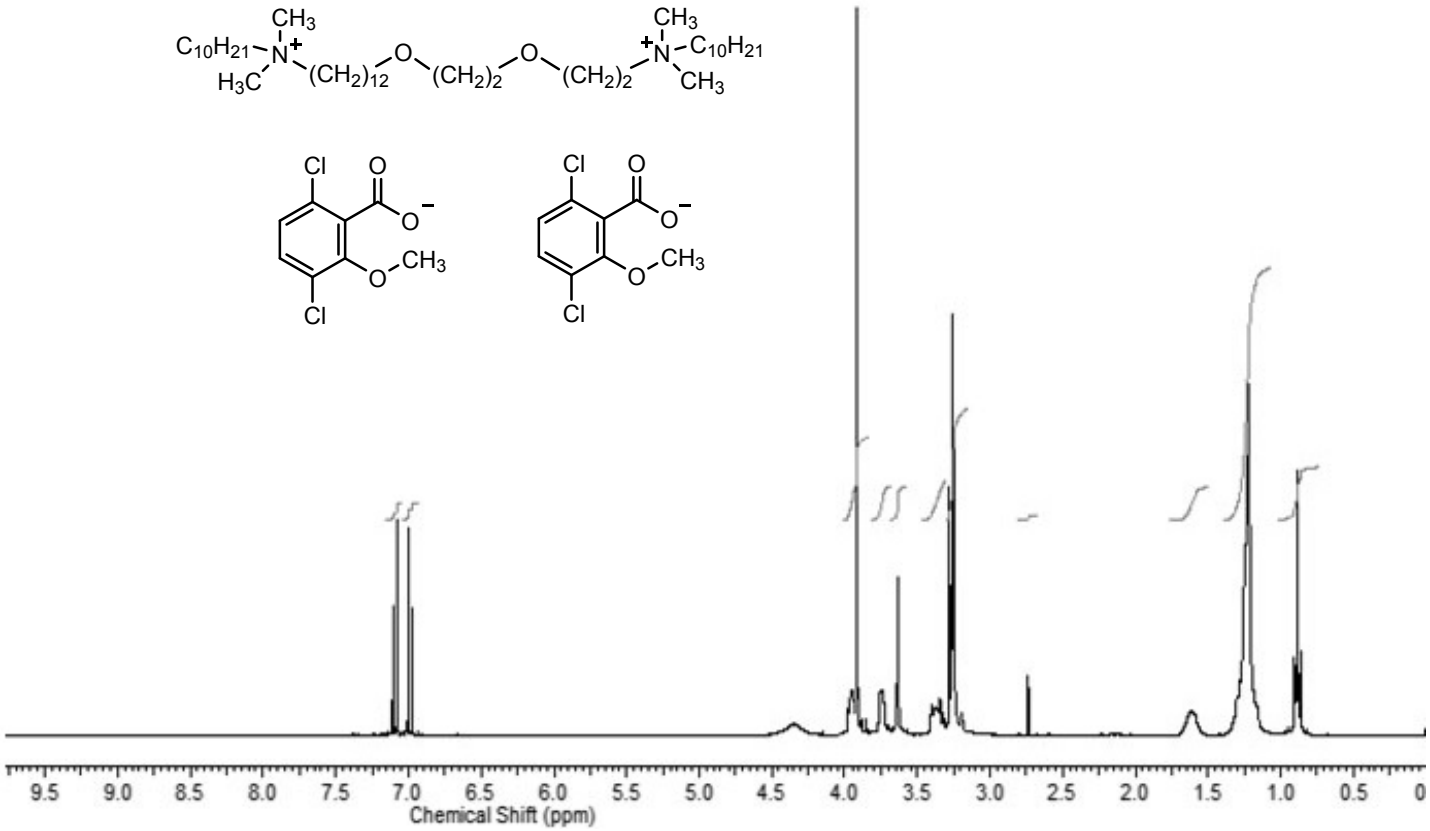

Figure S16. ^{13}C NMR spectrum of **3b** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[3.6-dichloro-2-methoxybenzoate]).

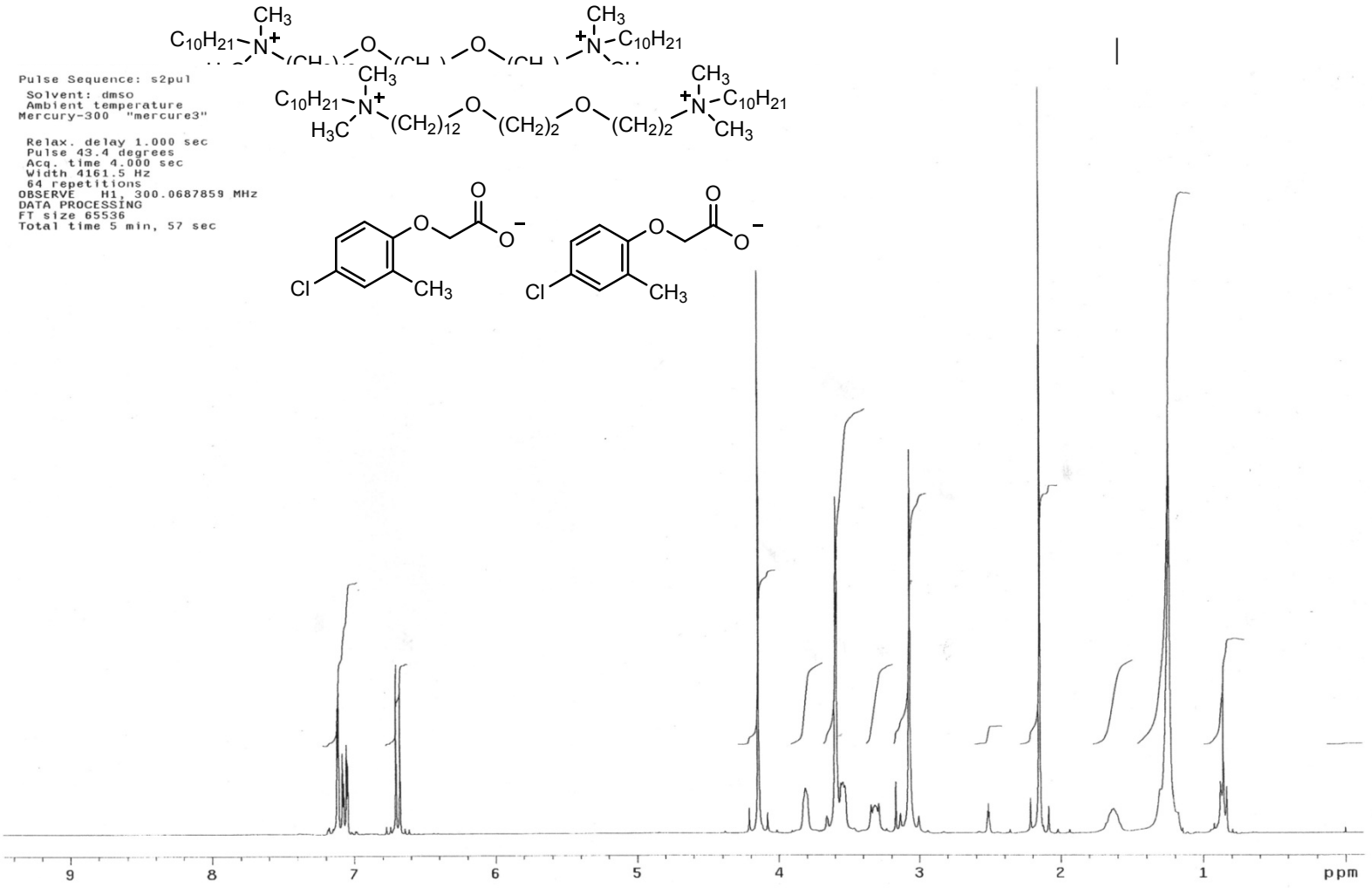

Figure S17. ^{1}H NMR spectrum of **3c** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

Figure S18. ^{13}C NMR spectrum of **3c** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(4-chloro-2-methylphenoxy)acetate]).

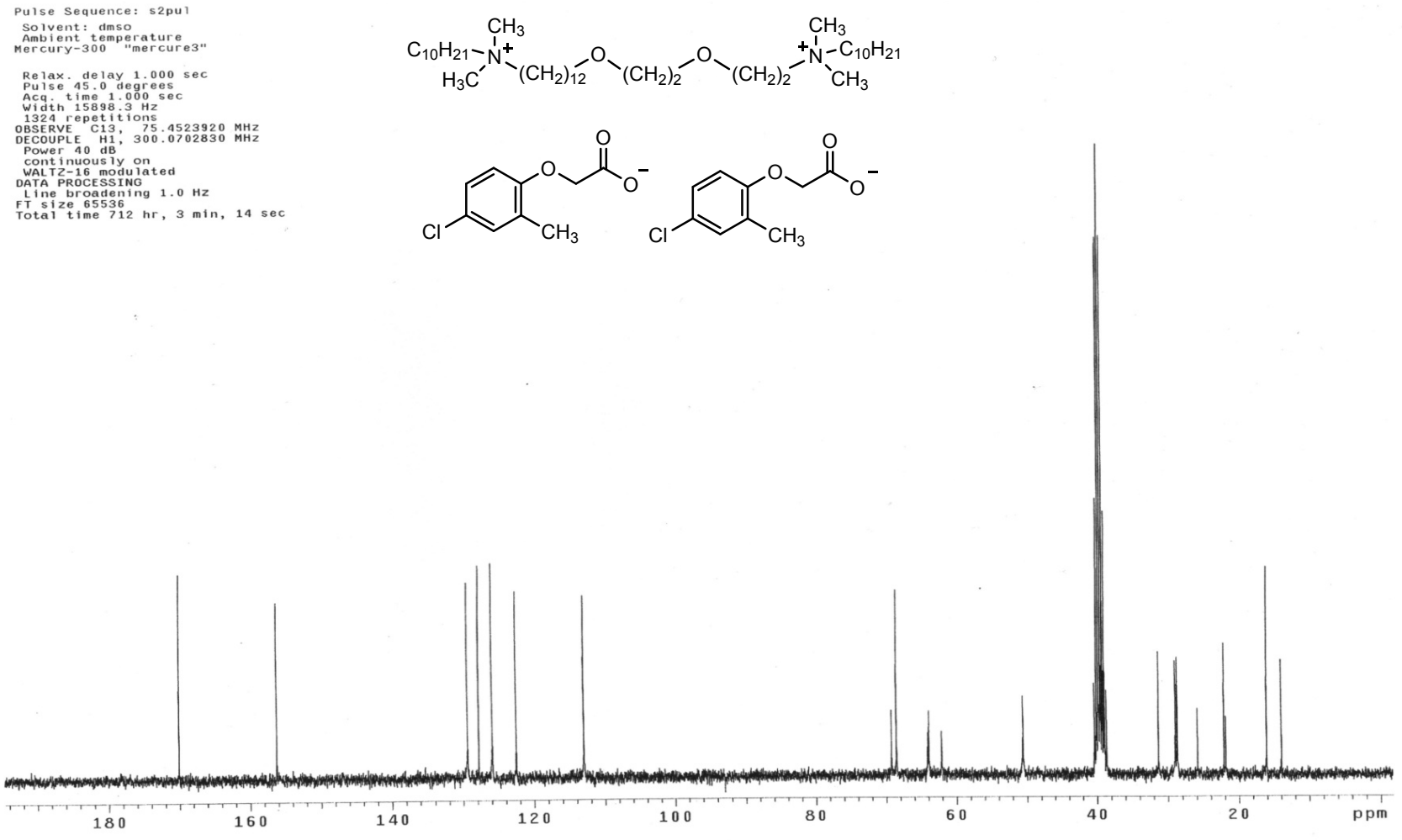

Figure S19. ^{1}H NMR spectrum of **3d** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

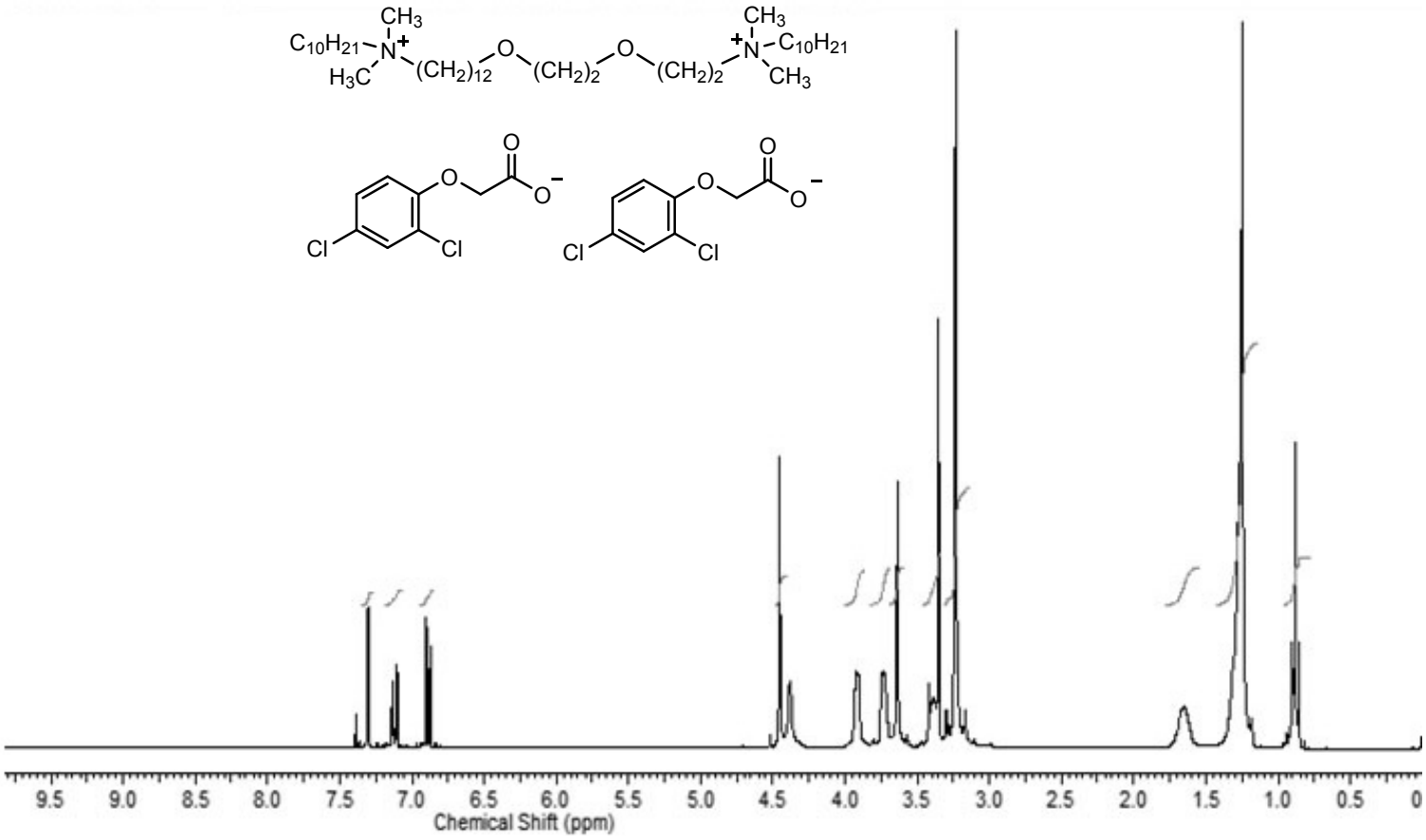

Figure S20. ^{13}C NMR spectrum of **3d** (ethylenebis(oxyethylene)bis(dimethyldecylammonium) di[(2,4-dichlorophenoxy)acetate]).

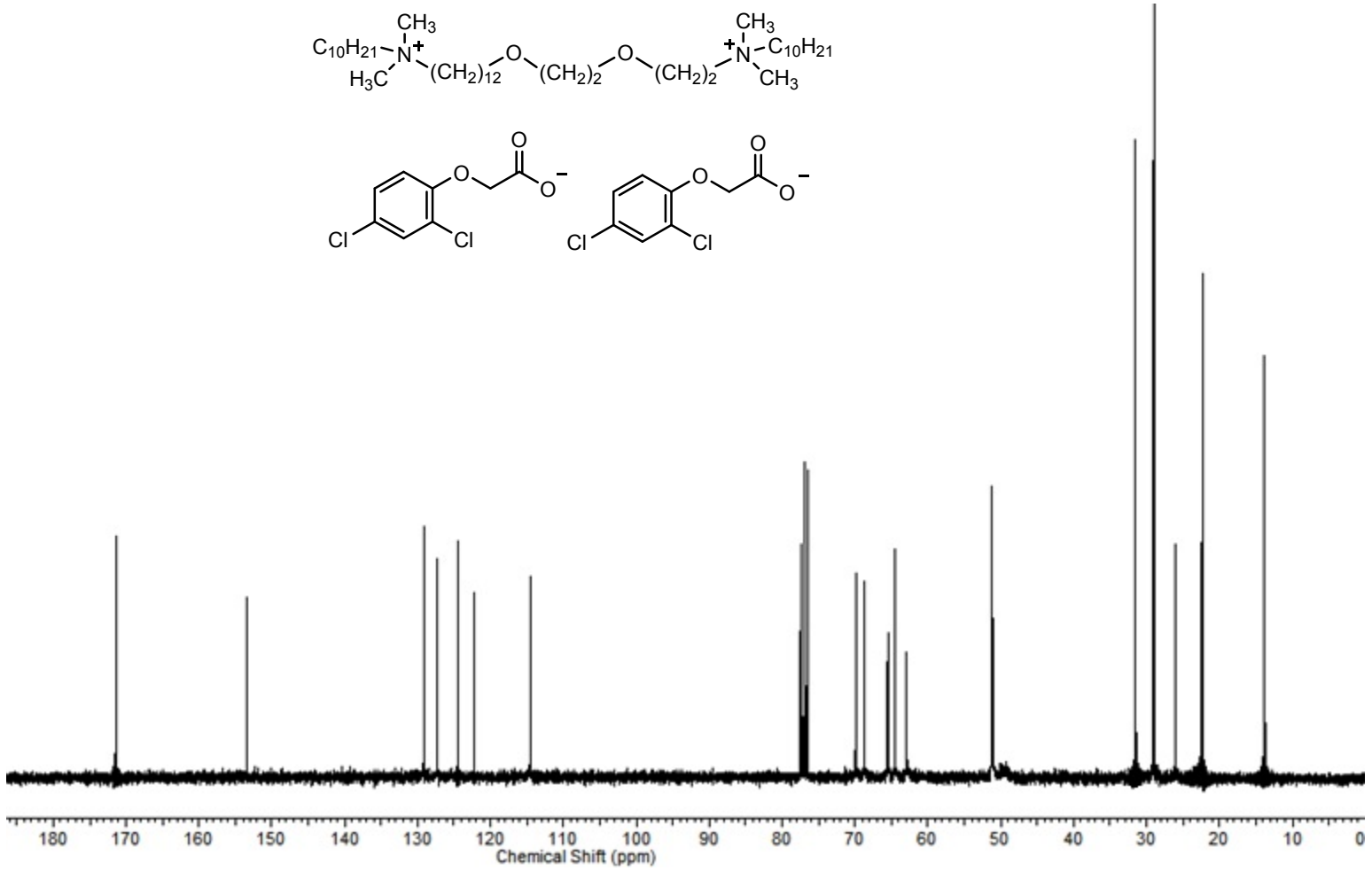

Figure S21. DSC thermogram of **1a**

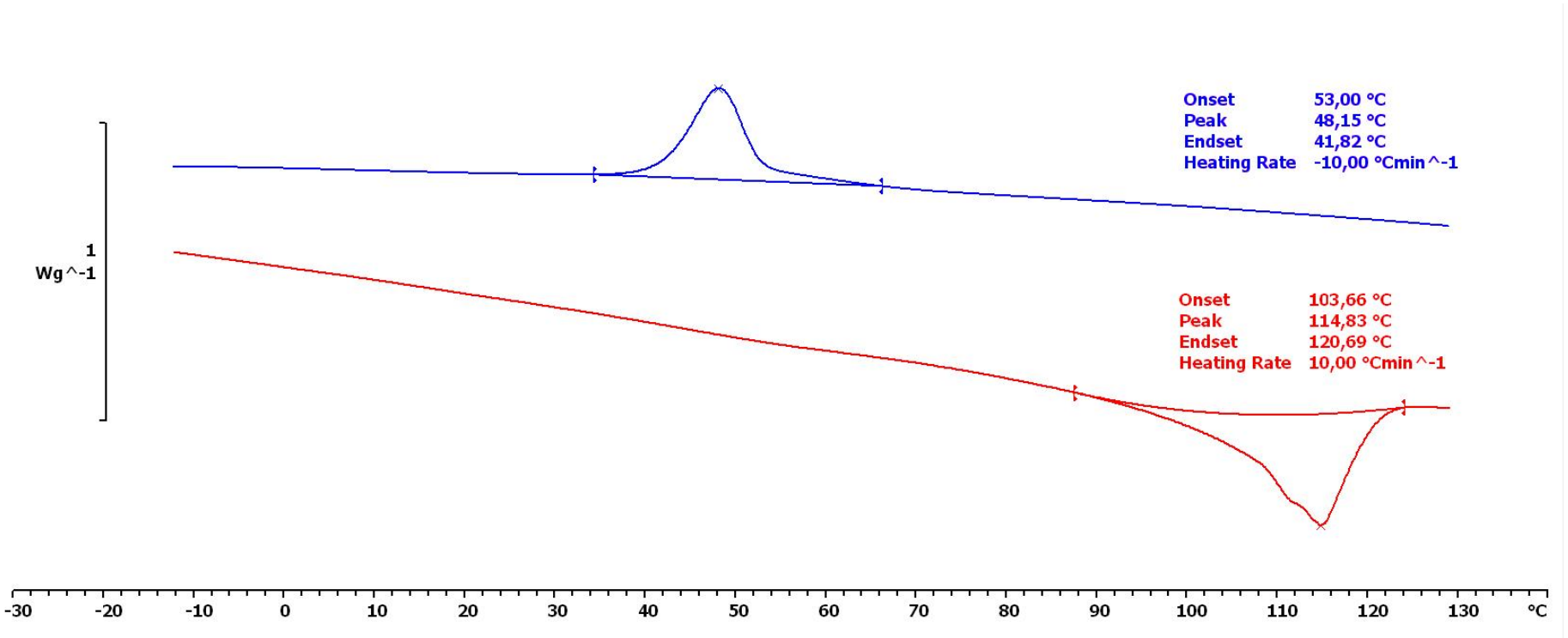

Figure S22. DSC thermogram of **1b**

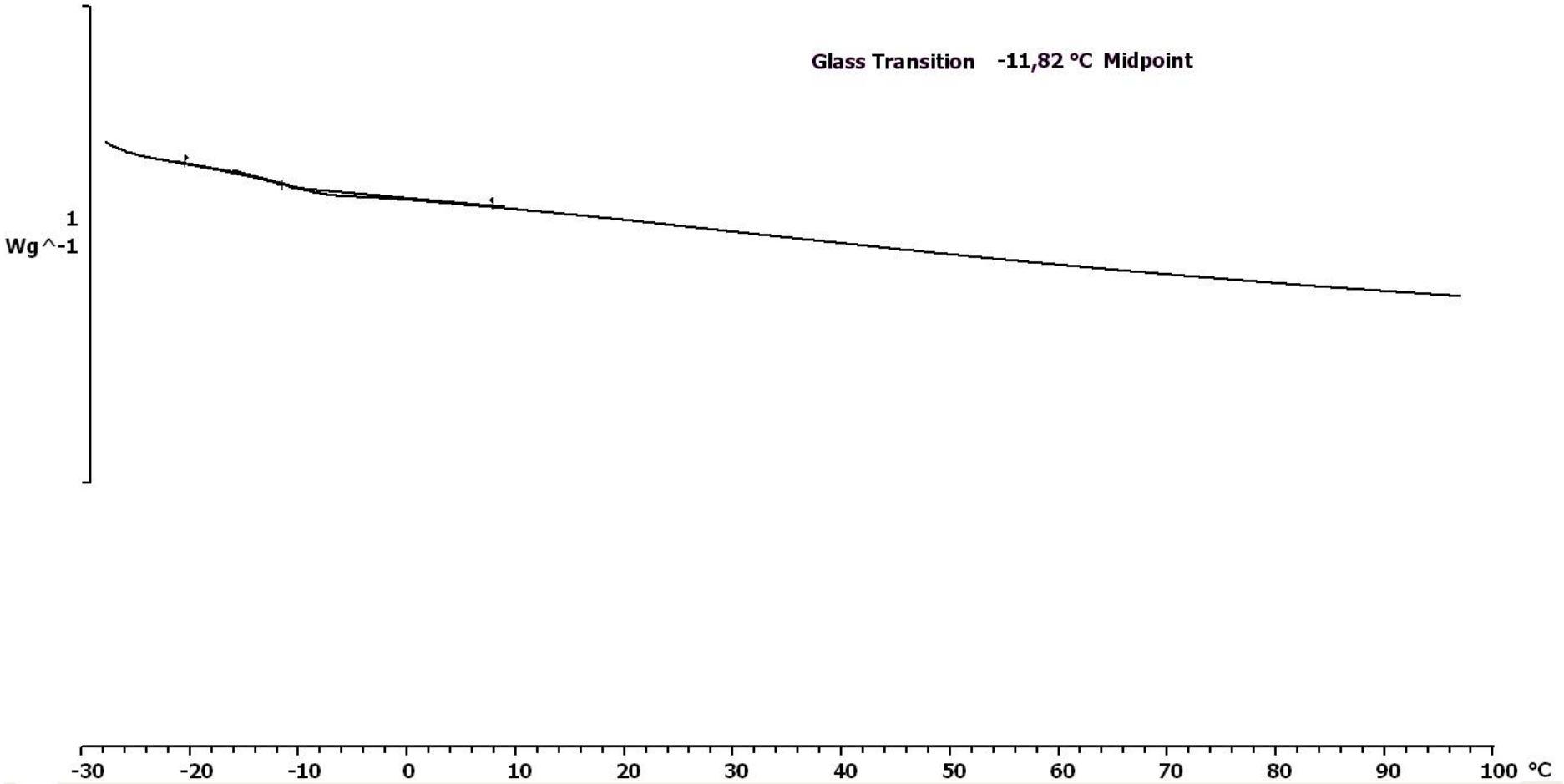

Figure S23. DSC thermogram of **2a-2d**

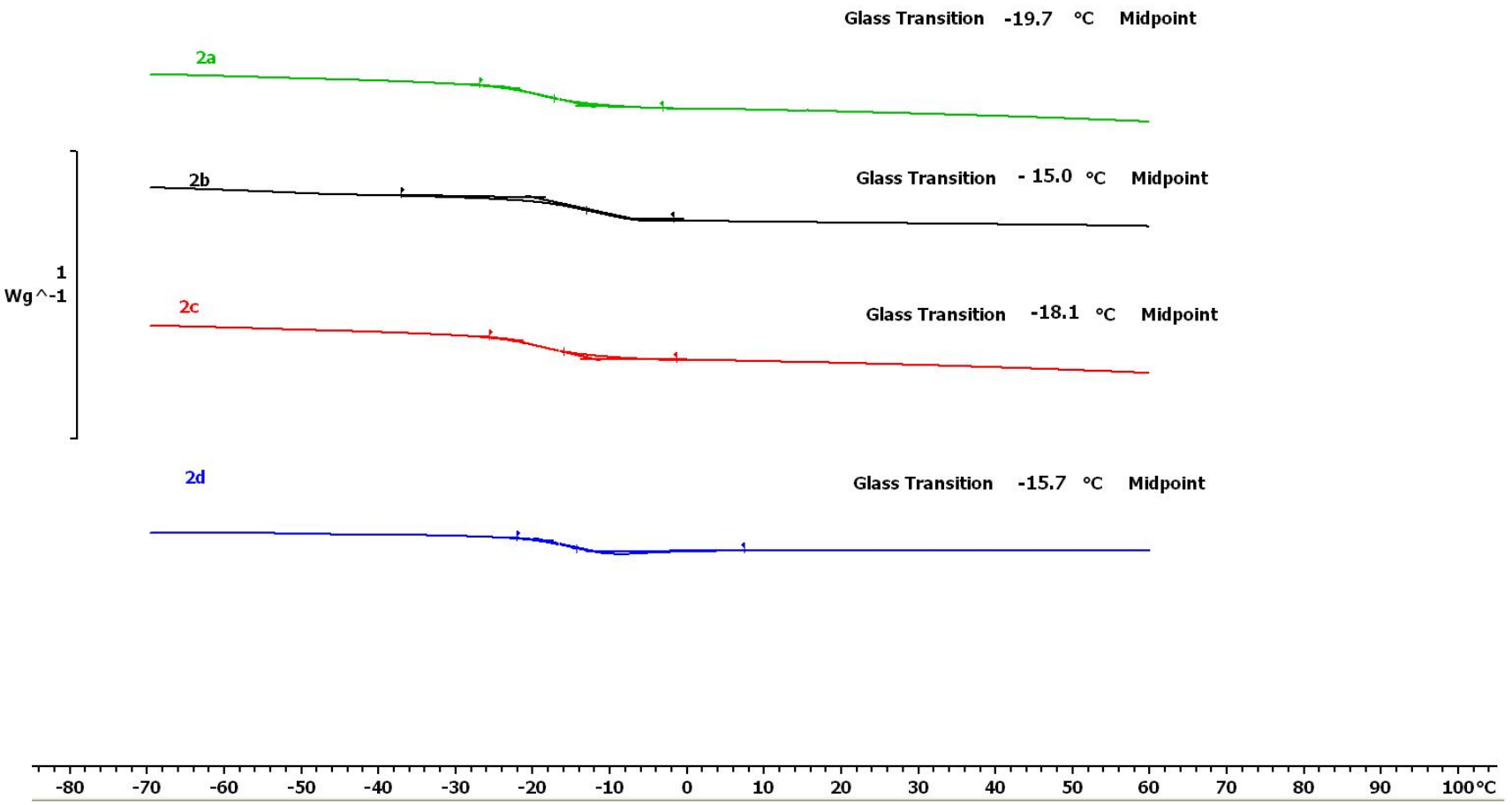

Figure S24. DSC thermogram of **3a-3d**

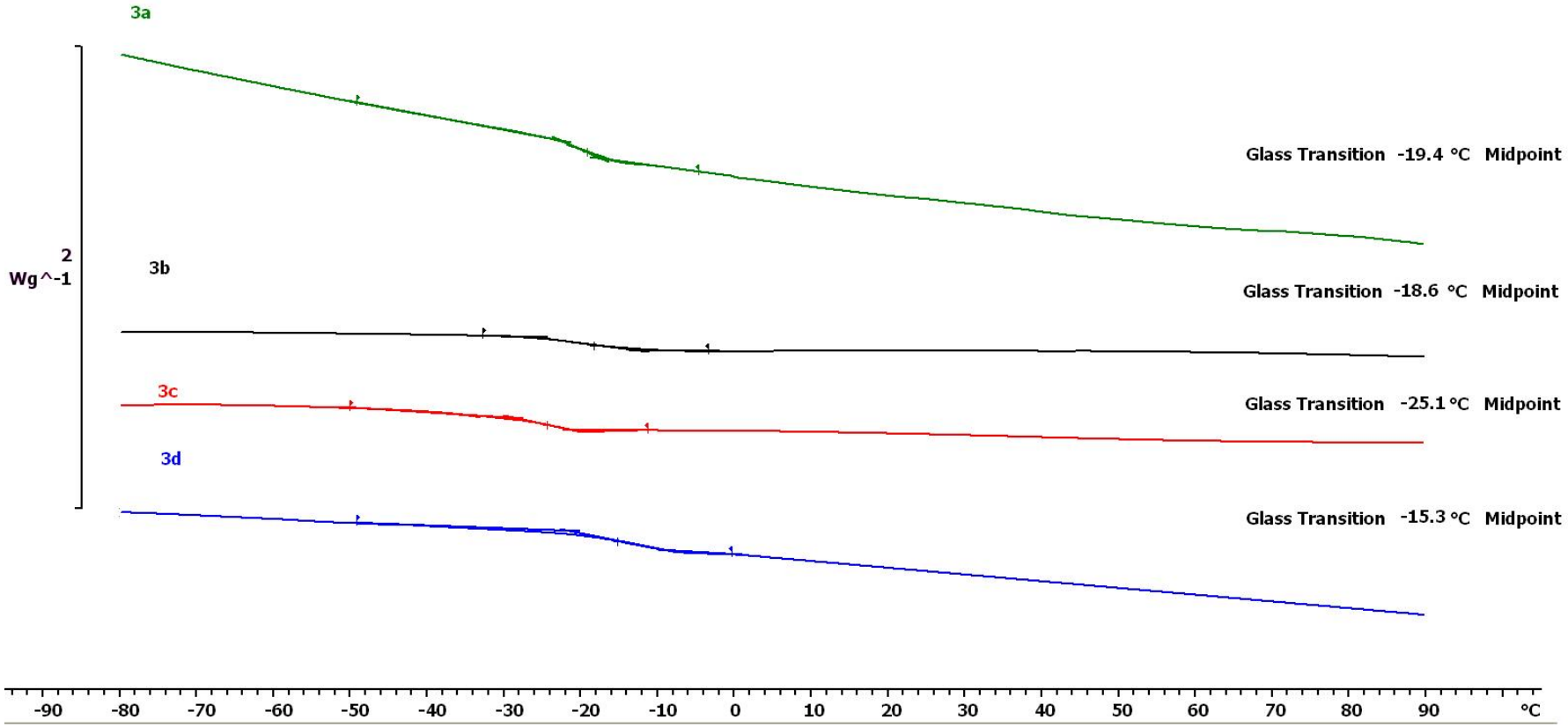

Figure S25. TGA thermogram of **1a** and **1b**

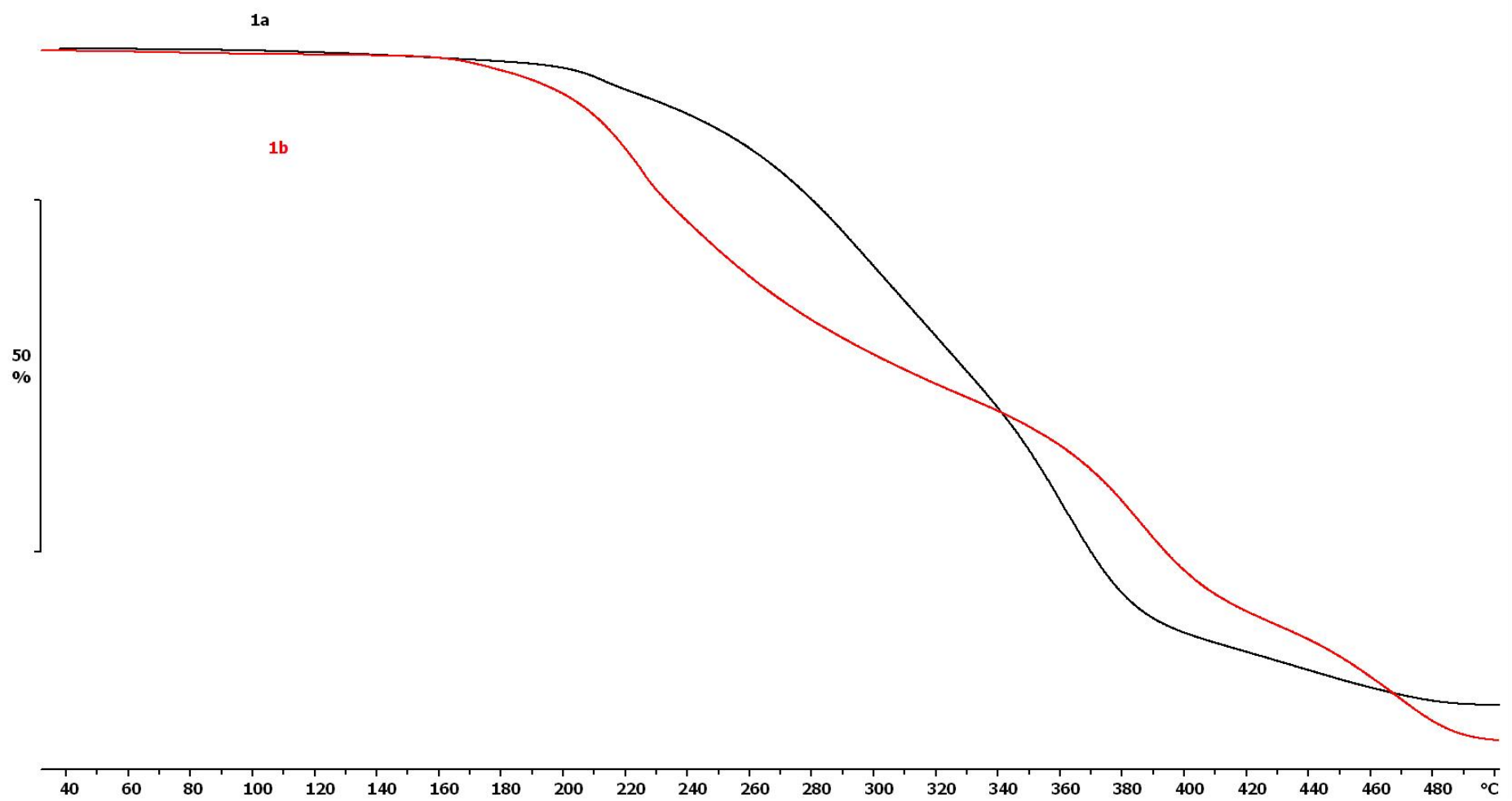

Figure S26. TGA thermogram of **2a**-**2d**

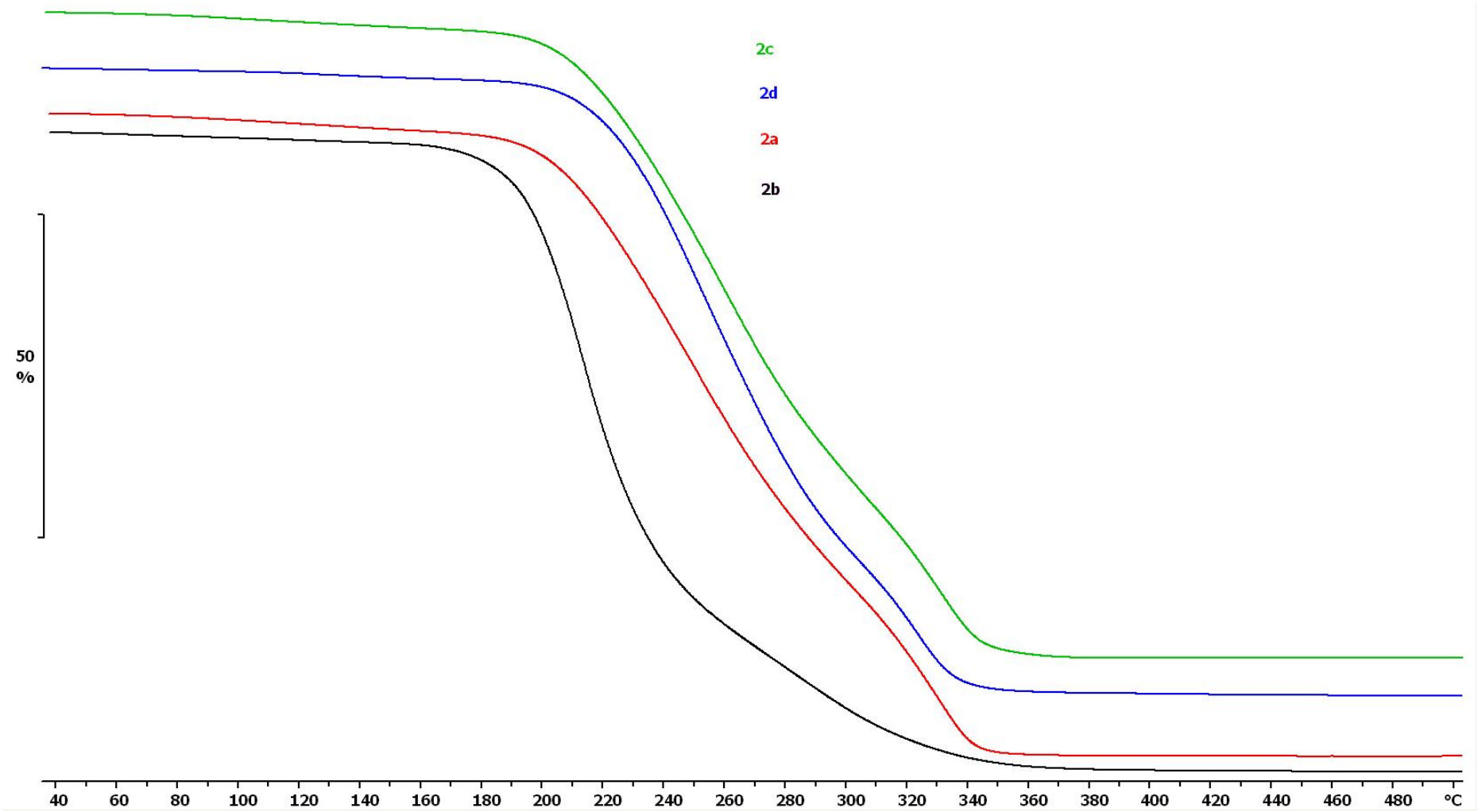

Figure S27. TGA thermogram of **3a-3d**

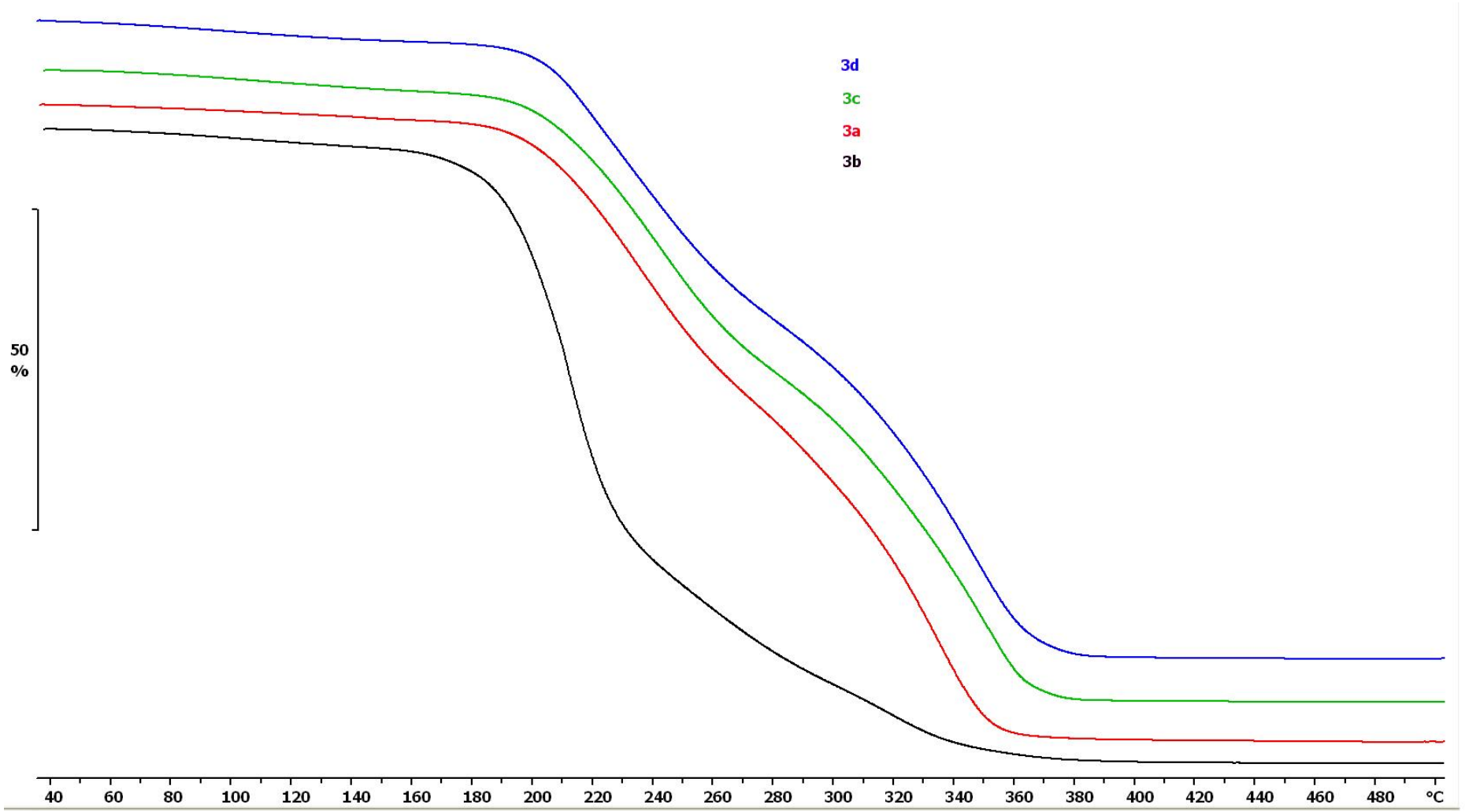
3d
3c
3a
3b
50
%
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
°C

Table S1. Efficacy tests for bis(ammonium) HILs in the greenhouse experiments.

Salt	CHEAL - Lambsquarters (*Chenopodium album* L.)	SINAL - White mustard *(Sinapis alba* L.*)*
	Fresh weight reduction (%)	
2a	37	8
2b	32	9
2c	60	55
2d	47	52
3a	51	22
3b	58	33
3c	32	33
3d	27	47
MCPA[a]	20	25
Dicamba[a]	26	13
2,4-D[a]	10	40

[a]the commercial herbicides