Electronic Supplementary Material (ESI) for RSC Advances.

Synthesis and assessment of new cationic Gemini surfactants as inhibitors for carbon steel corrosion in oilfield water

F. El-Taib Heakal[1*], A.E. Elkholy[2], M.A. Deyab[2], M.M. Osman[2], M.I. Nessim[2]

[1]*Chemistry Department, Faculty of Science, Cairo University, 12613 Giza, Egypt*

[2]*Department of Analysis and Evaluation, Egyptian Petroleum Research Institute, 11727 Cairo, Egypt*

[*]Corresponding author. Tel.: +20 1002449048; Fax: +20 35727556; +20 35728843

E-mail address: fakihaheakal@yahoo.com; feltaibheakal@gmail.com

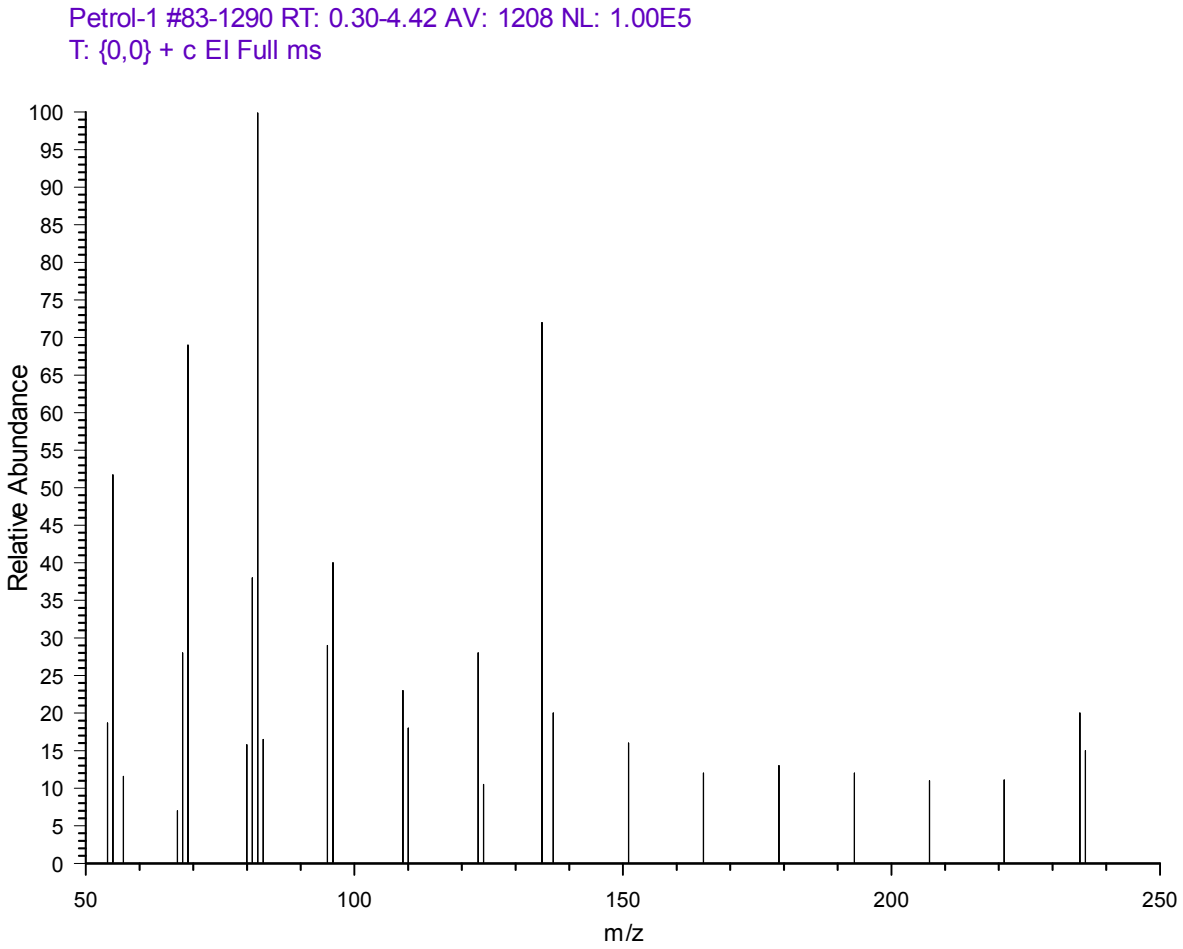


Fig. S 1: Mass spectrum of the intermediate compound.

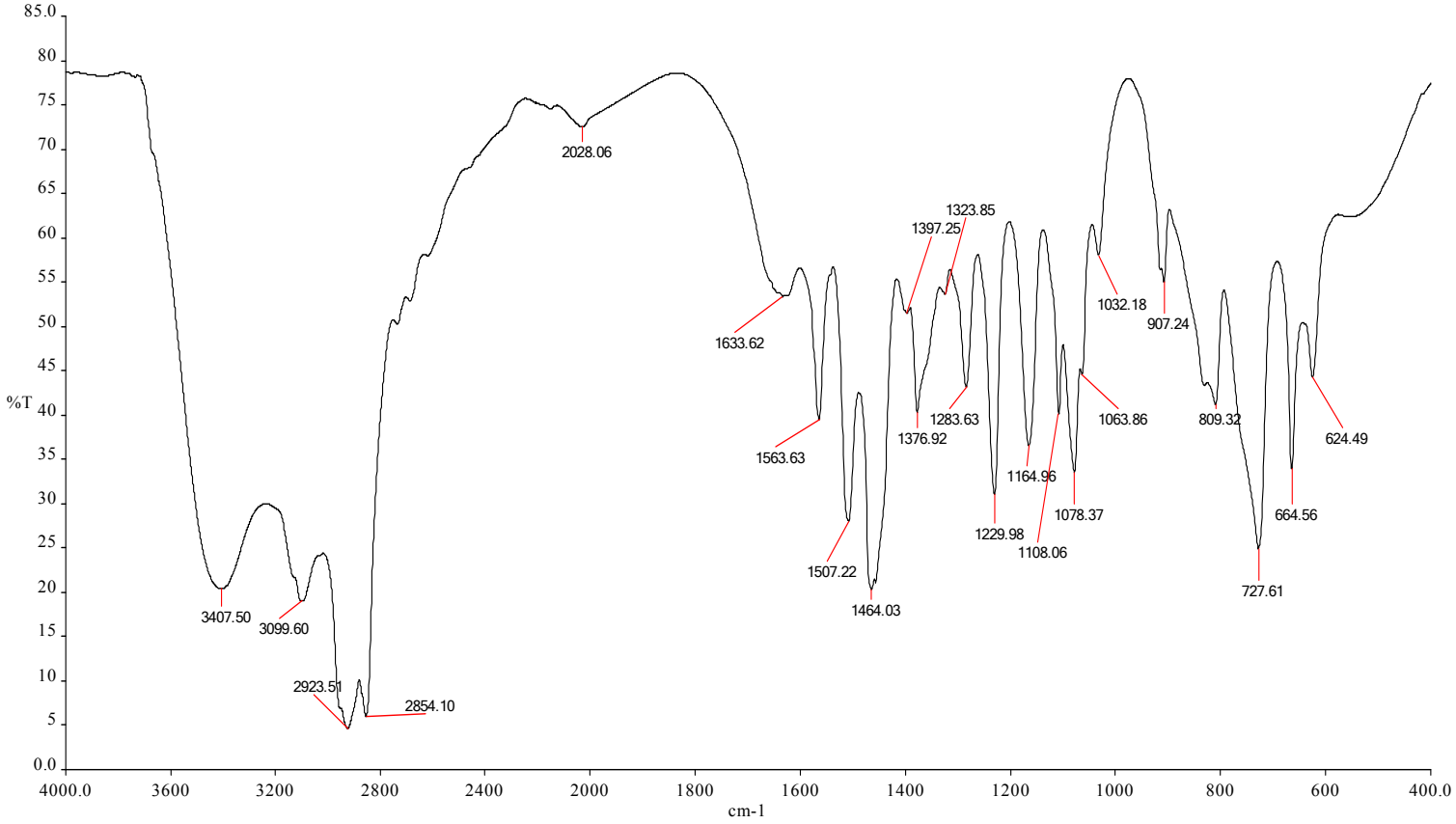


Fig. S 2: FT-IR spectrum of the intermediate compound.

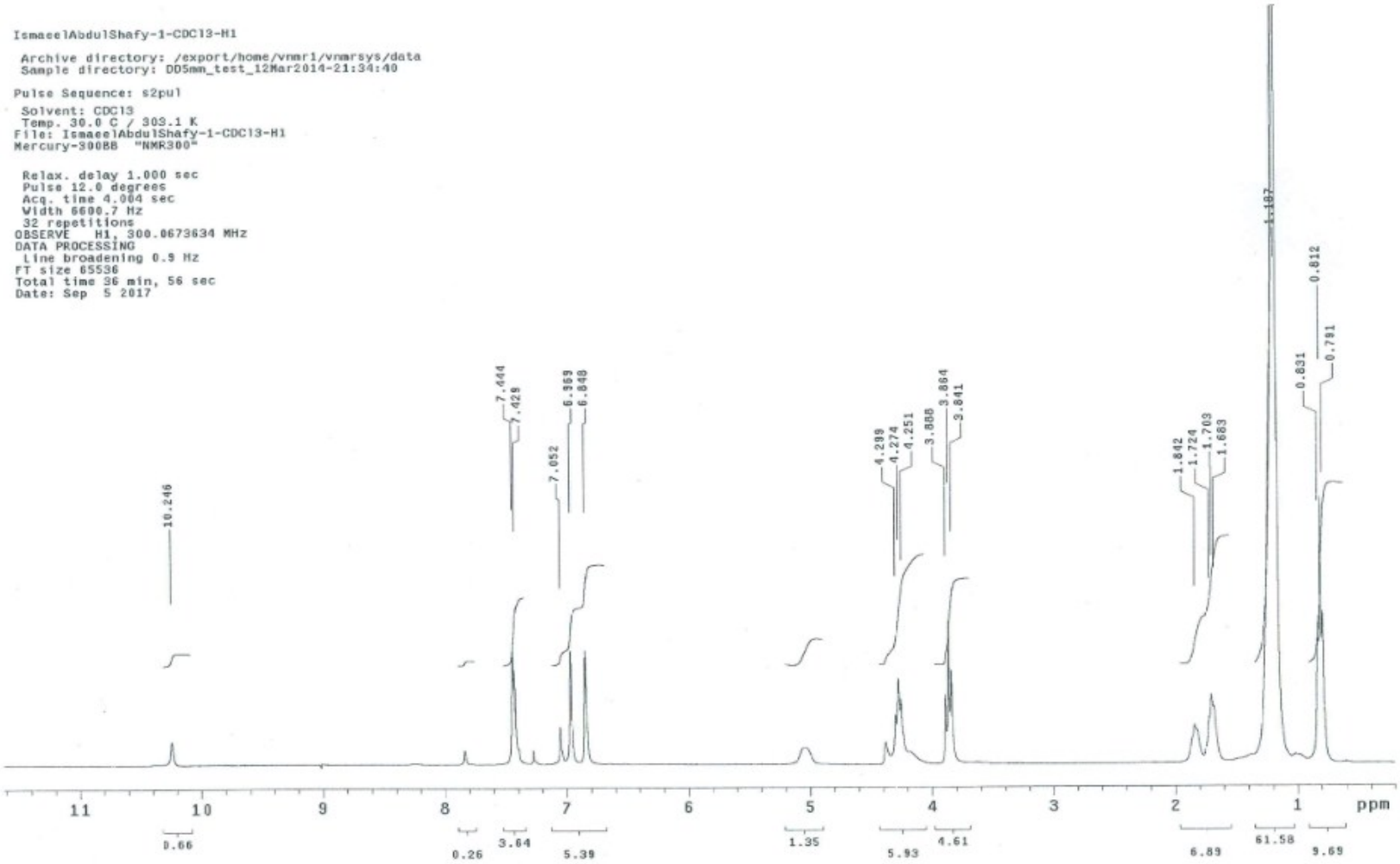


Fig. S 3: H^1-NMR spectrum of the intermediate compound.

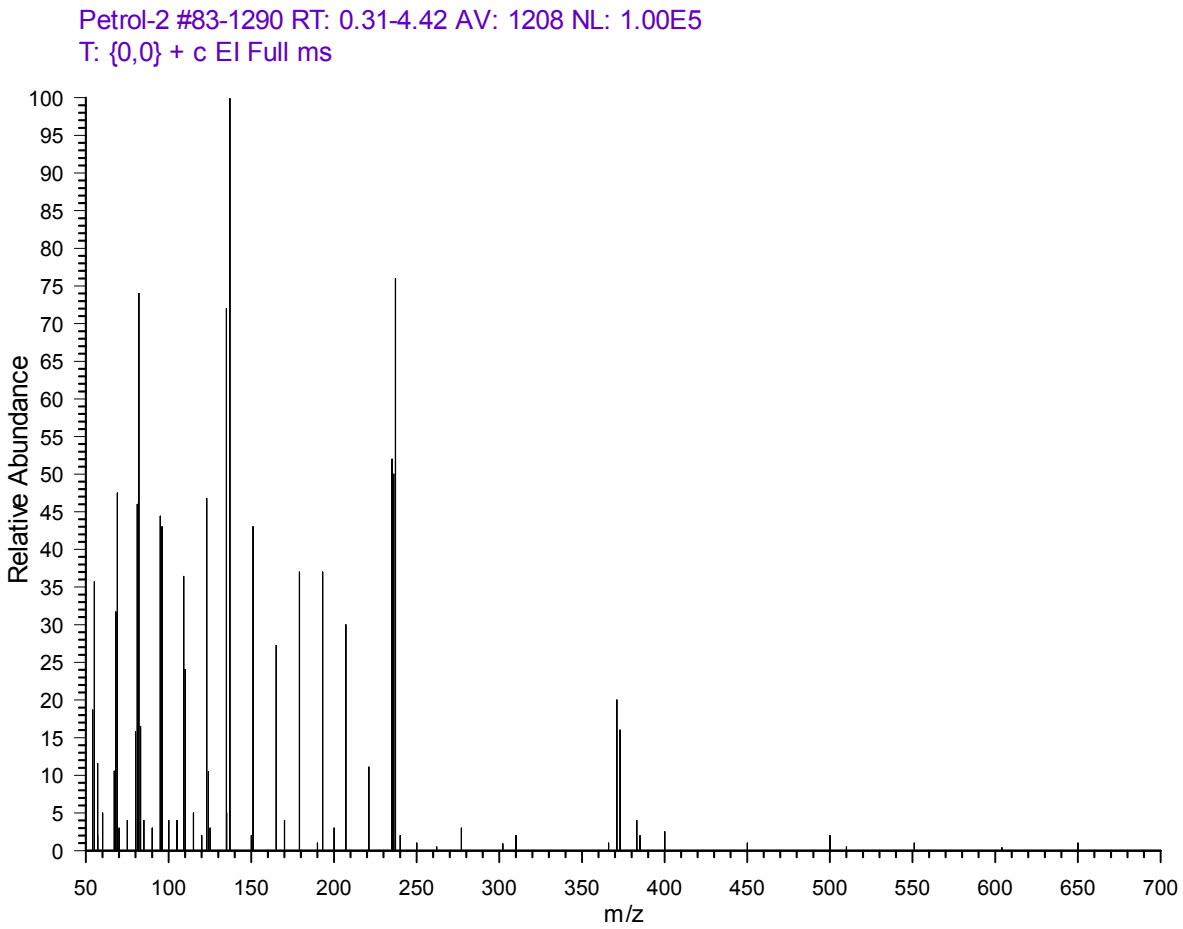


Fig. S 4: Mass spectrum of GS2.

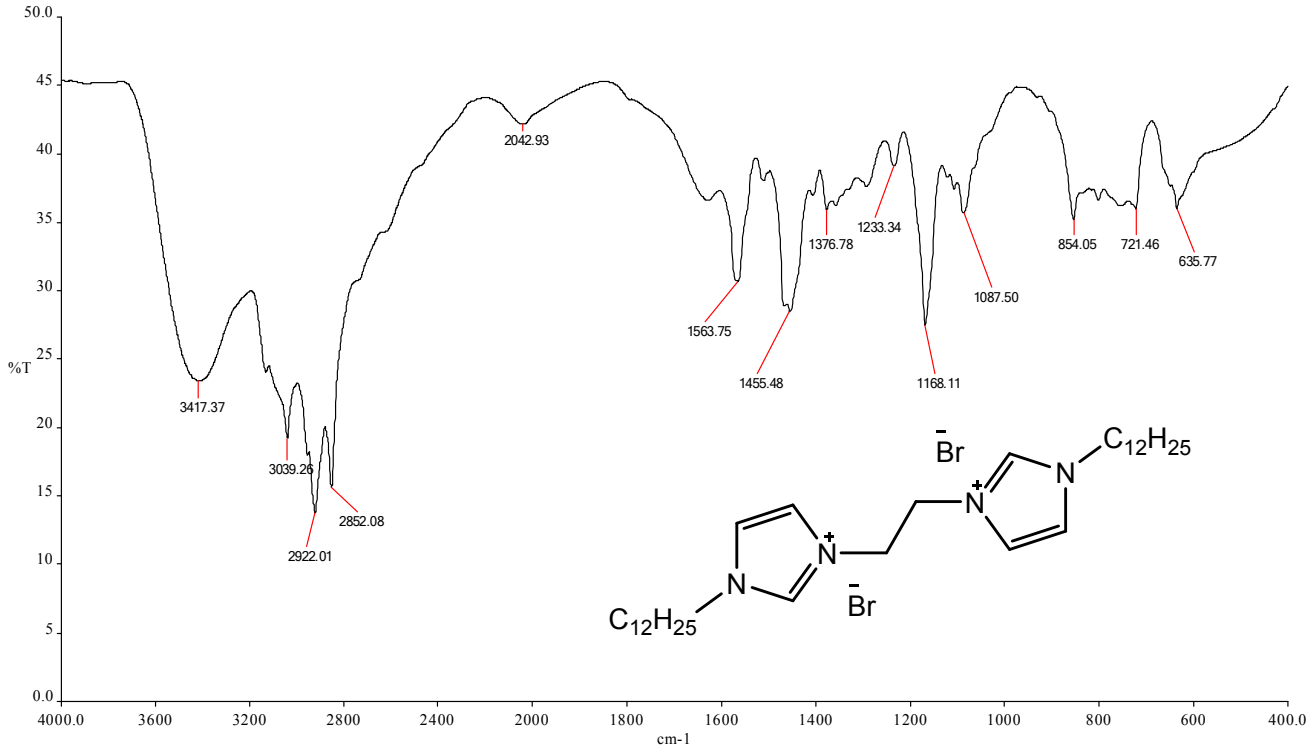


Fig. S 5: FT-IR spectrum of GS2.

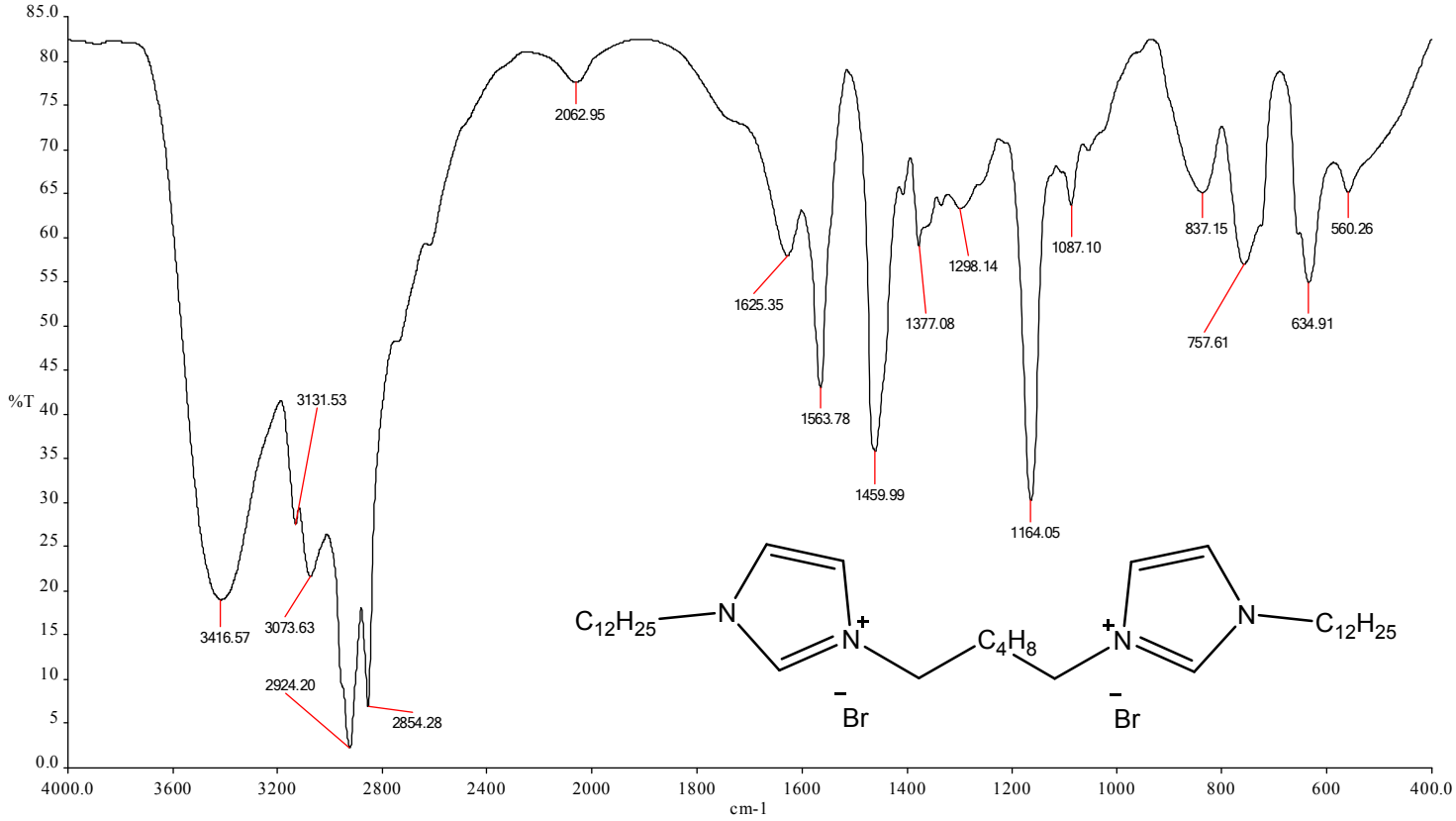


Fig. S 6: FT-IR spectrum of GS6.

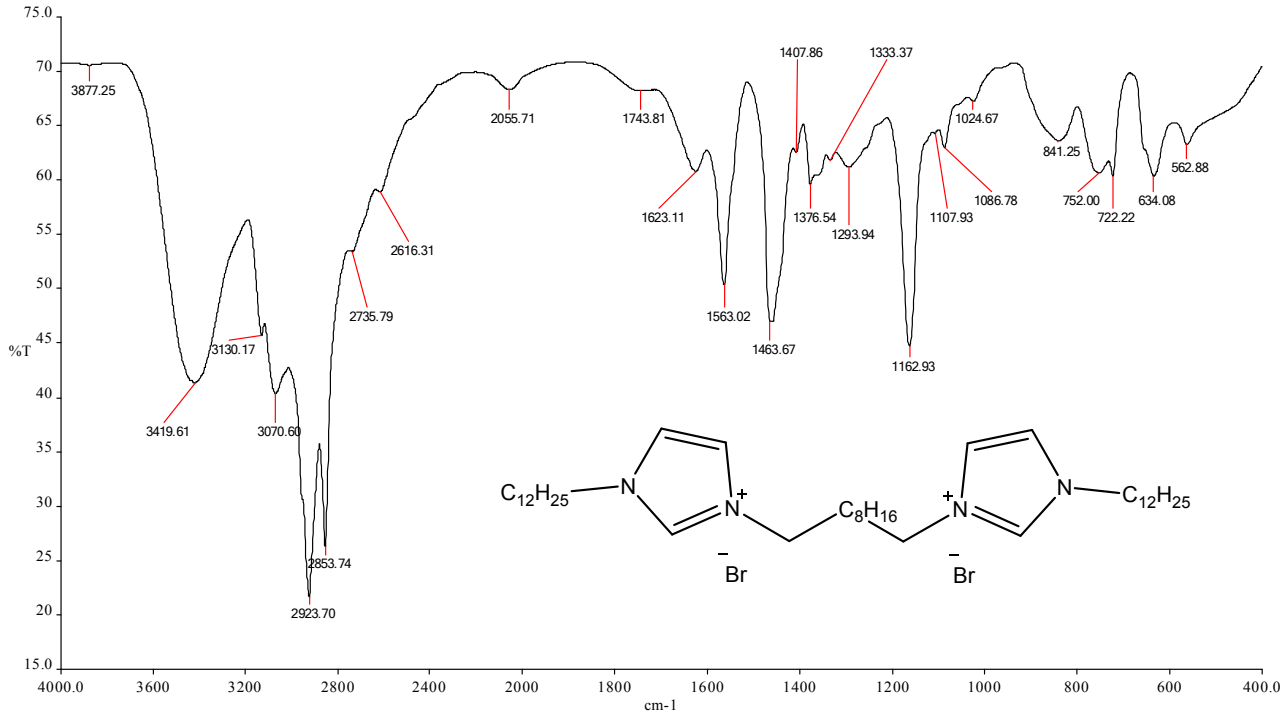


Fig. S 7: FT-IR spectrum of GS10.

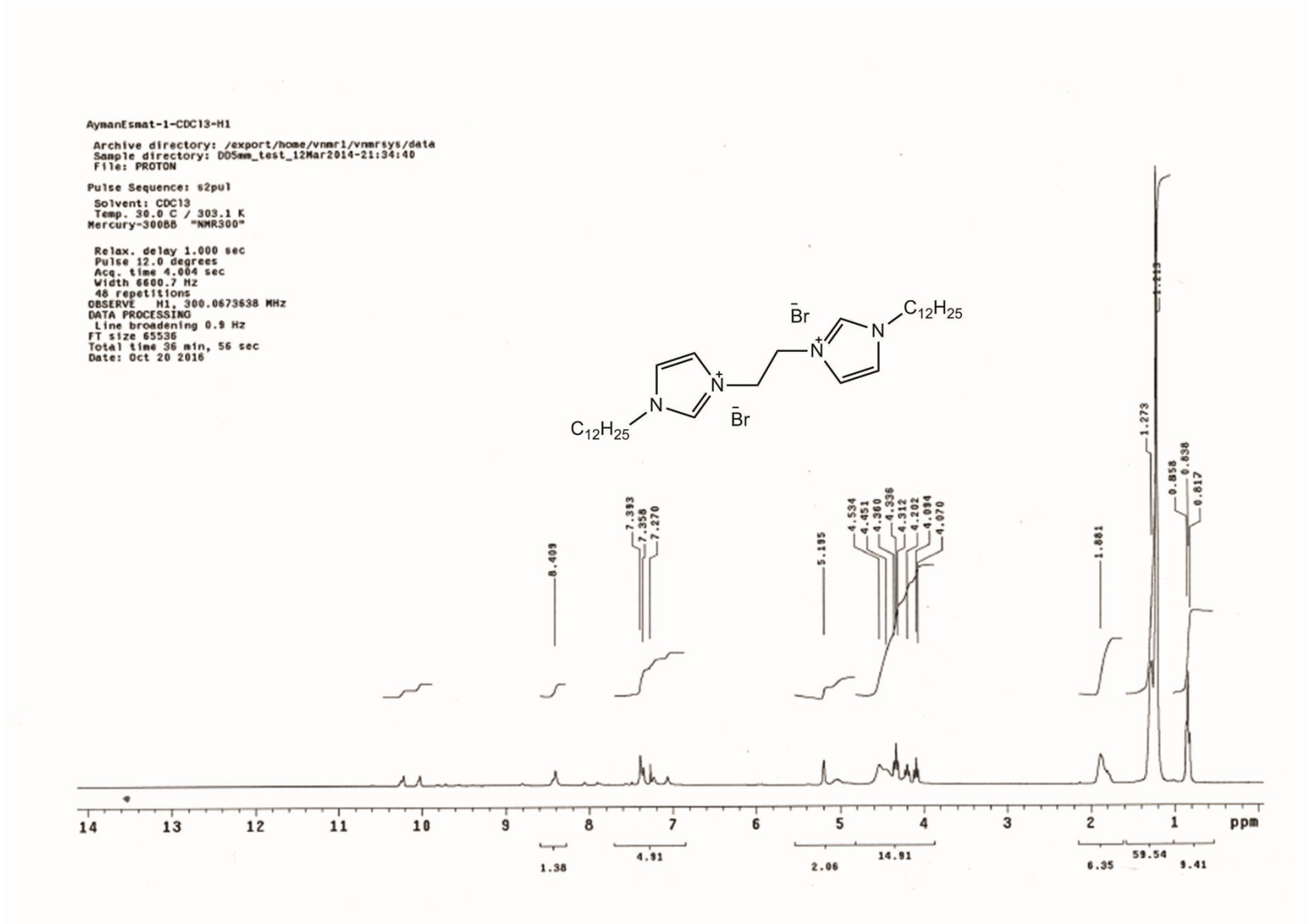


Fig. S 8: H^1-NMR spectrum of GS2.

GS6

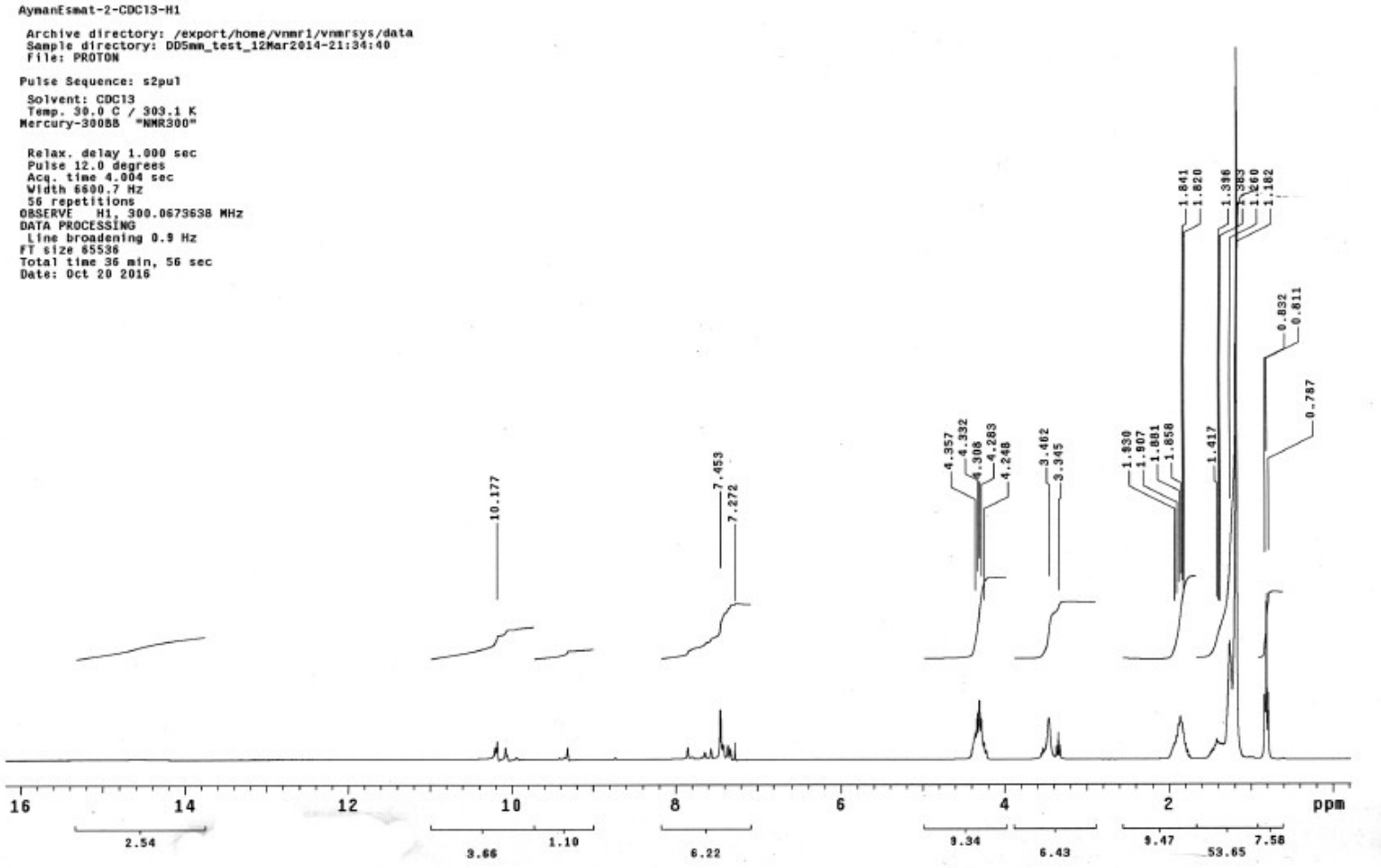


Fig. S 9: H^1-NMR spectrum of GS6.

GS10

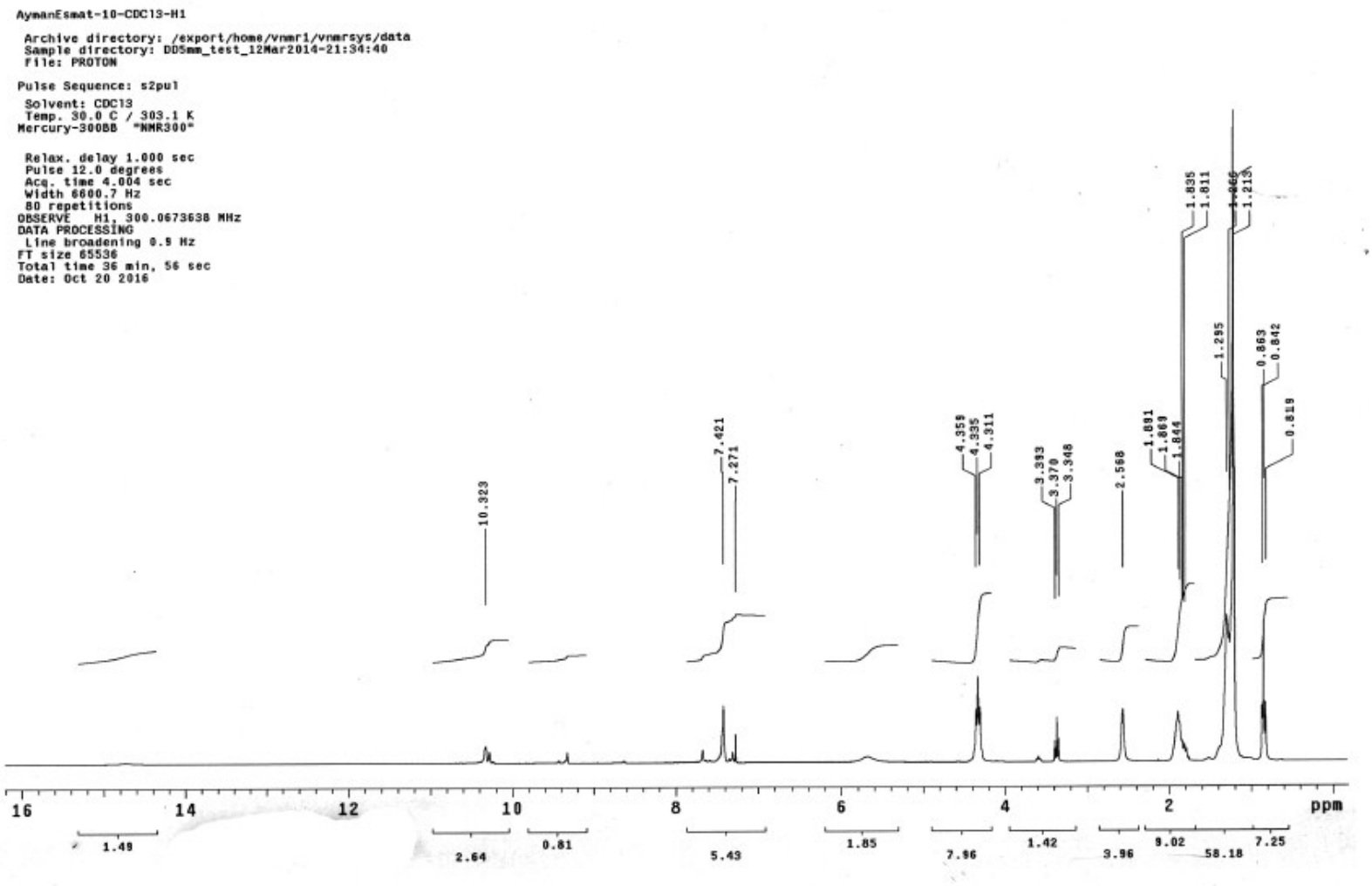


Fig. S 10: H^1-NMR spectrum of GS10.

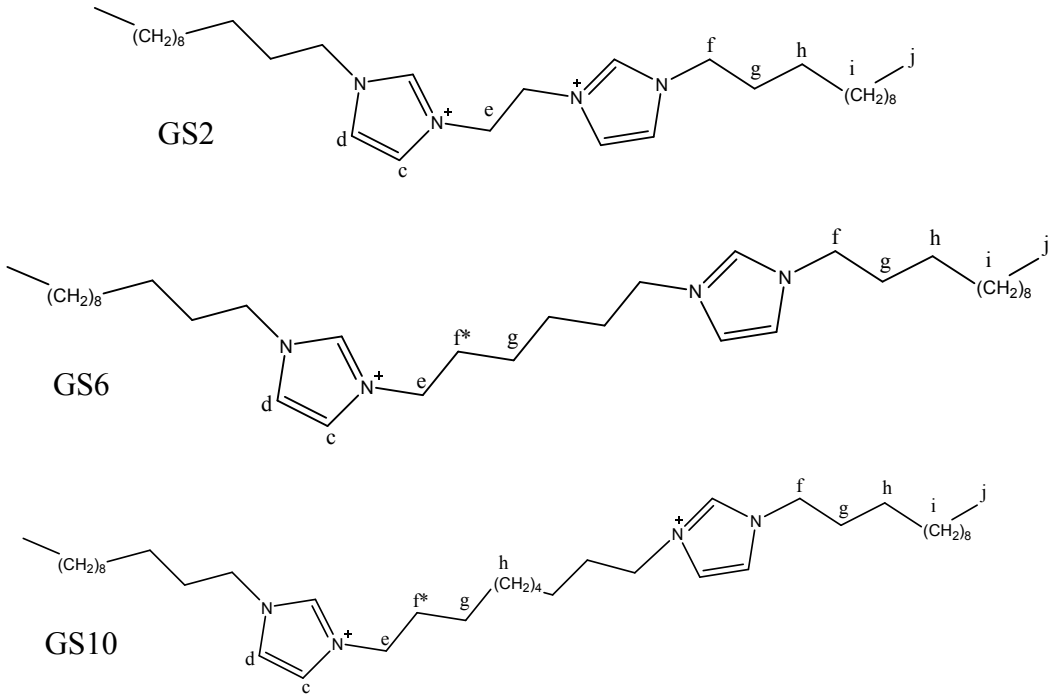
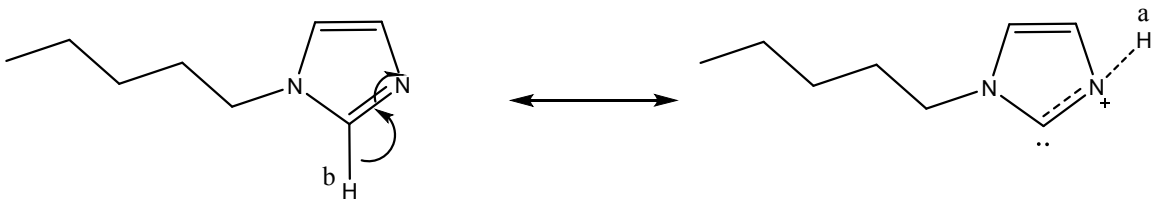
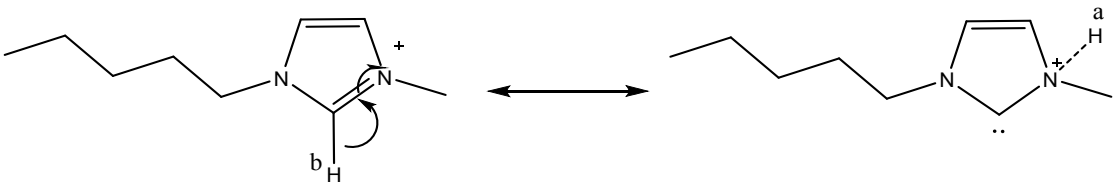


Fig. S 11: Different types of protons in Gemini surfactants.



Scheme S 1: Carbene proton and NH^+ tautomerism for the intermediate compound.



Scheme S 2: Carbene proton and NH^+ tautomerism for the Gemini compounds.

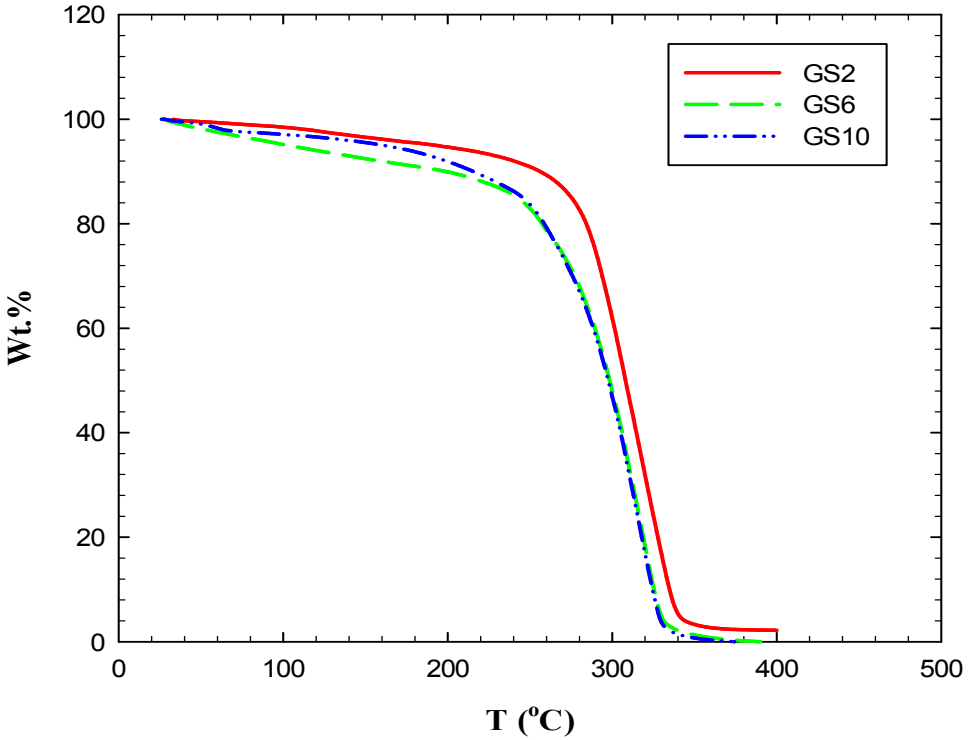


Fig. S 12: TGA curves for the synthesized Gemini surfactants.

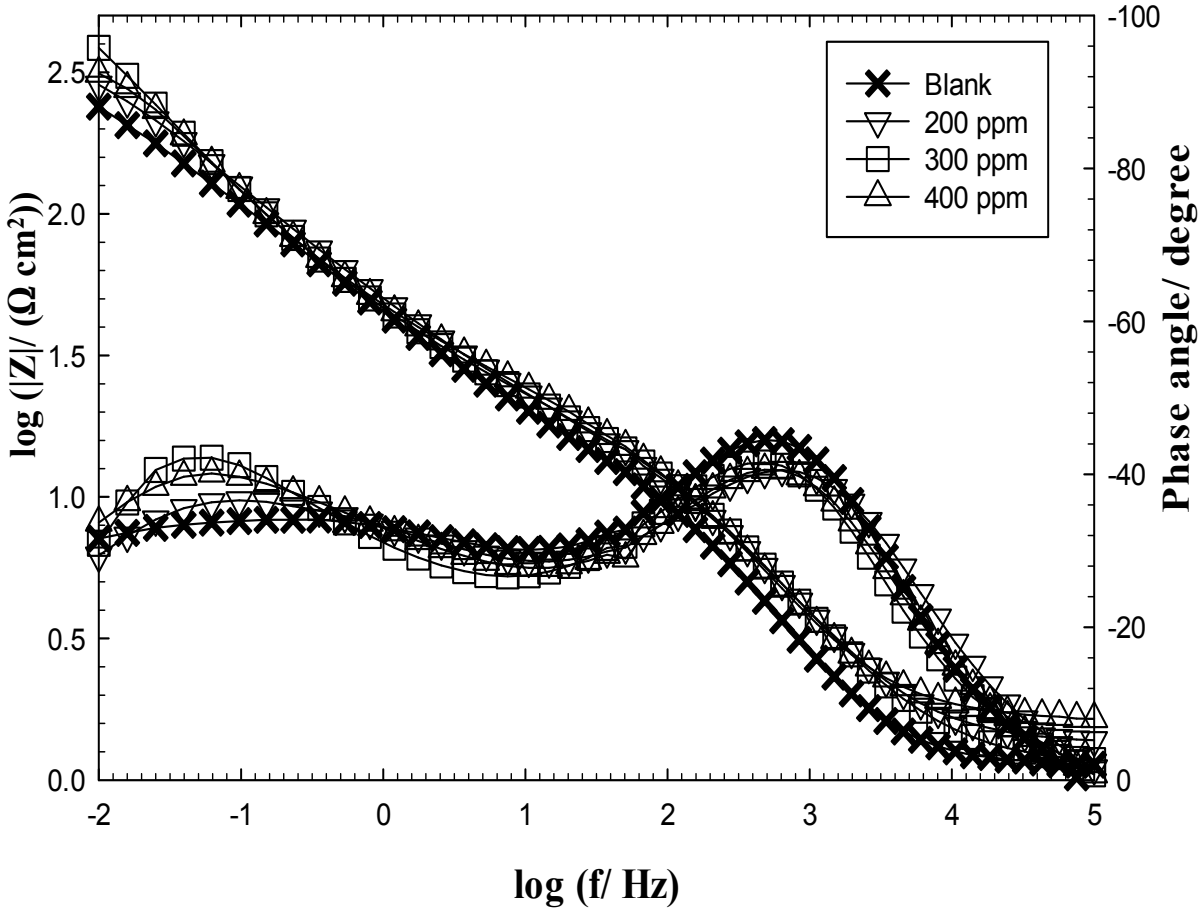


Fig. S 13: Bode plot for carbon steel in formation water as a function of GS6 concentration at 293 K.

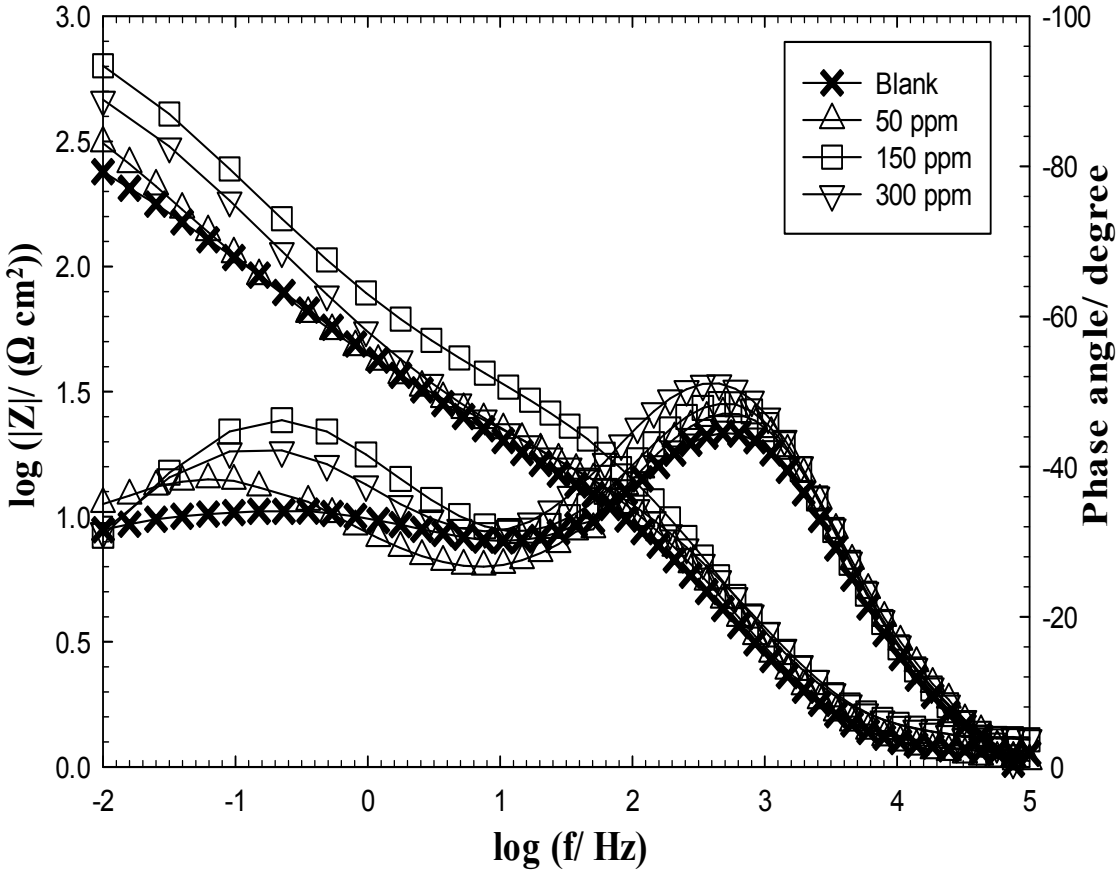


Fig. S 14: Bode plot for carbon steel in formation water as a function of GS10 concentration at 293 K.

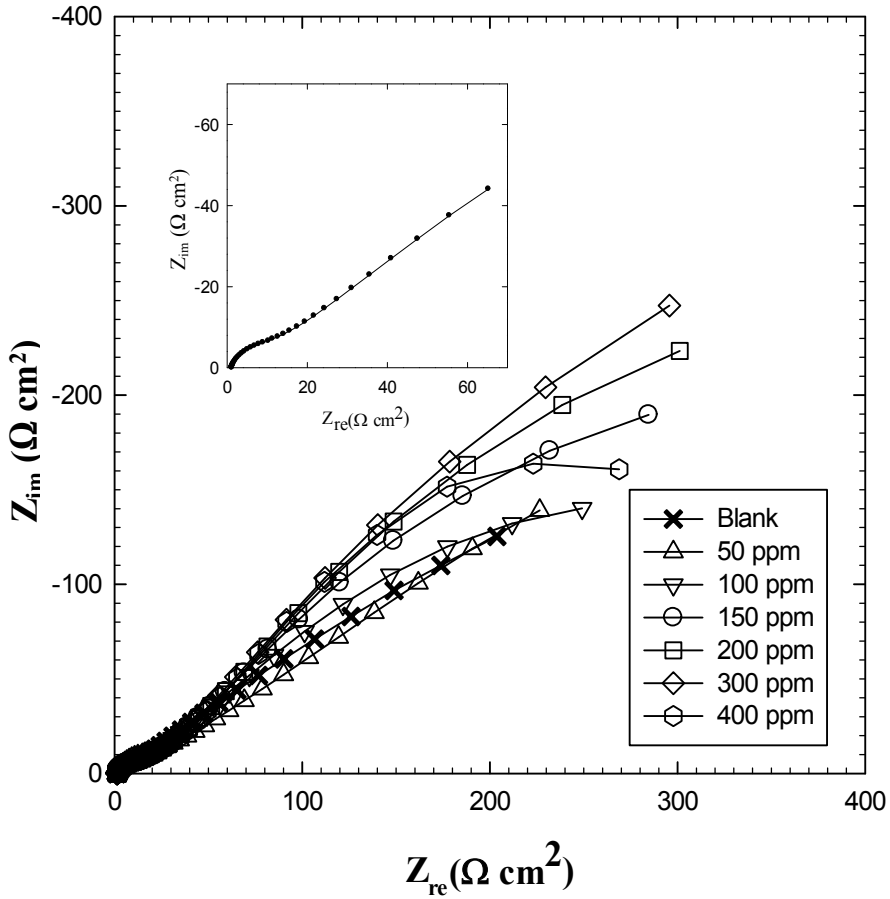


Fig. S 15: Nyquist plot for carbon steel in formation water as a function of GS6 concentration at 293 K. Inset: the Nyquist plot for CS in blank formation water.

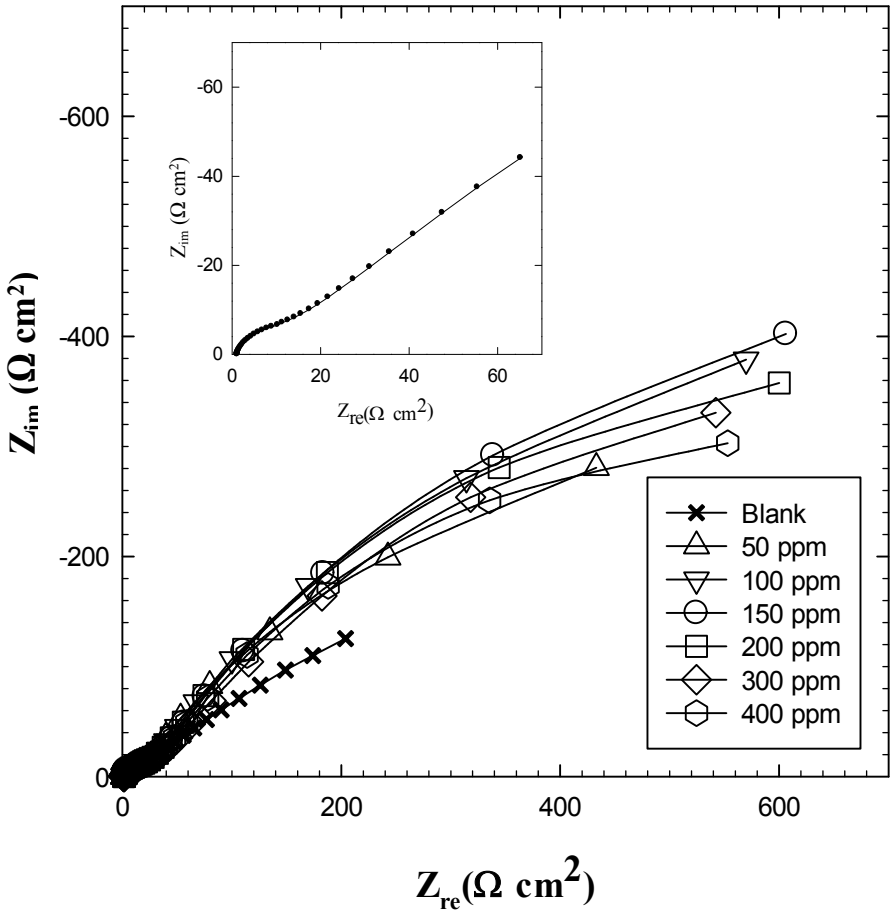


Fig. S 16: Nyquist plot for carbon steel in formation water as a function of GS10 concentration at 293 K. Inset: the Nyquist plot for CS in blank formation water.

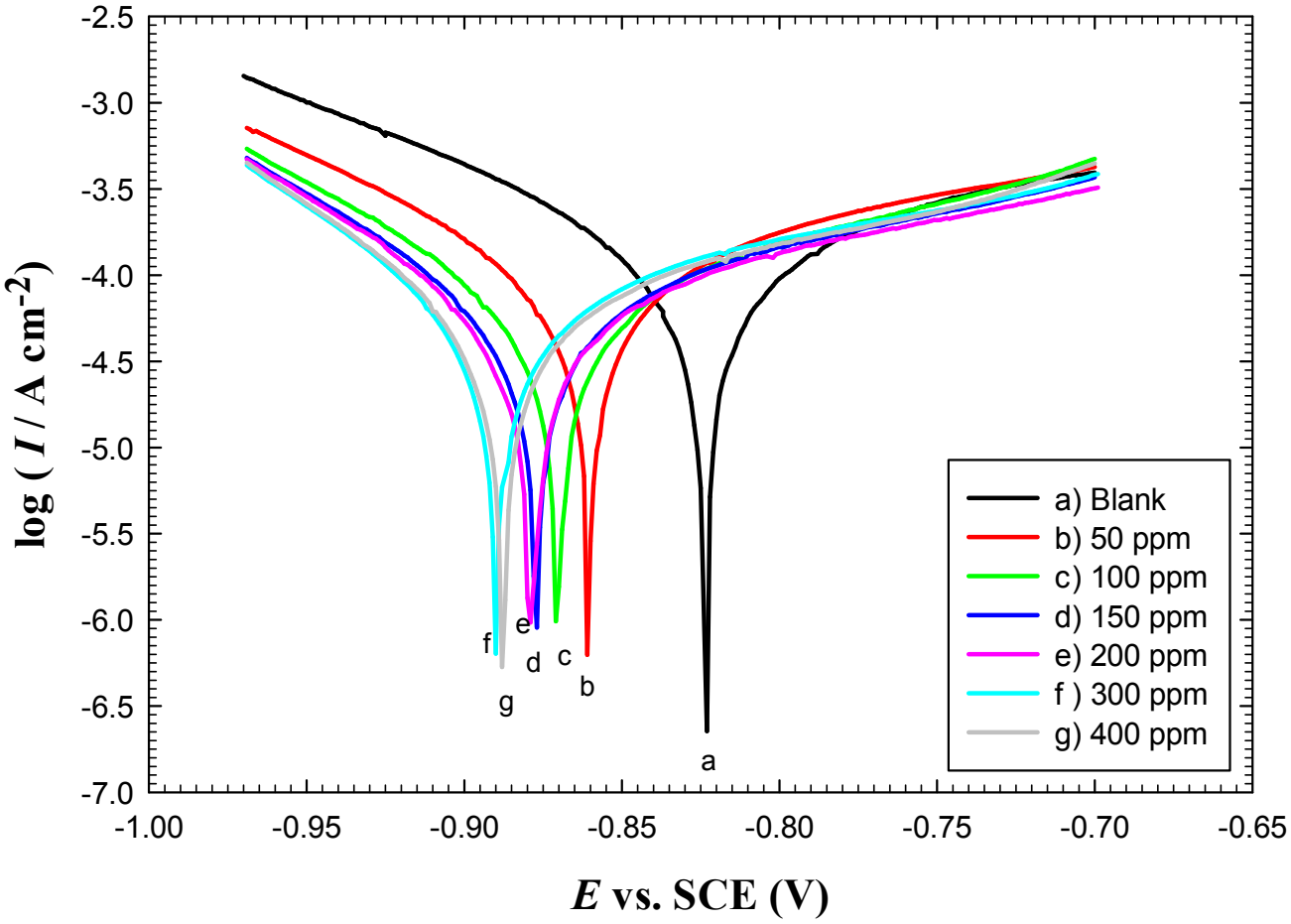


Fig. S 17: Polarization curves for carbon steel in formation water as a function of GS6 concentration at 293 K.

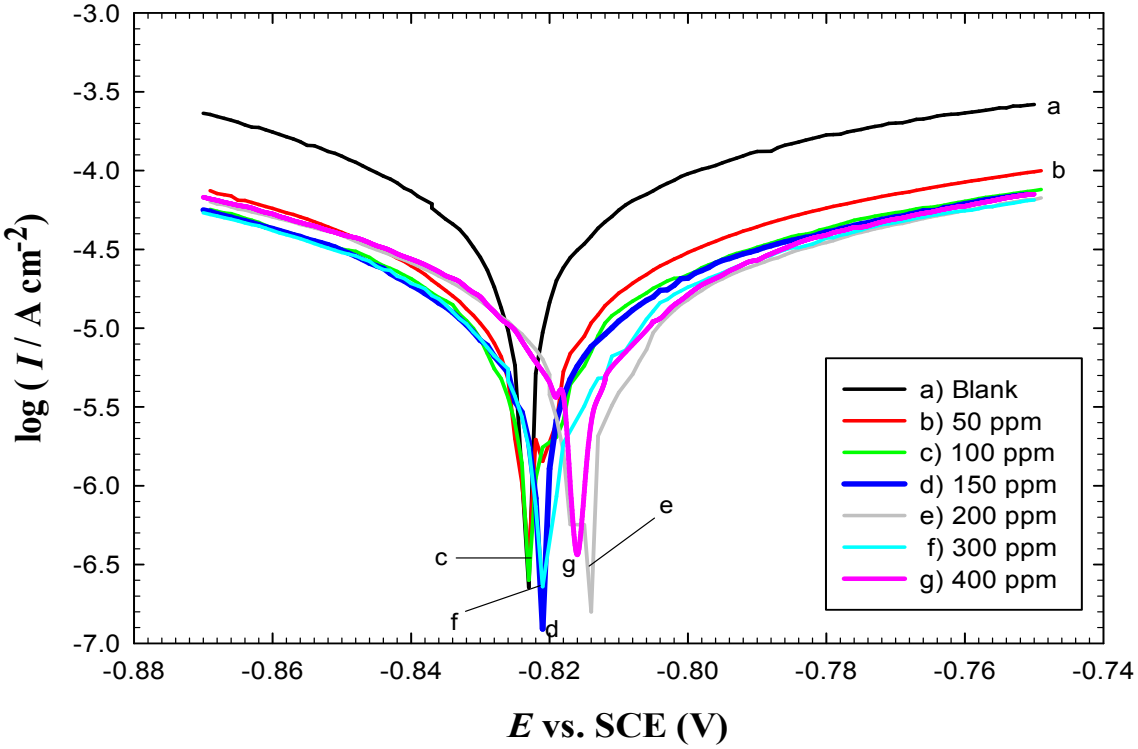


Fig. S 18: Polarization curves for carbon steel in formation water as a function of GS10 concentration at 293 K.

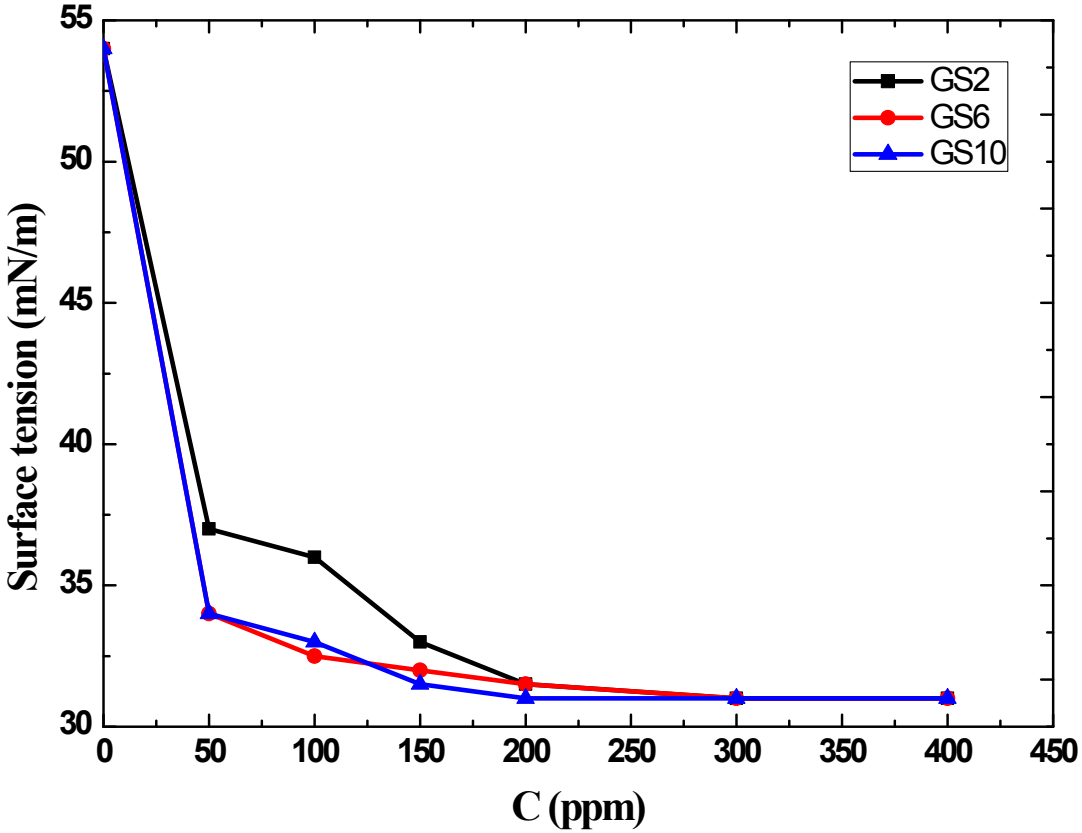


Fig. S 19: Variation of the surface tension with concentrations of GS2, GS6 and GS10.

Table S 1: FT-IR absorption bands (ν/cm^{-1}) for the intermediate, GS2, GS6 and GS10.

Assignment [78]		N-H	Aromatic C - H	Aliphatic C - H	Combination N–H	Aromatic C=C or C=N	C - Br
Absorption bands (cm^{-1})	Intermediate	3407	3099	2923 - 2854	2028	1564	…….
	GS2	3417	3039	2922 - 2852	2042	1563	636
	GS6	3416	3073	2924 - 2854	2062	1625	635
	GS10	3419	3070	2923 - 2853	2055	1623	635

Table S 2: Chemical shifts (δ/ppm) for the intermediate. Notes: spin multiplicity; s = singlet, d = Doublet, t = Triplet, m = Multiplet.

Protons	a	b	c	d	e	f, f*	g	h	i
Signals	10.246 (s)	7.436 (d)	6.969 (d)	6.843 (d)	4.274 (t)	3.864 (m)	1.703 (m)	1.187 (m)	0.812 (t)

Table S 3: Chemical shifts (δ/ppm) for GS2, GS6 and GS10. Notes: spin multiplicity; s = singlet, d = Doublet, t = Triplet, m = Multiplet.

Compound	a	b	c	d	e	f, f*	g	h	i	J
GS2	10.168 (s)	8.409 (s)	7.376 (d)	7.270 (d)	4.534 (t)	4.202 (t)	4.094 (m)	1.881 (m)	1.273 (m)	0.838 (t)
GS6	10.177 (s)	9.375 (s)	7.453 (d)	7.272 (d)	4.308 (t)	4.248 (t) 4.283 (m)	3.462 (m)	1.858 (m)	1.383 (m)	0.811 (t)
GS10	10.323 (s)	9.274 (s)	7.421 (d)	7.271 (d)	4.335 (t)	3.370 (t) 3.393 (m)	2.568 (m)	1.844 (m)	1.235 (m)	0.842 (t)

Table S 4: Elemental analysis of compounds GS2, GS6 and GS10.

Compound	Element							
	C%		H%		N%		Br%	
	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.
GS2	58.18	57.98	9.15	9.24	8.48	8.37	24.19	24.41
GS6	60.33	60.57	9.56	9.47	7.82	7.67	22.30	22.44
GS10	62.16	61.79	9.91	9.99	7.25	7.49	20.68	20.73