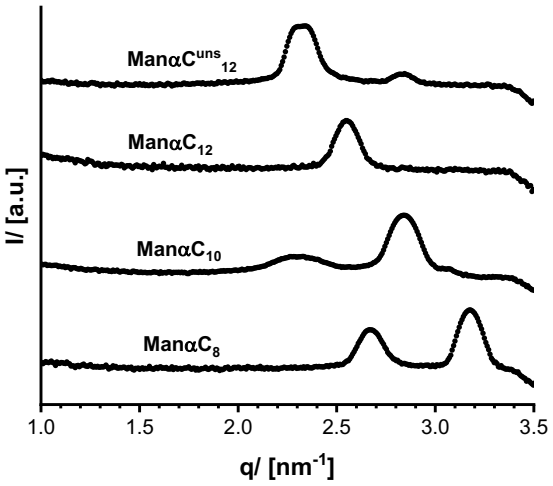
Sweet Surfactants: Packing Parameter-Invariant Amphiphiles as Emulsifiers and Capping Agents for Morphology Control of Inorganic Particles

Michael Voggel, [a] Rebecca M. Meinusch, [a] Vanessa Siewert, [a] Marius Kunkel, [a] Valentin Wittmann [a]* and Sebastian Polarz [a]*

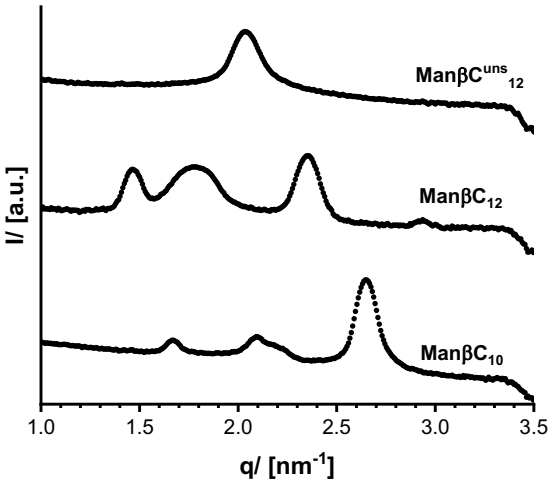
Electronic Supporting Information

Fig. ESI-1.

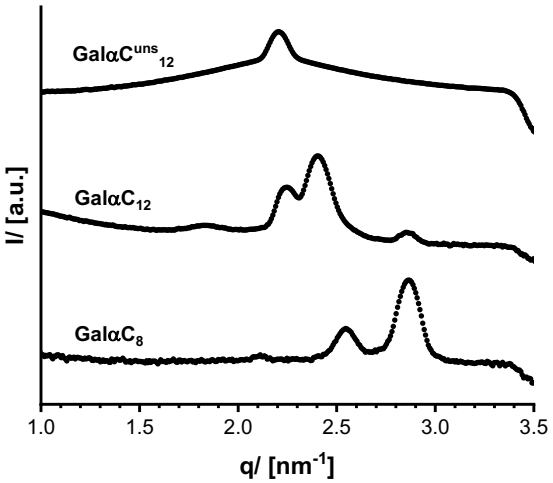
(a) SAXS patterns of ManαC_n surfactants.



(b) SAXS patterns of ManβC_n surfactants.



(c) SAXS patterns of GalαC_n surfactants.



(d) SAXS patterns of GalβC_n surfactants.

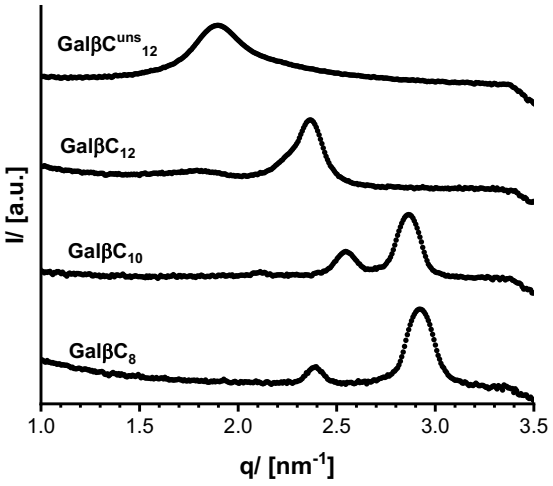
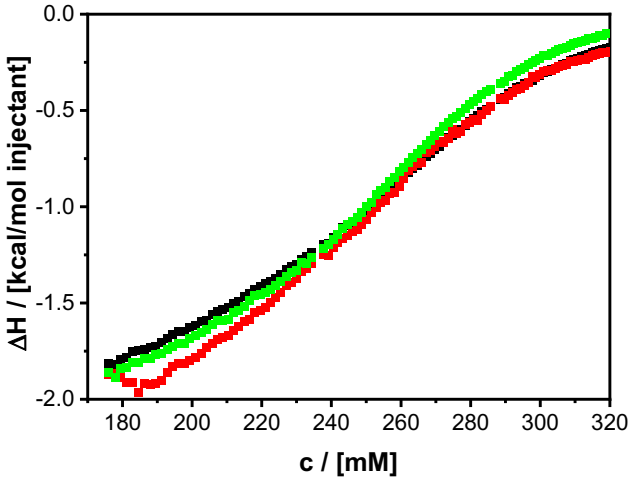


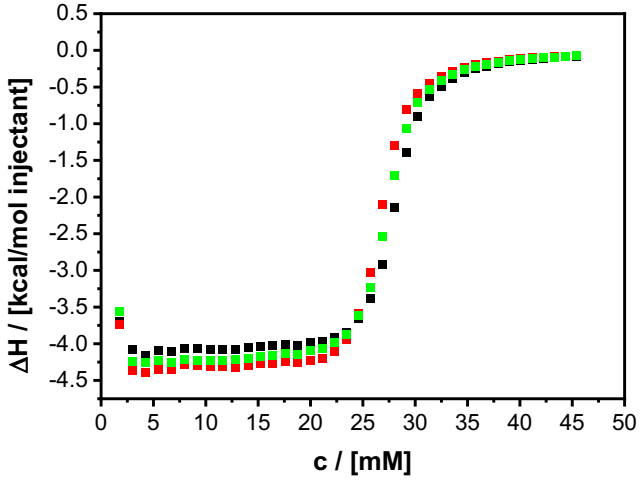
Fig. ESI-2. ITC data.

(a) Integrated ITC data of GalαC_6



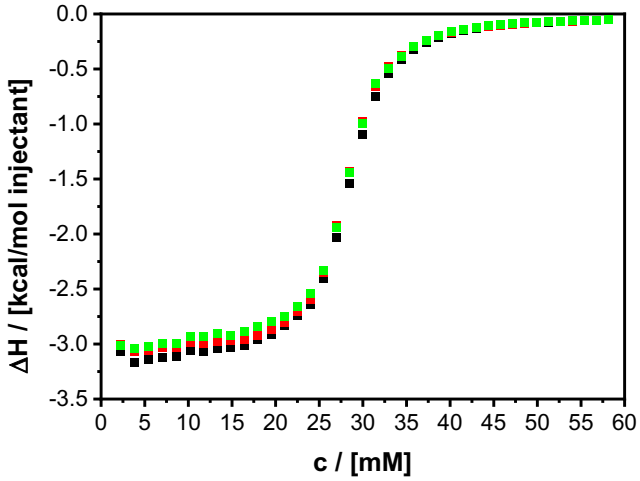
CAC: 256.4 ± 3.0 mM

(b) Integrated ITC data of GalαC_8



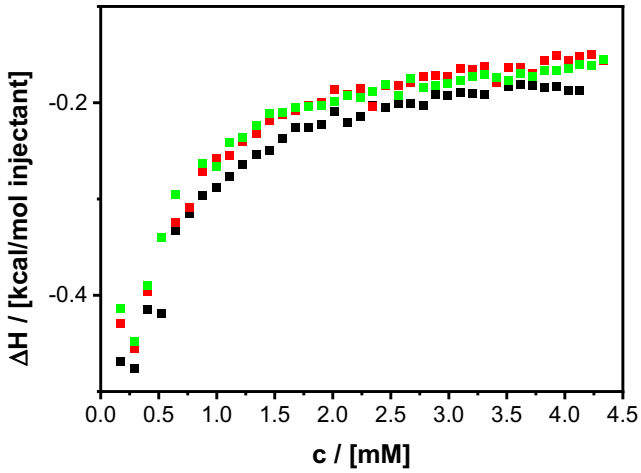
CAC: 27.41 ± 0.54 mM

(c) Integrated ITC data of GalβC_8



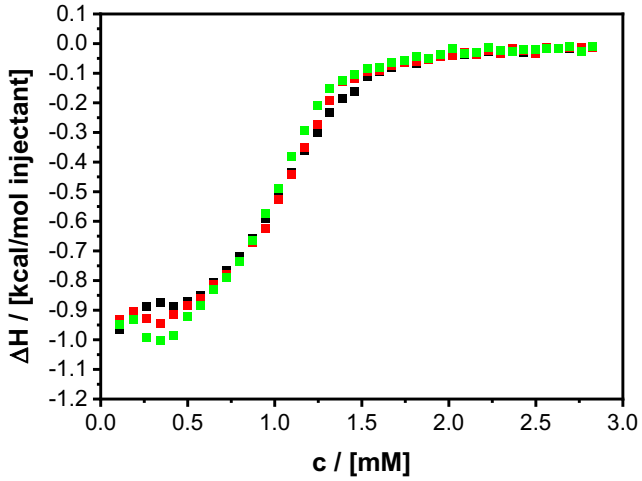
CAC: 28.28 ± 0.09 mM

(d) Integrated ITC data of GalαC_{10}



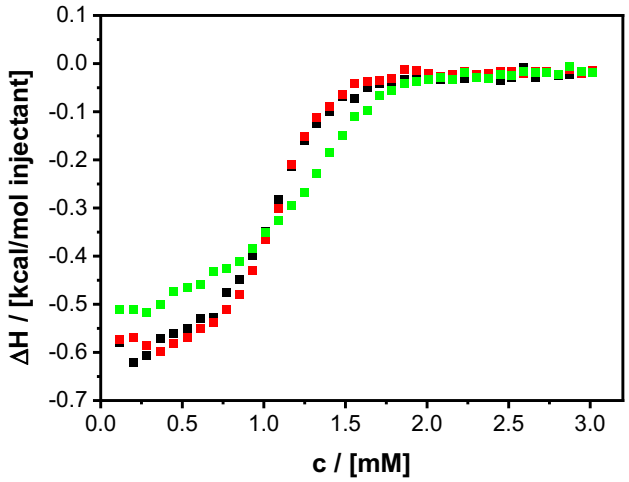
CAC: 0.80 ± 0.06 mM

(e) Integrated ITC data of GalαC^{uns}_{12}



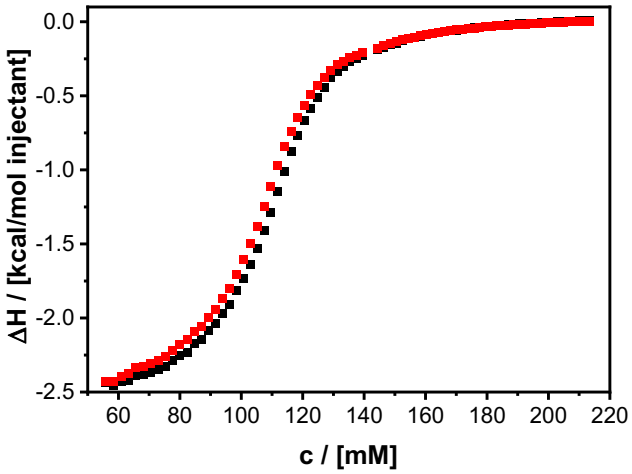
CAC: 1.02 ± 0.04 mM

(f) Integrated ITC data of GalβC^{uns}_{12}



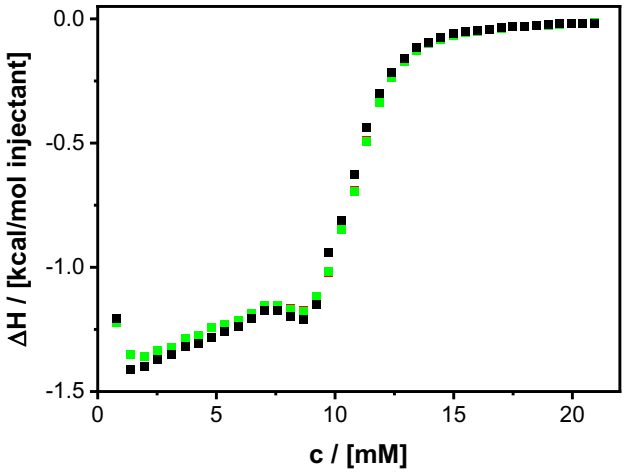
CAC: 1.12 ± 0.08 mM

(g) Integrated ITC data of ManαC_6



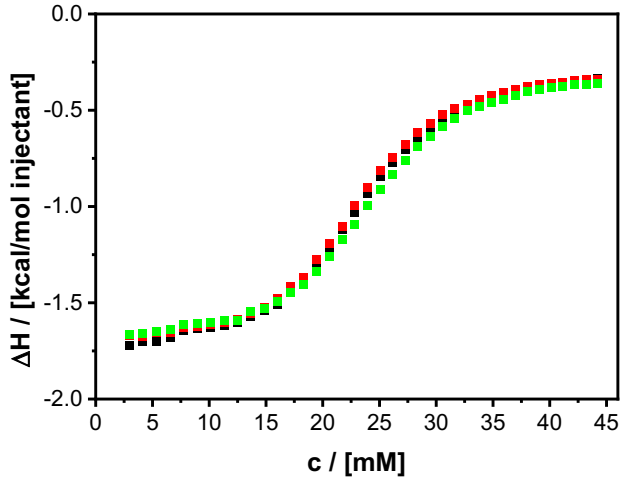
CAC: 109.1 ± 1.3 mM

(h) Integrated ITC data of ManαC_8



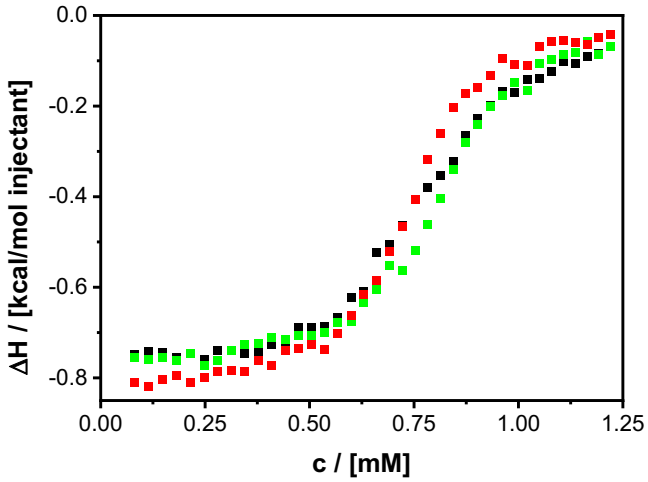
CAC: 10.83 ± 0.10 mM

(i) Integrated ITC data of ManβC_8



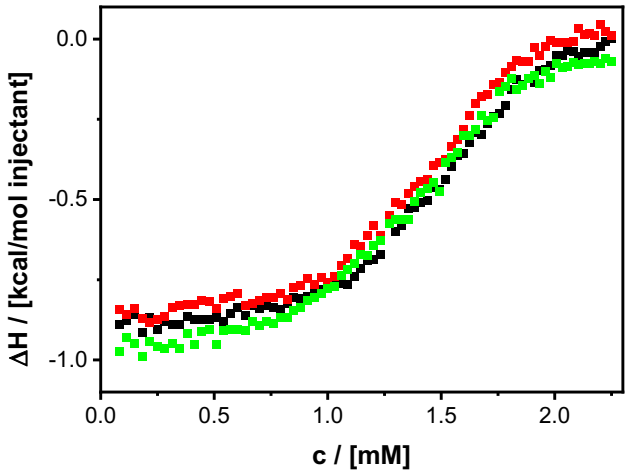
CAC: 23.57 ± 0.52 mM

(j) Integrated ITC data of ManαC_{10}



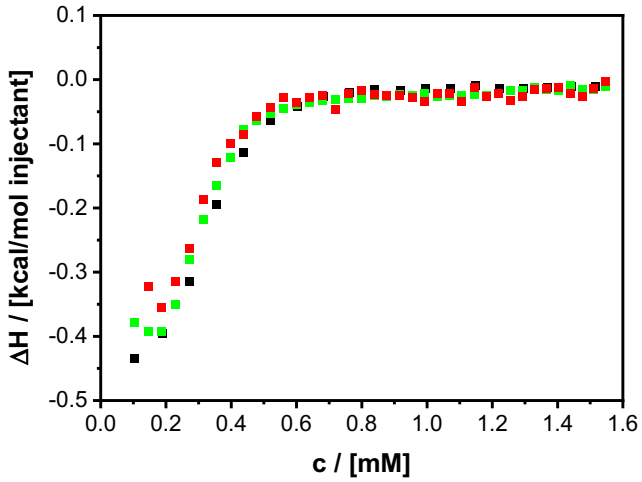
CAC: 0.78 ± 0.03 mM

(k) Integrated ITC data of ManβC_{10}



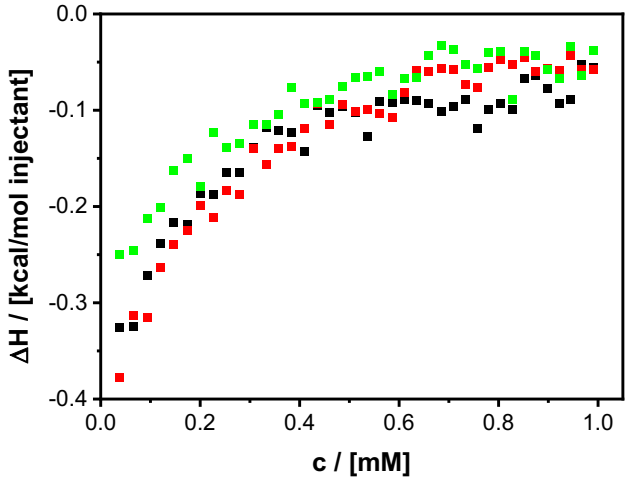
CAC: 1.52 ± 0.04 mM

(l) Integrated ITC data of ManαC^{uns}_{12}



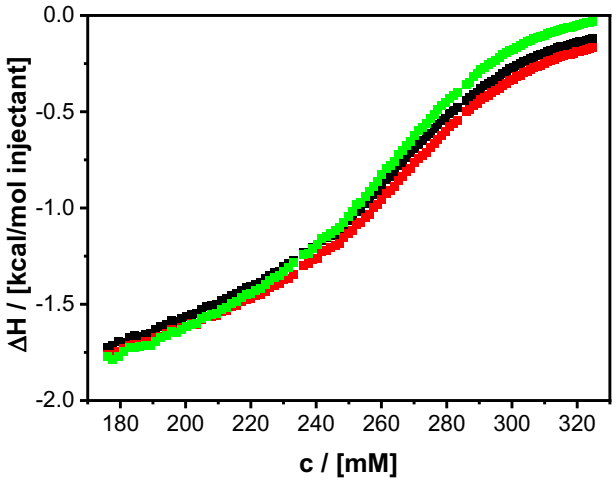
CAC: 0.33 ± 0.01 mM

(m) Integrated ITC data of ManβC^{uns}_{12}



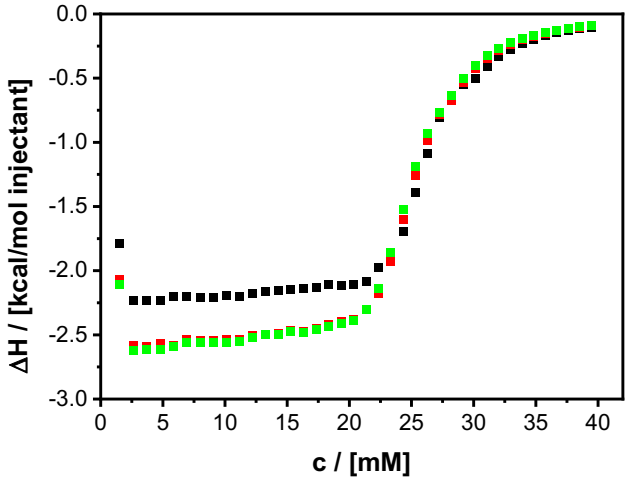
CAC: 0.20 ± 0.02 mM

(n) Integrated ITC data of MalβC_6



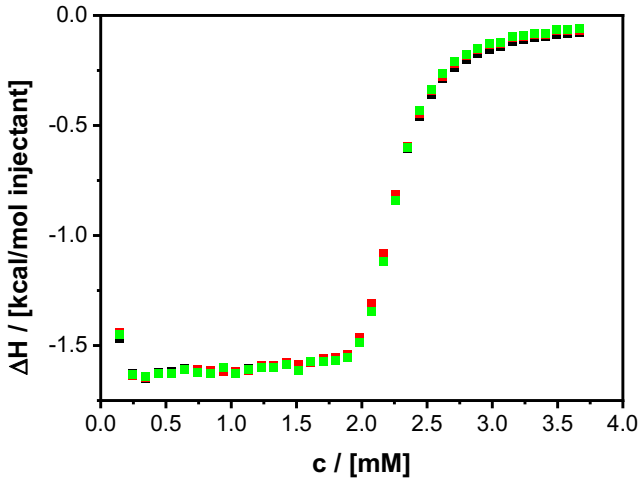
CAC: 264.6 ± 2.0 mM

(o) Integrated ITC data of MalβC$_8$



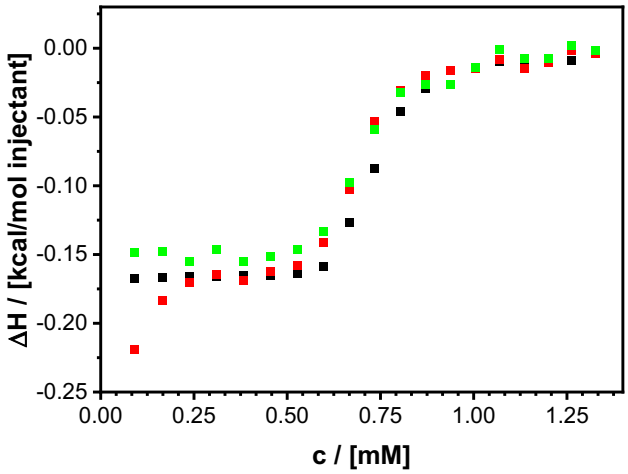
CAC: 25.57 ± 0.46 mM

(p) Integrated ITC data of MalβC$_{10}$



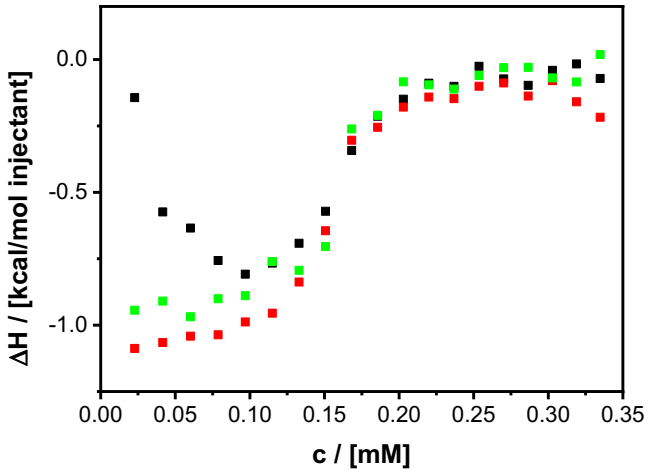
CAC: 2.67 ± 0.01 mM

(q) Integrated ITC data of MalαC_{12}



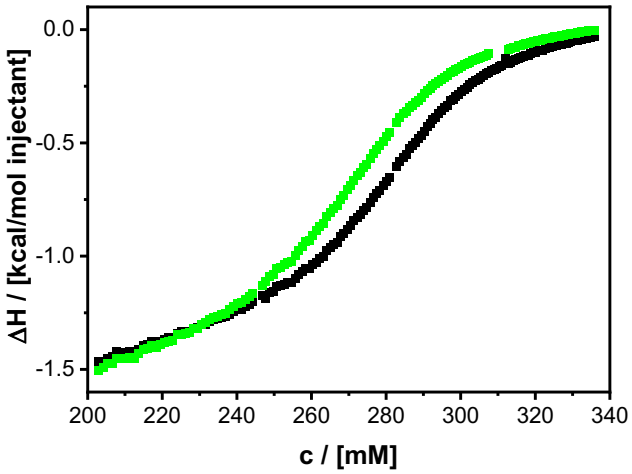
CAC: 0.70 ± 0.02 mM

(r) Integrated ITC data of MalβC_{12}



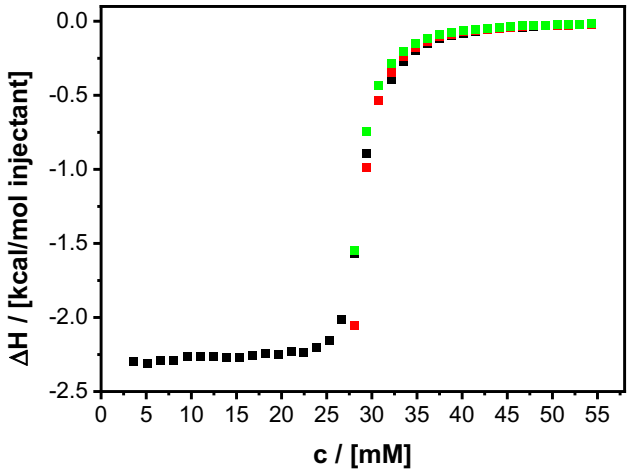
CAC: 0.16 ± 0.01 mM

(s) Integrated ITC data of GlcβC_6



CAC: 272.0 ± 4.9 mM

(t) Integrated ITC data of GlcβC_8



CAC: 28.31 ± 0.52 mM

(u) Thermodynamic data of demicellation determined via ITC

	GalαC_6	**ManαOC_6**	**GlcαC_6**	**MalβC_6**
cmc' [x10^{-4}]	45.93 ± 0.53	19.59 ± 0.22	49.04 ± 0.90	47.40 ± 0.36
ln cmc'	-5.38 ± 0.01	-6.24 ± 0.01	-5.32 ± 0.02	-5.35 ± 0.01
$\Delta G°_{demic}$ [kJ mol^{-1}]	13.12 ± 0.03	15.20 ± 0.03	12.96 ± 0.04	13.04 ± 0.02
$\Delta H°_{demic}$ [kJ mol^{-1}]	-16.87 ± 0.21	-12.21 ± 0.14	-15.70 ± 0.24	-15.96 ± 0.40
$T\Delta S°_{demic}$ [kJ mol^{-1}]	-29.99 ± 0.19	-27.41 ± 0.11	-28.66 ± 0.20	-29.00 ± 0.42
$\Delta S°_{demic}$ [J K^{-1} mol^{-1}]	-102.31 ± 0.65	-93.51 ± 0.38	-97.76 ± 0.68	-98.94 ± 1.42

	GalαC_8	**GalβC_8**	**ManαC_8**	**ManβC_8**	**GlcβC_8**	**MalβC_8**
cmc' [x10^{-4}]	4.93 ± 0.10	5.09 ± 0.02	1.95 ± 0.02	4.24 ± 0.09	5.03 ± 0.04	4.54 ± 0.02
ln cmc'	-7.61 ± 0.02	-7.58 ± 0.01	-8.54 ± 0.01	-7.77 ± 0.02	-7.59 ± 0.01	-7.70 ± 0.01
$\Delta G°_{demic}$ [kJ mol^{-1}]	18.56 ± 0.05	18.48 ± 0.01	20.82 ± 0.02	18.93 ± 0.05	18.51 ± 0.02	18.76 ± 0.01
$\Delta H°_{demic}$ [kJ mol^{-1}]	-18.76 ± 0.41	-13.32 ± 0.23	-5.72 ± 0.07	-6.23 ± 0.09	-16.95 ± 0.16	-11.24 ± 0.05
$T\Delta S°_{demic}$ [kJ mol^{-1}]	-37.32 ± 0.46	-31.81 ± 0.23	-26.54 ± 0.09	-25.15 ± 0.13	-35.46 ± 0.14	-30.00 ± 0.06
$\Delta S°_{demic}$ [J K^{-1} mol^{-1}]	-127.30 ± 1.55	-108.50 ± 0.77	-90.53 ± 0.30	-85.81 ± 0.44	-120.98 ± 0.46	-102.35 ± 0.22

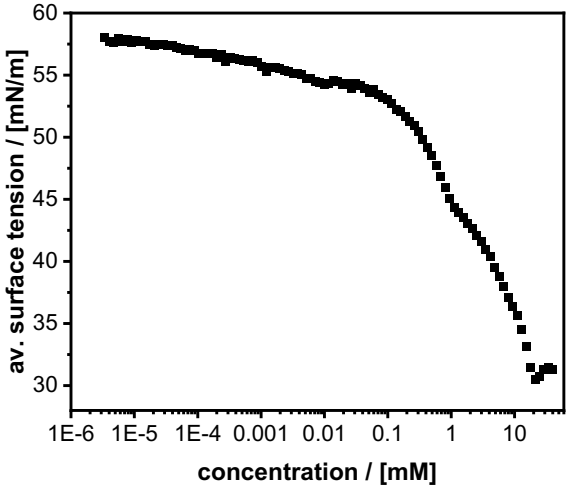
	ManαC_{10}	**ManβC_{10}**	**GalαC_{10}**	**MalβC_{10}**
cmc' [x10^{-4}]	0.14 ± 0.01	0.27 ± 0.01	0.14 ± 0.01	0.41 ± 0.01
ln cmc'	-11.17 ± 0.04	-10.51 ± 0.03	-11.16 ± 0.08	-10.11 ± 0.01
$\Delta G°_{demic}$ [kJ mol^{-1}]	27.24 ± 0.10	25.61 ± 0.07	27.19 ± 0.19	24.63 ± 0.01
$\Delta H°_{demic}$ [kJ mol^{-1}]	-3.45 ± 0.07	-5.51 ± 0.12	-1.38 ± 0.07	-7.05 ± 0.04
$T\Delta S°_{demic}$ [kJ mol^{-1}]	-30.69 ± 0.16	-31.12 ± 0.11	-28.57 ± 0.25	-31.69 ± 0.04
$\Delta S°_{demic}$ [J K^{-1} mol^{-1}]	-104.67 ± 0.54	-106.17 ± 0.37	-97.46 ± 0.87	-108.09 ± 0.14

	MalαC_{12}	**MalβC_{12}**
cmc' [x10^{-4}]	0.13 ± 0.01	0.03 ± 0.01
ln cmc'	-11.28 ± 0.04	-12.79 ± 0.03
$\Delta G°_{demic}$ [kJ mol^{-1}]	27.49 ± 0.09	31.17 ± 0.08
$\Delta H°_{demic}$ [kJ mol^{-1}]	-1.11 ± 0.06	-4.00 ± 0.14
$T\Delta S°_{demic}$ [kJ mol^{-1}]	-28.60 ± 0.12	-35.17 ± 0.22
$\Delta S°_{demic}$ [J K^{-1} mol^{-1}]	-97.56 ± 0.42	-119.97 ± 0.75

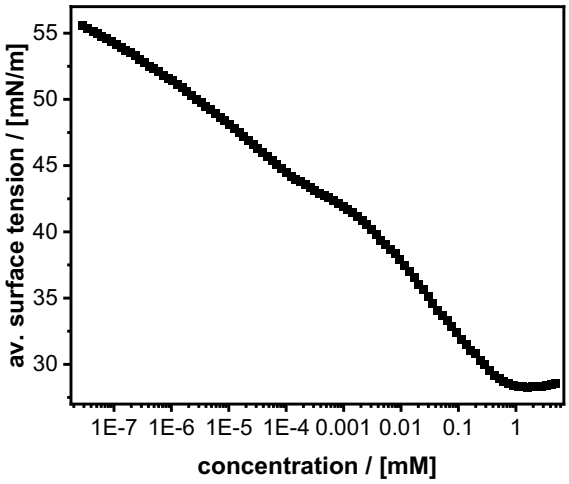
	GalαC^{uns}_{12}	**GalβC^{uns}_{12}**	**ManαC^{uns}_{12}**	**ManβC^{uns}_{12}**
cmc' [x10^{-4}]	0.18 ± 0.01	0.20 ± 0.02	0.06 ± 0.01	0.04 ± 0.01
ln cmc'	-10.91 ± 0.04	-10.81 ± 0.07	-12.04 ± 0.02	-12.54 ± 0.11
$\Delta G°_{demic}$ [kJ mol^{-1}]	26.58 ± 0.10	26.35 ± 0.18	29.36 ± 0.07	30.57 ± 0.27
$\Delta H°_{demic}$ [kJ mol^{-1}]	-4.09 ± 0.10	-2.40 ± 0.14	-1.54 ± 0.12	-1.37 ± 0.27
$T\Delta S°_{demic}$ [kJ mol^{-1}]	-30.67 ± 0.19	-28.75 ± 0.31	-30.90 ± 0.06	-31.93 ± 0.38
$\Delta S°_{demic}$ [J K^{-1} mol^{-1}]	-104.63 ± 0.64	-98.08 ± 1.07	-105.41 ± 0.21	-108.93 ± 1.29

Fig. ESI-3. Tensiometry data.

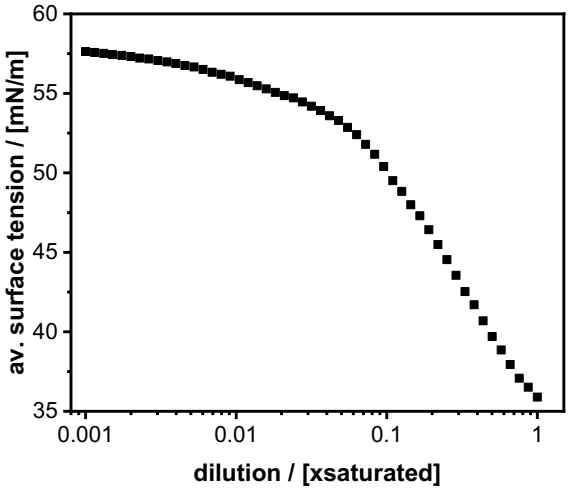
(a) Concentration dependent surface tension of an aqueous solution of GalβC_8



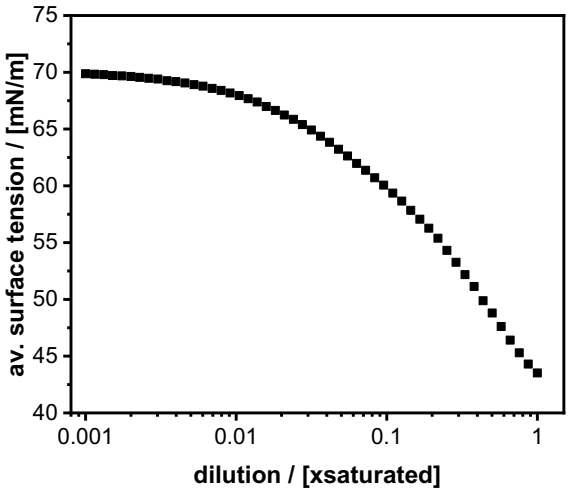
(b) Concentration dependent surface tension of an aqueous solution of GalβC^{uns}_{12}



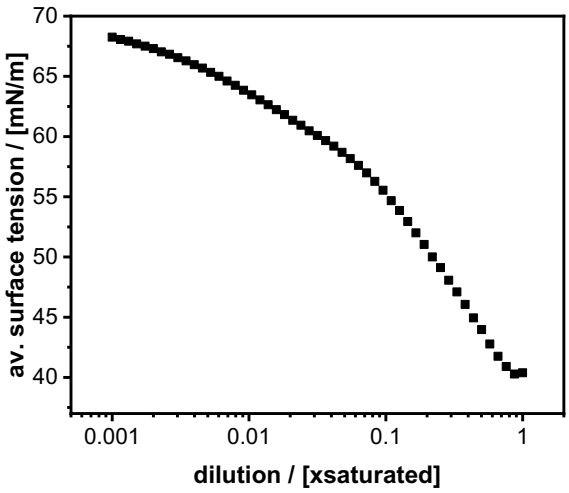
(c) Concentration dependent surface tension of a saturated aqueous solution of GalαC_{12}



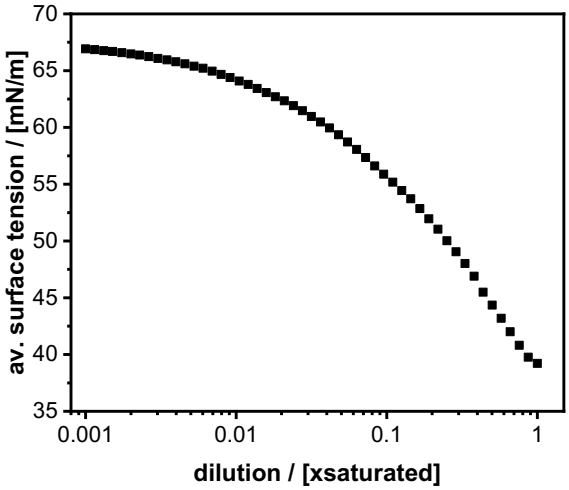
(d) Concentration dependent surface tension of a saturated aqueous solution of GalβC_{12}



(e) Concentration dependent surface tension of a saturated aqueous solution of ManαC_{12}



(f) Concentration dependent surface tension of a saturated aqueous solution of GlcβC_{12}



(g) Concentration dependent surface tension of a saturated aqueous solution of XylβC_{12}

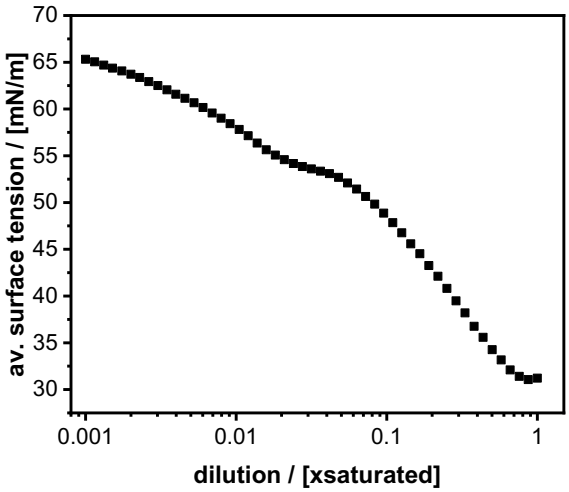


Fig. ESI-4. HLB values.

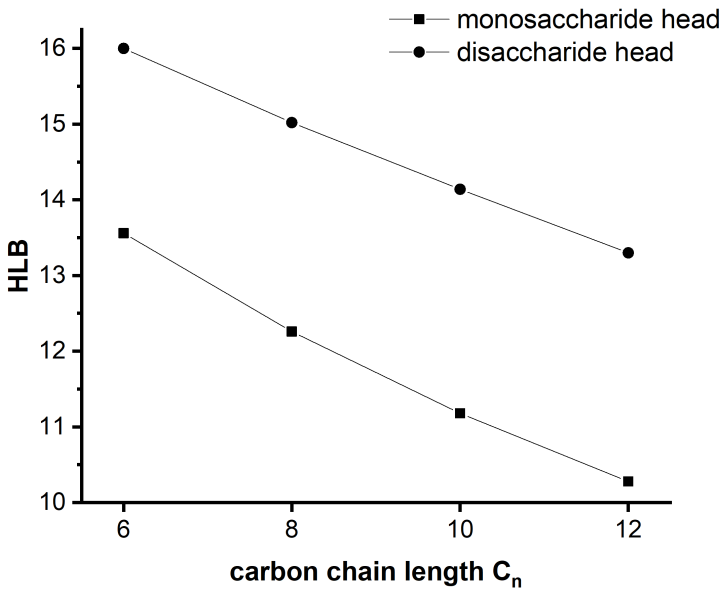
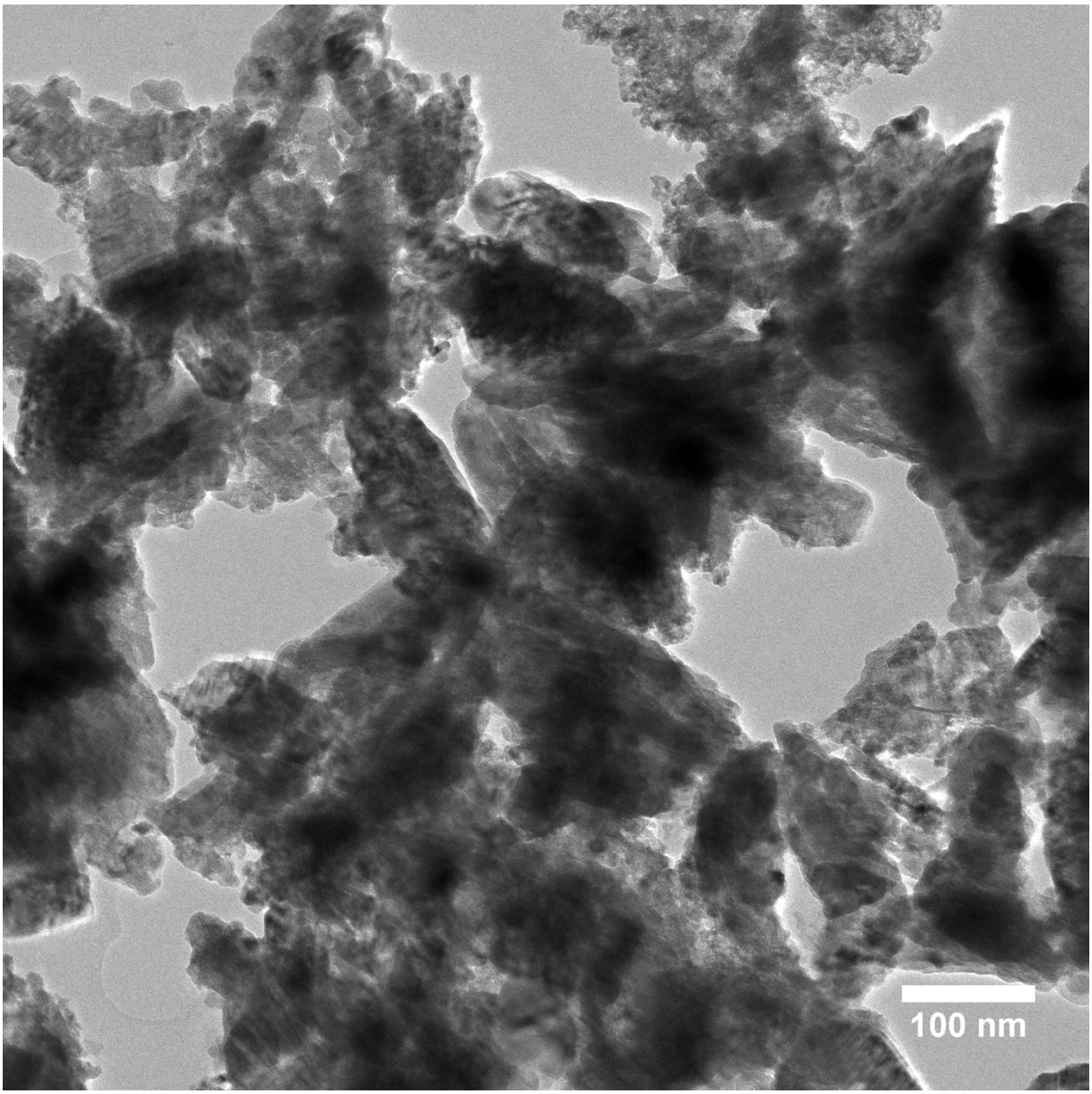
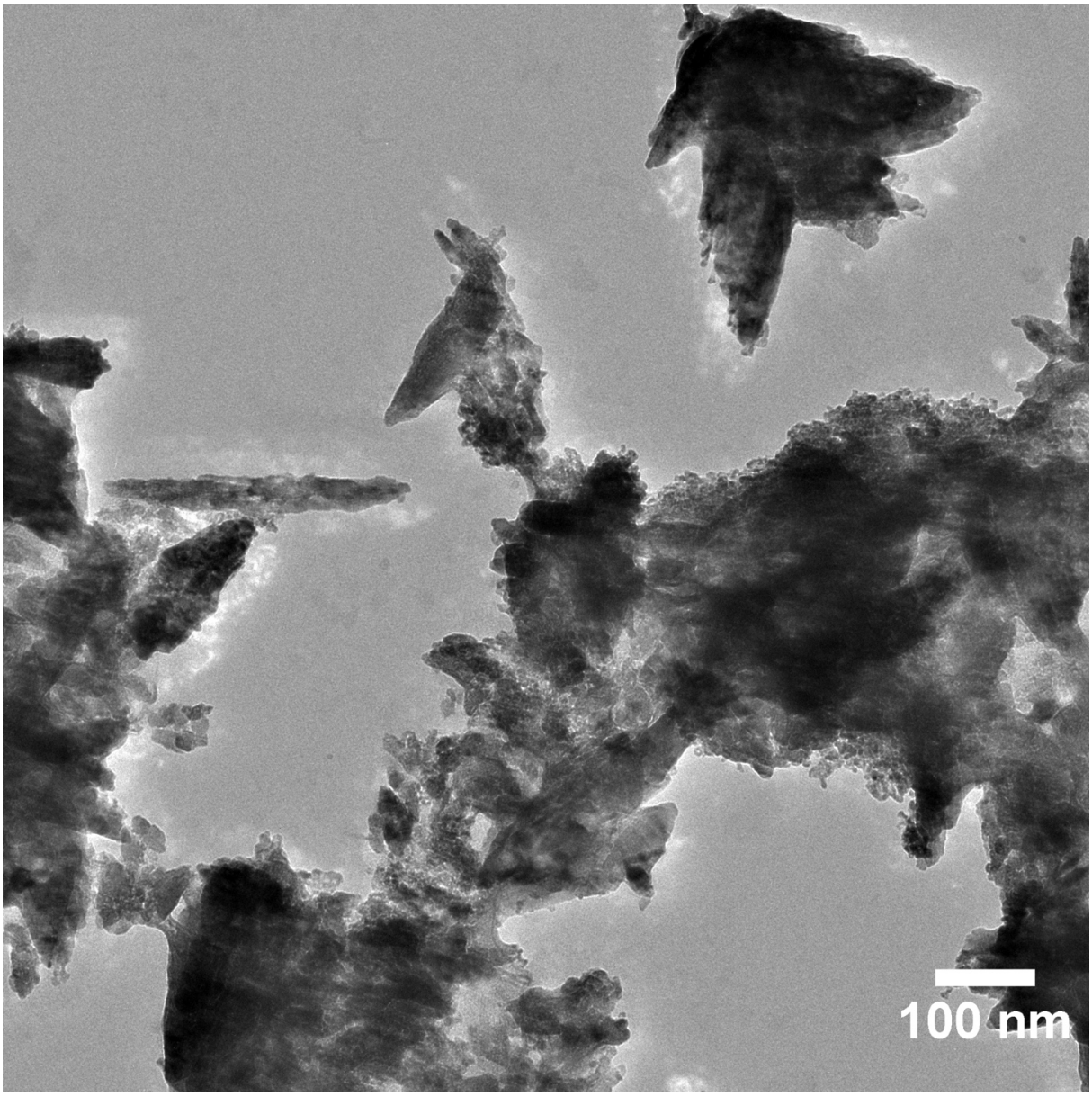
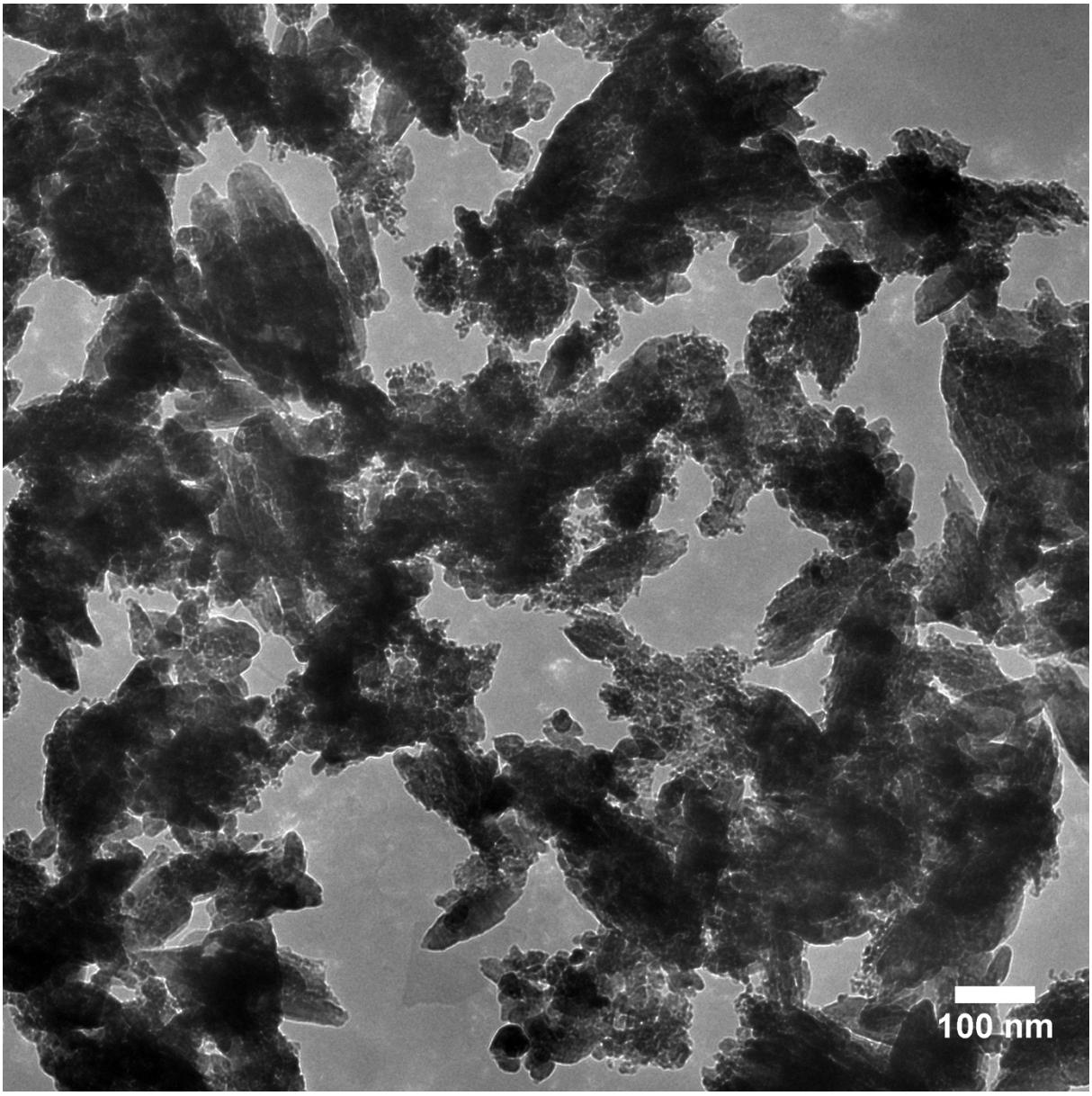


Fig. ESI-5. TEM micrographs.

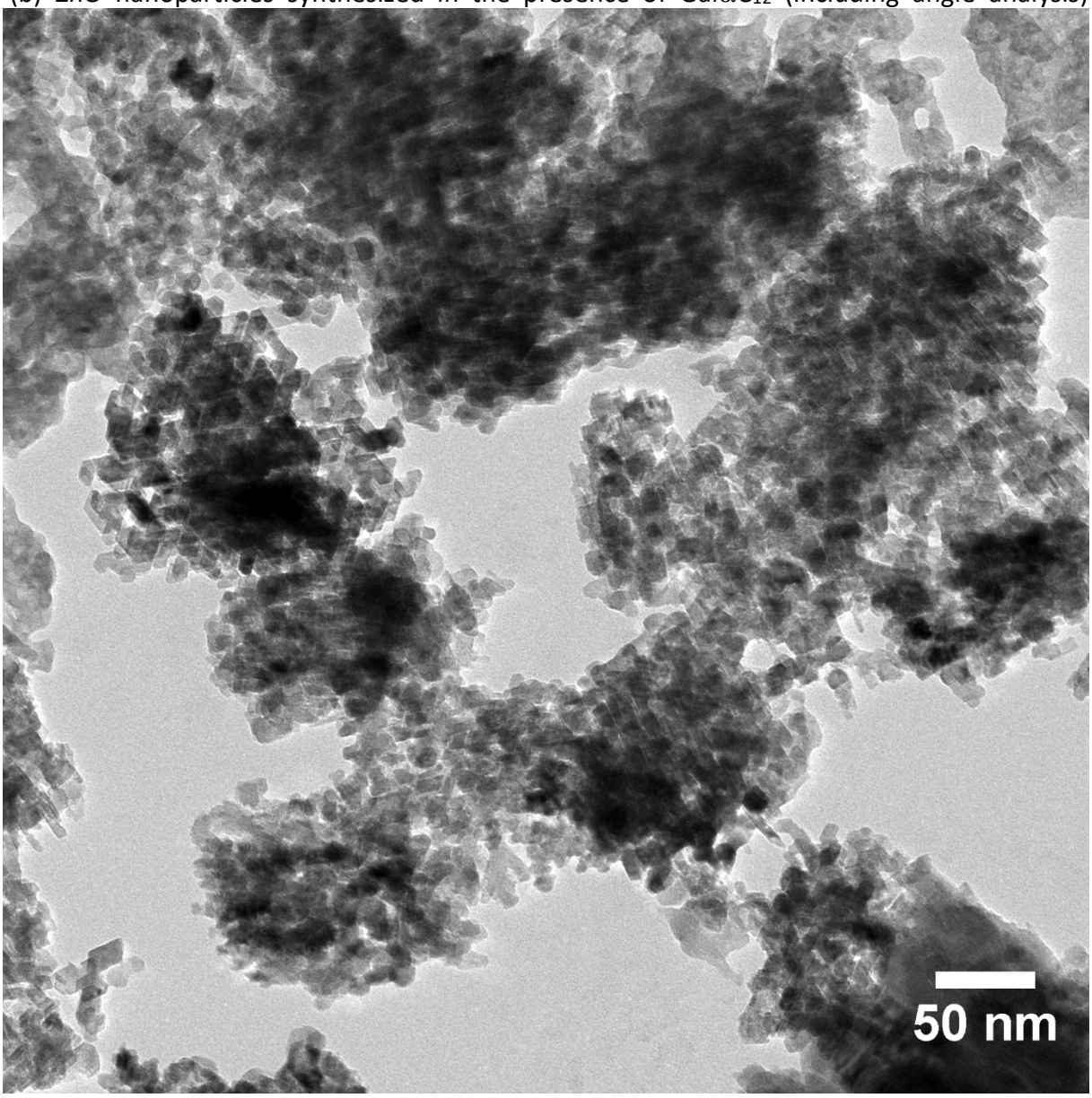
(a) ZnO nanoparticles synthesized in the presence of MalβC$_{12}$

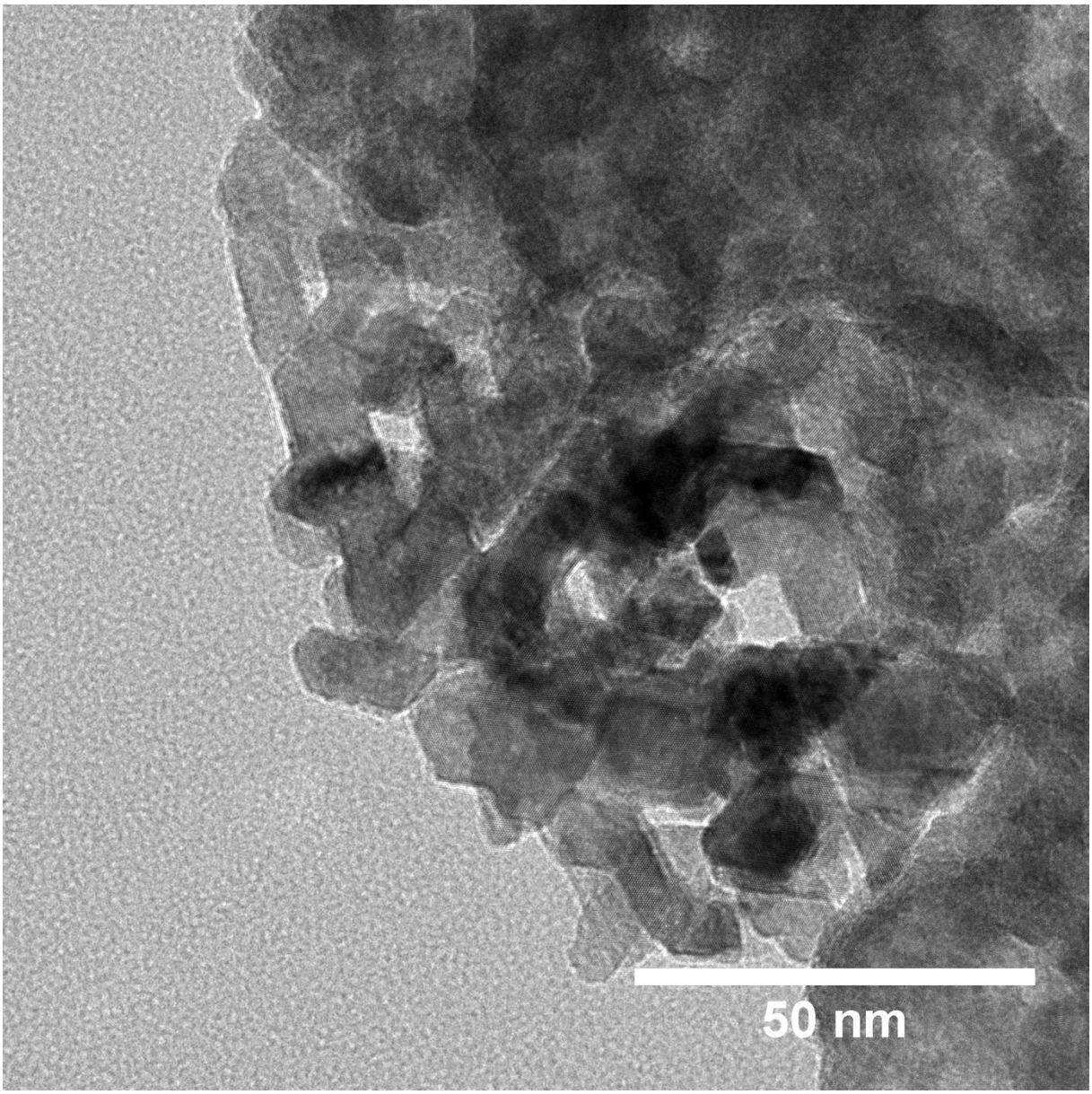


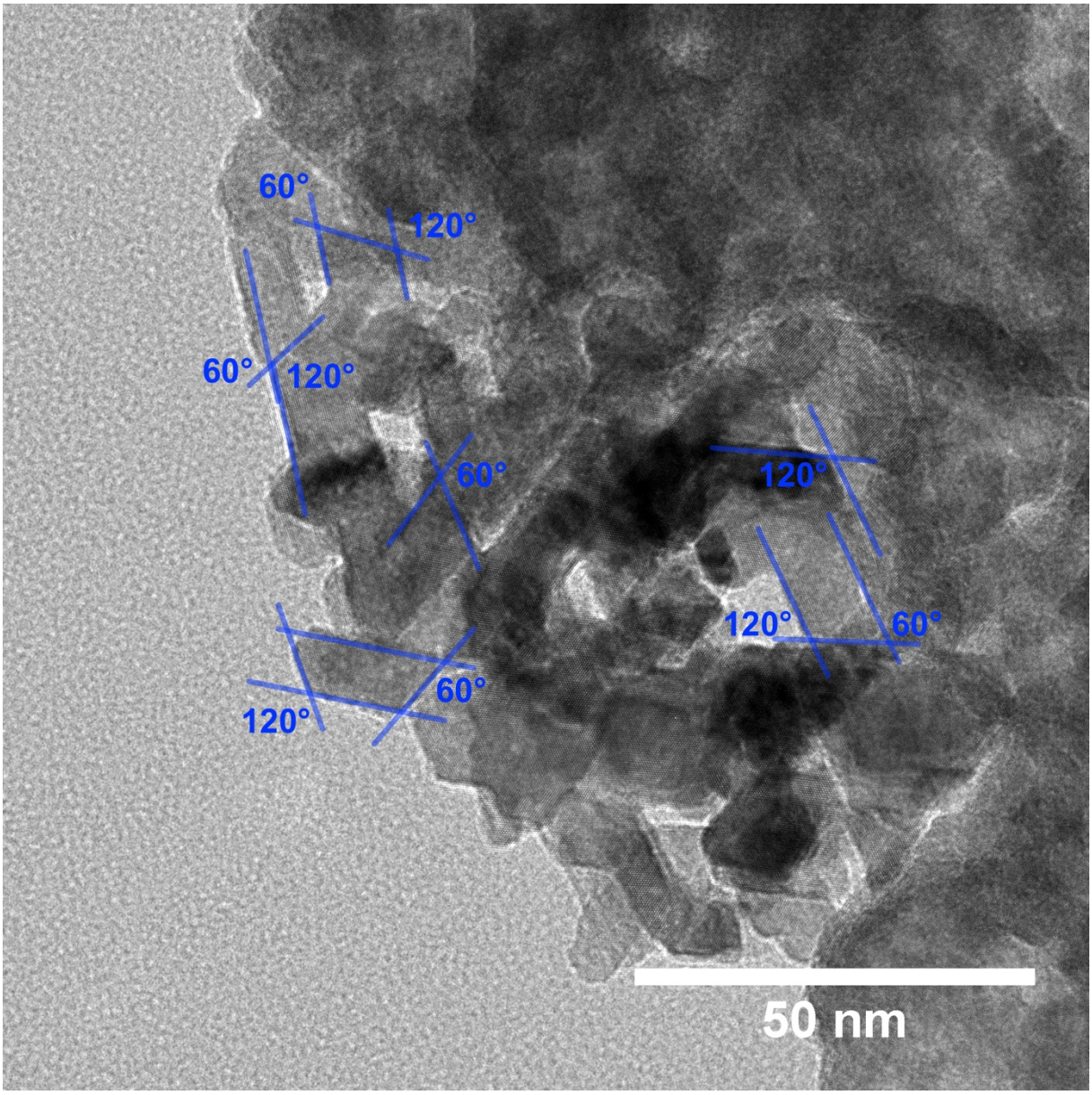

100 nm


100 nm

(b) ZnO nanoparticles synthesized in the presence of GalαC_{12} (including angle analysis)




50 nm


60°
120°
60°
120°
60°
120°
120°
60°
60°
120°
50 nm