In situ Handedness Inversion of Self-assembled Nano-Helix from Gemini-Tartrate Amphiphiles

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We have previously reported that right-handed chiral ribbons are formed by non-chiral cationic bis-quaternary ammonium gemini surfactants in the presence of chiral L-tartrate counter-anions in water [1]. The morphologies of these chiral ribbons are highly sensitive to external and molecular factors. In this study, we show that the handedness of these helices can be inverted in situ to left-handed twisted, helical or flat ribbons with tunable shapes and sizes which can be controlled by enantiomeric excess (ee) with a solution of D-tartaric acid. 16-2-16 L-tartrate amphiphiles in aqueous solution (ee = 1) form 3-D network (gel) of right-handed tubules. When the D-tartaric acid solution is passed through this network such that the final ee’s are 0, -0.33, -0.66, -0.90, these tubules are quickly unwound and chirality inversion was observed. This system shows the first direct visualization of in situ chirality inversion with chiral supramolecular structure at mesoscopic level (20 nm – microns) induced by the addition of the acid solution with opposite chirality.

When the stoichiometric quantity of D-tartaric acid was added such that the final ee = 0, tubular fibres were slowly unwound to twisted or flat ribbons. When an excess D-tartaric acid was added (ee = -0.33 ~ -0.60), chirality inversion occurred quickly and once tubules transformed to left-handed helical or twisted ribbons, but after several days only micrometric plates were observed accompanied by precipitate. On the other hand, when the quantity of D-tartaric acid was much higher (ee = -0.90), chirality inversion occurred much more quickly, left-handed tubules were rapidly formed and the system remained gel. The formation either of precipitate (plates) or gel (fibres) are therefore determined uniquely by the different speed of chirality inversion which depends on the final ee. This system provides an insight into the factors which determines the formation of precipitates or gels.

The kinetics of chirality inversion was followed by CD spectral.

Figure TEM images show the morphology transition of 16-2-16 tartrate using various enantiomeric.

References: