Correlations between chemical structure and self-assembly behaviour in LC oligomers and mesogen covered nanoparticles

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A considerable research effort has been directed towards the investigation of spherical colloidal particles dispersed in low molecular liquid crystals. The spatial arrangement of the particles has often been manipulated by external fields or laser tweezers resulting in chains or raft like assemblies. The interest in smaller nanometric sized particles in LC matrices has been driven, in the main, by their ability to alter the dielectric behaviour of LCs, potentially resulting in faster switching devices. The investigation of small LC functionalized nanoparticles leading to systems where the self assembly behaviour is determined by an interplay of the particles' structure and the self-assembly behaviour of mesogens is surprisingly limited.

Either the LC behaviour of mesogen functionalized nanoparticles was not fully determined, or occurred only in mixtures or cubic lattices expected for the packing of spherical particles were detected.

Following earlier work on LC oligomers and LC cuboid silsesquioxanes we recently investigated a number of mesogen-covered gold nanoparticle systems were combinations of mesogen size, spacer length and mole fraction of unsubstituted alkylthiol were varied. A calamitic mesogen motif with a lateral connection to the nanoparticles was selected because we found earlier for cuboid silsesquioxaens that such systems exhibit nematic phase behaviour and at low temperatures columnar assemblies.

Based on DSC and OPM experiments nematic phase behaviour of the mesogens functionalized nanoparticle structure was detected. However detailed X-ray diffraction experiments carried out on powder and oriented samples permitted to detect the formation of a more complex self-assembly behaviour. The calculation of electron density maps allowed the identification of superlattices, where the nanoparticles are organised in 3D strings embedded in a nematic like matrix, indicating a delicate balance in the interplay of the self assembly behaviour of the nanoparticles and the nematic mesogens.