

Inorganic colloids of nanometer scale in liquid crystals : from surface modulations to topological defects

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Inorganic liquid crystal colloids are of two kinds. Either they are inorganic colloids organized in liquid crystal phases by themselves, or they are inorganic colloids embedded within a liquid crystal organic matrix that is able to transmit its orientation and organization to the colloid assembly. Composites with colloids of nanoparticle size (NPs for nanoparticles) have been studied since a long time, in particular to take advantage of the liquid crystal matrix to drive original assemblies of NPs [1]. One main issue remains however the often bad compatibility between NPs and liquid crystals that usually either moves NPs to the surface of the liquid crystal film [2] or leads to the more favorable confinement of NPs in the liquid crystal topological defects [1]. In this talk I will show how to take advantage of the surfacic structure of liquid crystals for creation of specific assemblies of NPs. I will also show recent progresses in the understanding of the interaction between NPs and topological defects when we evolve from dislocations to disclinations or grain boundaries, these progresses now allowing full control of the NP assemblies and optical properties, from nanospheres to nanorods.

- (1) Cholesteric liquid crystal films under hybrid anchorings are associated with periodic surfacic modulations. It is known that formation of NP assemblies is induced that reproduce the cholesteric modulation geometry [3-5]. I will show that combination of experimental characterizations and simulations of the cholesteric modulations allows to understand the exact localization of the nanoparticle assemblies at the surface. It results from a delicate balance between elastic energy in the cholesteric modulation saved by the presence of the NPs and the anchoring energy at the NP monolayer surface which in the same time controls the local crystallographic structure of the monolayer of NPs [6].
- (2) We have recently demonstrated that in thin smectic films under hybrid anchorings we have coexistence of oriented arrays of dislocations, disclinations and grain boundaries [7]. We have combined X-ray diffraction to optical spectroscopic measurements and varied size and shape of the NPs, from plasmonic gold nanospheres and nanorods to fluorescent nanospheres and nanorods. We show that depending on the size and shape of the NPs we can choose the confinement in one or another defect. In each defect the interaction with the NPs is different in relation with the size of the defect core but also the geometry of the smectic layers around the defect core. This leads to different structures of the NP assemblies depending on the confining defect thus allowing to manipulate the NP optical properties by their interaction with the defects.

References

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