

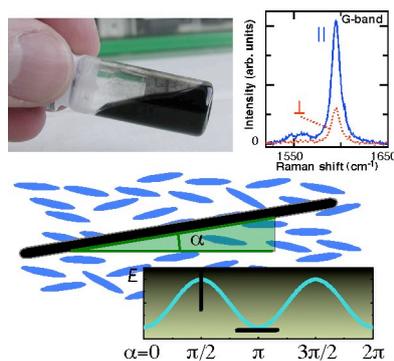
# Anisotropic fluids hosting anisotropic nanoparticles: Carbon nanotube—liquid crystal composites

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Liquid crystals (LCs) constitute a fascinating and rich field of research within soft matter physics and chemistry. While these anisotropic fluids are perhaps best known for their use in displays (LCDs), current academic research is largely focusing on other issues. The two main properties of LCs which are in the research spotlight today are their huge response function to external influences (e.g. electric or magnetic fields, temperature changes or chirality)—rendering LCs interesting for use in sensing devices, modulators and actuators—and their inherent ability to self-organize with orientational and / or translational order of varying degree and dimensionality. The characteristic length scales go from the nano- to the micrometer range and at least in the case of nematic LCs (exhibiting orientational but no translational order) a high degree of fluidity is maintained. The resulting structures are currently being employed for instance as templates for nanoporous silica or in the creation of complex composites with new functionalities, including colloidal systems where the LC can constitute either the solvent or the interior of the particles. In this talk I will, after giving a general introduction to the liquid crystalline state of matter and to modern LC research, concentrate on the employment of LC self-organization, giving examples from my current main research project: the preparation and study of carbon nanotube—liquid crystal composites<sup>1</sup>.

During the last few years a number of stimulating reports have revealed mixtures of carbon nanotubes (CNTs) in LCs to be multifaceted and attractive composites. On the one hand they have application potential in diverse areas of science and technology, on the other the meeting between CNTs and LCs also brings up many new intriguing questions of fundamental research character. After having shown (using polarized resonant Raman spectroscopy) that CNTs align along the LC director in lyotropic as well as thermotropic LCs my collaborators and I are now trying to better understand the sensitive stability of the CNT-LC dispersions. Both types of LC can disperse the CNTs well, but incorrect handling can quickly induce nanotube flocculation. It turns out that not only the direct intermolecular interactions between the CNT guest and the LC host, but also the elastic interactions within the composite medium as a continuum, must be considered to understand the behavior of these systems. We also look into the effects that the CNTs may have on the LC, in particular regarding phase sequence, switching dynamics and electrical properties.



Uniform dispersion (top left) and uniaxial alignment (top right) of CNTs in a lyotropic nematic liquid crystal. The cartoon at the bottom schematically illustrates the alignment concept.

[1] J.P.F. Lagerwall, G. Scalia, M. Haluska, U. Dettlaff-Weglikowska, S. Roth, and F. Giesselmann, *Adv. Mater.*, **19**, pp. 359-364 (2007); J.P.F. Lagerwall, R. Dabrowski, and G. Scalia, *J. Non-Cryst. Solids*, in press, (2007); G. Scalia, J. P. F. Lagerwall, M. Haluska, U. Dettlaff-Weglikowska, F. Giesselmann, and S. Roth, *Phys. Stat. Solidi. B*, **243**, pp. 3238-3241 (2006); J.P.F. Lagerwall, G. Scalia, M. Haluska, U. Dettlaff-Weglikowska, S. Roth, and F. Giesselmann, *Phys. Stat. Solidi. B*, **243**, pp. 3046-3049 (2006)