ESF Exploratory Workshop on

Frontiers in European Research on Liquid Crystalline Soft Matter

LC Lab Bandol, France, May 27-29th 2009

Session iii. Colloidal liquid crystals and liquid crystal colloids

Single wall carbon nanotubes: liquid crystal properties and nematic ordering in composites

Christophe Blanc

Laboratoire des Colloïdes, des Verres et des Nano-matériaux (UMR 5587)
Université Montpellier II - CC26
34095 Montpellier Cedex 5
France

http://www.lcvn.univ-montp2.fr/webperso/webperso.php?user=blanc

Single wall carbon nanotubes (SWCNTs) display remarkable anisotropic mechanical, optical, conductivity properties among others. Exploiting these features at large scale, in composite materials, requires both a good dispersion of individual tubes and a control of their orientational order. A recent trend has been the use of liquid crystals to orient single-wall carbon nanotubes, by doping a liquid crystal matrix with SWNTs. The direct formation of a nematic phase at large concentrations has been much less explored. We will discuss the specific problems risen by such composites.

Using single-stranded DNA as a stabilizer in water renders possible the preparation of concentrated (above 1% wt.) dispersions of individualized SWCNTs. We have explored two main techniques to obtain anisotropic materials from such dispersions. First, a highly viscous nematic phase is observed at concentrations above 4% wt and can be processed to form SWCNTs films after drying. Second, the addition of a water-soluble polymer and subsequent water evaporation yields the formation of concentrated composite materials in which the tubes remain individualized, as shown by the persistence of photoluminescence properties. A controllable alignment in the films is then performed or reinforced by stretching.

We will finally discuss the measurement of the nematic order parameter in such materials. Various methods are found in the literature to estimate roughly the orientational order from optical absorption, Raman or X-Ray scattering properties of carbon nanotubes, but some discrepancies are observed. We have proposed a method to compute it exactly from polarized Raman and photoluminescence scatterings. To test its accuracy, we have followed the polarization changes of the scattered intensity in progressively stretched polymer composites of increasing concentrations.