Single wall carbon nanotubes-based materials and their orientational order

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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.
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 viscous nematic phase is observed at concentrations above 4% wt and can be processed to form SWCNTs films after drying [1]. 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 by stretching.
We will discuss here 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. We have proposed an exact method to compute it from polarized Raman and photoluminescence scatterings [1]. To test its accuracy, we have followed the polarization changes of the scattered intensity in progressively stretched polymer composites of increasing concentrations.
We will finally report the rather low order parameter found in the SWCNTs nematic phase and discuss its possible origins.

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