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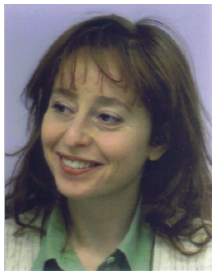
Session iii. Colloidal liquid crystals and liquid crystal colloids

Self-organized nanocomposites: carbon nanotubes ordered by liquid crystals



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Organizing nanoparticles is a current challenge of fundamental and technological importance. Among nanoparticles carbon nanotubes (CNTs) have attracted great attention because of their extremely anisotropic shape, making them the existing objects closest to one-dimensionality, but especially due to their exceptional electrical, mechanical and thermal properties[1]. These appealing aspects have as counterpart a difficulty in manipulation due to the nanotube tendency to bundle resulting into disorganized aggregates that prevent the transfer into the macroscopic world of the properties of isolated nanotubes. Liquid crystals, thanks to their self-organization constitute a route for ordering CNTs via a transfer of their unidirectional alignment onto CNTs dispersed in them[2]. The mechanisms behind the alignment appear not straightforward and have been recently studied theoretically[3].

In our work we have used non-functionalized CNTs and in the case of thermotropic hosts even the use of surfactants was avoided despite their possible aid in improving the dispersion. This choice was taken in order to avoid introducing unknown variables that could affect the properties of our system. As we can monitor directly the CNT behavior from their Raman response our system can be considered a model system for studying liquid crystalline based nanocomposites. We have demonstrated that liquid crystals can impose an alignment independently from the type of liquid crystalline host system[4] . This means that a liquid crystalline state has aligning effect *per se*. In fact, single-walled carbon nanotubes have been unidirectional aligned by thermotropic as well as by lyotropic liquid crystals. The specific molecular structure of the host enters into play in the dispersion and presumably in the aligning efficiency. Differences in the interaction between liquid crystal molecules of various structure and carbon nanotubes has been observed indicating a stronger effect in aromatic systems[5]. Ordering power is also affected by the nanotube concentration and interestingly alignment of carbon nanotubes could still be observed for relatively high carbon nanotube concentration, for which percolation is observed.

References

1. R. H. Baughman, A. Zakhidov, W. A. De Heer, *Science*, **297**, p. 787 (2002)
2. M. Lynch and D. Patrick, *Nano. Lett.*, **2**, p. 1197 (2002); I. Dierking, G. Scalia, P. Morales and D. LeClere, *Adv. Mater.*, **16**, p. 865 (2004); I. Dierking, G. Scalia and P. Morales, *J. Appl. Phys.*, **97**, 044309 (2005); J. Lagerwall, and G. Scalia, *J. Mater. Chem.*, **18**, p. 2890 (2008)
3. P. van der Schoot, V. Popa-Nita, S. Kraij, *J. Phys. Chem. B*, **112**, p. 4512 (2008)
4. G. Scalia, M. Haluska, U. Dettlaff-Weglikowska, F. Giesselmann and S. Roth, *AIP Conf. Proc.*, **785**, p. 114 (2005); J. Lagerwall, G. Scalia, M. Haluska, U. Dettlaff-Weglikowska, S. Roth and F. Giesselmann, *Adv. Mater.* **19**, p. 359 (2007); G. Scalia, J. Lagerwall, S. Schymura, M. Haluska, F. Giesselmann and S. Roth. *Phys. Stat. Sol. (b)*, **244**, p. 4212 (2007); G. Scalia, C. von Buehler, C. Haegele, S. Roth, F. Giesselmann and J. Lagerwall. *Soft Matter*, **4**, p. 570 (2008)