Liquid crystals based on carbon nanotubes and graphene: synthesis and applications

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Most of the potential applications in carbon nanotubes and graphene-based composites require suitable methods for making aligned assemblies on a large scale. Liquid crystal ordering is an opportunity to develop such materials and applications [1]. In this talk, we will present a review of our recent results in the preparation and characterization of lyotropic liquid crystals based on concentrated aqueous suspensions stabilized by surfactants, of single-walled carbon nanotubes (SWNT) or reduced graphene oxide (RGO). In the first part we will focus on anisotropic conductive films, which are prepared by shearing and drying the LC. In particular, we will show how the electrical conductivity anisotropy increases with the order parameter of the nematic liquid crystal. The order parameter can be tuned by controlling the length and entanglement of the nanotubes [1-3]. In the second part we present recent results on the morphology and anisotropy of thin conductive lines of SWCNT, inkjet-printed. Its morphology can be tuned from rail track to quasi-continuous lines by increasing nanotube concentration and drop density. The average order parameter is in the range 0.2–0.4 for all samples. The electrical resistivity is larger for rail tracks with respect to continuous layers, due to large amounts of electrical dead-ends in and between the inner edges of rail tracks [4]. Finally we will present how to prepare water-based Graphene Oxide (GO), and Reduced Graphene Oxide (RGO) liquid crystals stabilized by surfactant molecules. We will discuss their structural and thermodynamic characterizations, which provide indirect but statistical information on the organizations and dimensions of the graphene flakes [1-3].

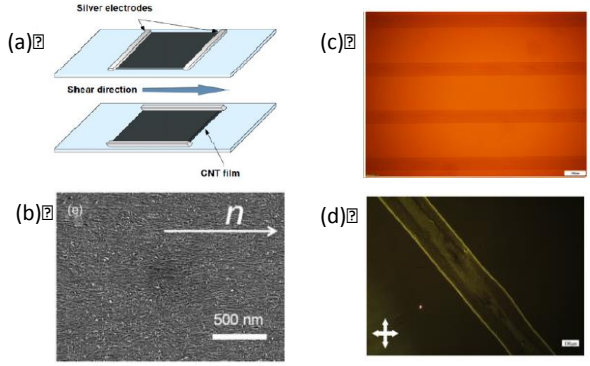

Figure 1. (a) Sketch of SWNT conducting films obtained by mechanical shearing. (b) SEM picture of a SWNT conducting films. (c) Typical Optical Microscopy images and (d) Polarized Optical Microscopy images of SWCNT Ink-jet printed lines. Scale bars 200 and 100 μm respectively

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2. Zamora-Ledezma, C. *et al.* J. Phys. Chem. Lett., **3** (17), pp 2425–2430 (2012)
3. Zamora-Ledezma, C. *et al.* PRE. **3** (17), 84, 062701 (2011)
4. F. Torres-Canas et al, Mater. Res. Express. 4, 035037 (2017)

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Education:

Since 2017 – ***Qualified*** for 28th CNU Section (Milieux denses et matériaux) in France.

2009 – ***PhD thesis in cotuttele***, "Anisotropic materials based on single wall carbon nanotubes: Structure, orientational order and optical properties", Université de Montpellier, Laboratoire Charles Coulomb, team: Nanomateriaux, Pr. E. NGLARET and Instituto Venezolano de Investigaciones Científicas, Laboratorio de Física de la Materia Condensada, team: Dr. P. SILVA.

2004 – ***Physics undergraduate degree*** *(Bac+5) "*Magnetic characterization of the system CoIn2-2xCr2xS4" Pr. V. SAGREDO and Dr. P. SILVA, Universidad de los Andes, Mérida-Venezuela

Professional Experience:

Since April 2017: **Assistant Professor,** Yachay Tech University, School of Physical Sciences and Nanotechnology, Ibarra-Ecuador.

Since October 2009: **Associate Researcher II-3,** Instituto Venezolano de Investigaciones Científicas,Laboratorio de Física de la Materia Condensada, Caracas-Venezuela.

Since October 2009: **Assistant Professor,** Postgrado En Física de la Materia Condensada (PFMC),Universidad de los Andes, Merida-Venezuela.

2016-2017: **Experienced Postdoctoral fellow,** Université de Montpellier, Laboratoire Charles Coulomb, Montpellier-France.

2012-2016: **President,** Centro de Investigaciones de Astronomía, and **Head/Founder** Centro Nacional de Tecnologías Ópticas, Mérida-Venezuela

2010-2011: **Postdoctoral fellow**. Université de Bordeaux, Centre de Recherche Paul Pascal, Bordeaux-France