Fibrillar architectures from the self-assembly of chromonic building blocks

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Keywords (5 maximum): Nanofibers, Self-Assembly, Chromonic liquid crystals, Mesoporous silica

Molecular self-assembly is ubiquitous in nature and constitutes a bottom-up strategy for the fabrication of functional materials[1]. This contribution focus on the aqueous self-assembly of chromonic into fibrillar 1D architectures driven by electrostatic and $\pi-\pi$ interactions. The genesis of those structures starts at low concentrations when few molecules assemble into J and H aggregates. Our group has explored the concentrated region in several chromophores systems to study the formation of very long molecular stacks that undergo structuration into lyotropic liquid crystals, either with orientational (nematic) or positional (hexagonal) order [2.3]. These soft materials can be mineralized using sol-gel processing, so that hybrid chromonic-inorganic oxide nanofibers can be produced. In such materials, the molecular stacks are embedded in a silica matrix in the form of aligned stripes that generate arranged nanopores upon calcination. The silica fibers can be in turn used as hard templates for the synthesis of carbon nanofibers; graphitic structures are obtained at high processing temperatures. Carbon nanofibers can also be produced from ionically locked molecular stacks with high carbon yield. The fabricated materials show potential for applications in imaging, sensing and supercapacitors.

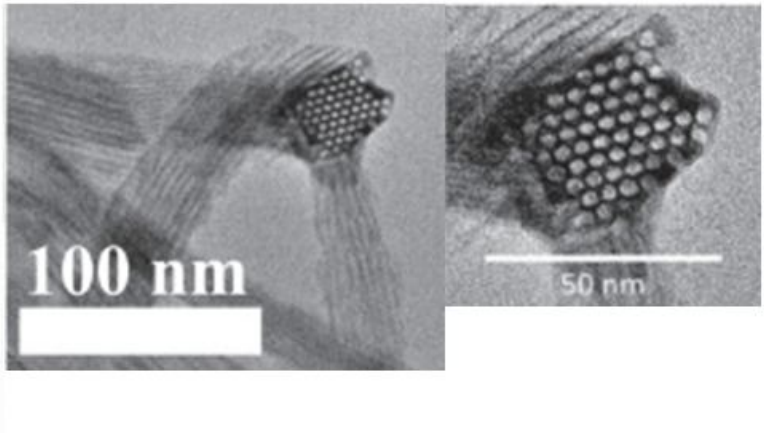

Fig. 1: TEM image of calcined silica nanofibers prepared using cromonics, showing ordered mesopores aligned along the fiber axis. Adapted from Ref. 4

[1]. Lazzari, M.; Rodríguez, C.; Rivas, J.; López-Quintela, A. Self-assembly: a Minimalist Route to the Fabrication of Nanomaterials. Journal of Nanoscience and Nanotechnology 2006, 6, 892-905.

[2] Rodriguez, C.; Aubery, C.; Tiddy, G.J.T. Chromonic Liquid-Crystalline Phases of Pinacyanol Acetate: characterization and use as templates for the preparation of mesoporous silica nanofibers. Langmuir 2011, 27, 3067–3073.

[3] Rodriguez, C.; Aubery, C.; Solans, C.; Lopez-Quintela, A.; Tiddy, G.J.T. Characterization of Perylene Diimide Dye Self-Assemblies and Their Use As Templates for the Synthesis of Hybrid and Supermicroporous Nanotubules. ACS Applied Materials & Interfaces 2011, 3, 4133–4141.

[4] Magana, J.R.; Solans, C.; Salonen, L.M.; Carbó-Argibay, E.; Gallo, J.; Tiddy, G.J.T.; Rodríguez, C. Chromonic Self-Assemblies in a Series of Dialkyl-Thiacarbocyanine Dyes and Generalization of a Facile Route for the Synthesis of Fluorescent Nanostructured Silica Fibers Journal of the Taiwan Institute of Chemical Engineers 2018, 92, 134–142.