

Observation of a Helical Intermediate During the Formation of Hexa-peri-hexabenzocoronene Graphitic Nanotubes

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Nanotubular objects have attracted considerable attention due to the unique one-dimensionality as well as the potential applications utilizing the nanoscopic channel. Self-assembly of suitable amphiphilic precursor molecules is a very promising approach toward the rational design of nanotubes.¹ Generally such nanotubes are formed when an isotropic solution of a precursor is cooled below the gel-to-liquid crystalline phase transition temperature. There are indications that the formation of self-assembled nanotubes occur over a helical intermediate, but in most cases only qualitative indications are presented.

The present work reports results on the kinetics of the formation of such nanotubes obtained by in-situ synchrotron SAXS at the electron storage ring ELETTRA, Italy,² where the data quality is high enough to reveal very detailed structural information about the intermediates in the formation process. As a model system we use the recently reported fabrication of a graphitic cylindrical object from hexa-peri-hexabenzocoronene (HBC) amphiphile (Figure 1) by Aida and co-workers.³

A solution of HBC was left at rest for 10 hours and the obtained scattering curve was successfully fitted with the form factor of a helix formed by a bilayer tape with 5 different electron density levels. The obtained thicknesses and electron density of each layer agree well with the previously suggested by TEM experiments.³

Besides, the kinetic of the process was followed in-situ, in which the assembly and disintegration of the nanotubes was followed, showing the formation of a hexagonal order of the nanotubes.

¹ (a) Shimizu, T.; M. Masuda, T.; Minamikawa, M. *Chem. Rev.* **2005**, *105* 1401. (b) Terech, P.; Geyer, A. D.; Struth, B.; Talmon, Y. *Adv. Mater.* **2002**, *14*, 495.

² Amenitsch, H.; Rappolt, M.; Kriechbaum, M.; Mio, H.; Laggner, P.; Bernstorff, S.; Synchrotron J. *Radiat.* **1998**, *5*, 506.

³ Hill, J. P.; Jin, W.; Kosaka, A.; Fukushima, T.; Ichihara, H.; Shimomura, T.; Ito, K.; Hashizume, T.; Ishii, N.; Aida, T. *Science* **2004**, *304*, 1481.

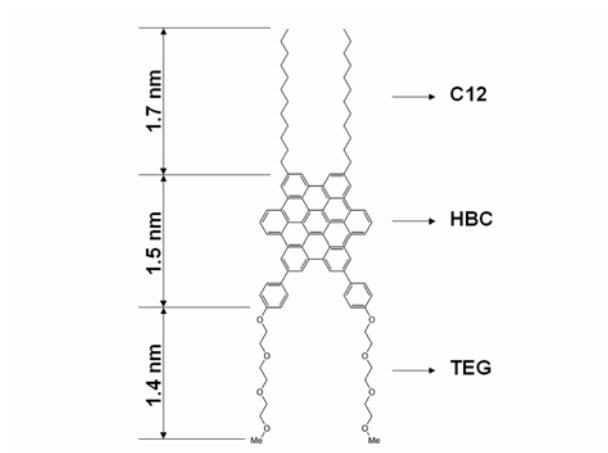


Figure 1. Hexa-peri-hexabenzocoronene (HBC) amphiphile molecule, precursor of the nanotubes.