Poster

ELECTRICAL TRANSPORT MEASUREMENTS ON SELF-ASSEMBLED ORGANIC MOLECULAR WIRES

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The electrical properties of nanorods and nanorings designed by supramolecular assemblies of highly π-conjugated oligomers are studied. On the chemist point of view, the best way to build nanostructure is to use molecular building blocks which form supramolecular structures through the use of non covalent interactions [1]. By using this bottom-up technique, it is possible to obtain numerous nanostructures such as nanorods, nanotubes or nanorings [2]. We report here the study of oligo(phenylenethienylene) bisurea which assemble itself in nanorings under specific conditions of dilution.

We synthesized a five benzene and thiophene sequence functionalized with two urea moieties (Fig.1). Thanks to hydrogen bonding [3,4], bisurea compounds self assemble into nanowires or nanorings (depending of the concentration fig 2). UV-visible absorption reveals that 1 forms H-aggregates where the π-oligomers are stacked one over each other. Evidence of H-bond association is observed from infrared spectroscopy, the NH strech region and the amide regions show characteristic peaks of a strong association of the urea moities. In these nano structures the distance between π-conjugated oligomers such as bithiophene is reduced. This leads to a better delocalisation of electron wave functions [4]. Charges injections and delocalisation with Electric Force Microscope (E.F.M) [5] have shown that electrical transport is governed preferentially by positive charges in these nanostructures (Fig.3). Holes are locally injected from the apex of the tip (at +2V for 2 mins) and the EFM image is recorded (at -2V, lift 50nm). In these conditions the darkness of the nanoring (after injections), which corresponds to a negative shift of the cantilever frequency, reveals that holes are injected and delocalized in the entire nanoring. The EFM signal amplitude corresponds to 500-1400 injected holes. Same experiments to inject electrons (at negative tip bias) were unsuccesfull. The delocalisation of positive charges inside these structures confirms that molecules assembled in these objects are well organized.

References:

[1] Lehn J.M Supramolecular Chemistry: Concept and Perspective, VCH Weinheim (1995).
[2] J.-C.G. Flores, O.J.Dautel, F.Serein-Spirau, J.P.Lère-Porte, J.J.E.Moreau, D.Tondelier, D.Guerin, S.Lenfant, D.Vuillaume submitted to JACS.
[3] Van Esch J., De Feyter S., Kellog R.., De Schryver F., Feringa B.L., Chem.Eur.J. **3** (1997) 1238.
[4] Rochefort A., Martel R., and Avouris P. Nanoletters, **2** (2002), 877
[5] Heim, T.; Lmimouni, K.; Vuillaume, D. Nanoletters, **4** (2004), 2145

Figures:

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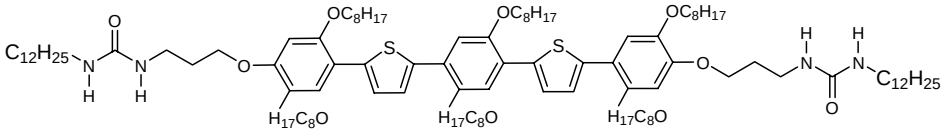

Fig.1 Molecular structure of oligo(phenylenethienylene) bisurea

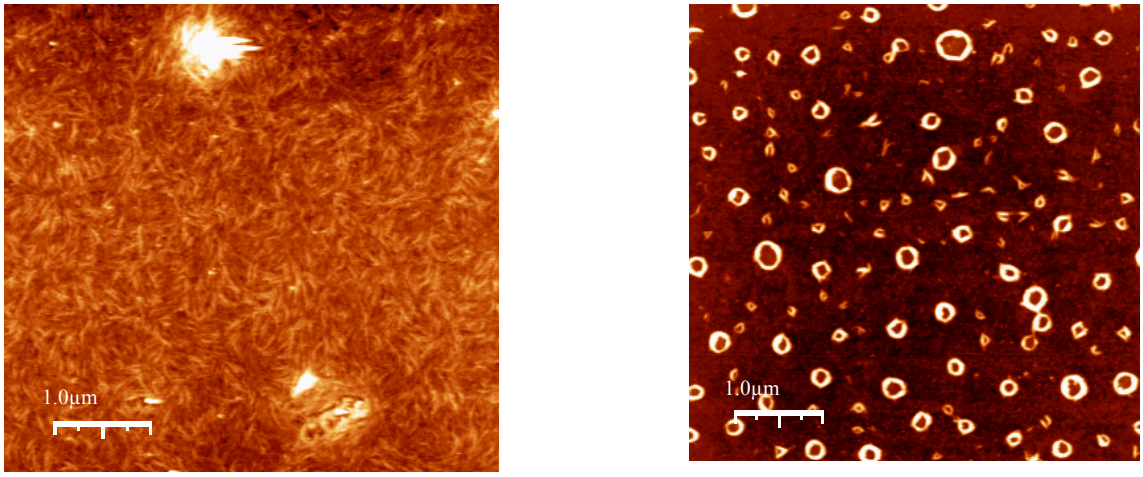

Fig.2 AFM topographic image (tapping mode) of solution-deposited film of the gel of **1** diluted in dichloromethane at 0.5 $g.L^{-1}$; we formed nanowires (SiO_2 substrate) (left) and of solution-deposited film of the gel of **1** diluted in dichloromethane at 0.05 $g.L^{-1}$; we formed nanorings (SiO_2 substrate) (right)

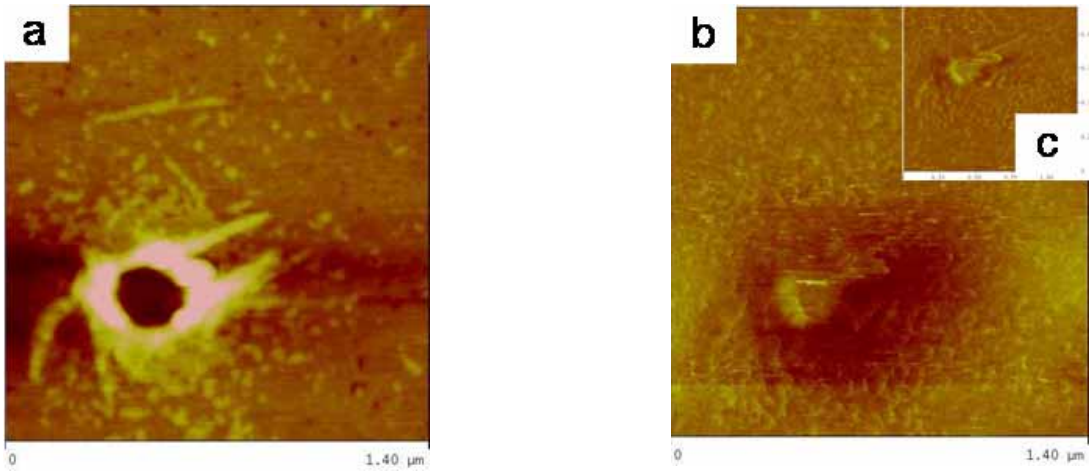

Fig.3 Topographic image of a nanoring after injecting holes (2V for 2 minutes) (a). EFM image corresponding to the topographic image recorded at -2V and lift 50 nm (b). Inset (c) is EFM image before injection.