

## 2D AND 3D SELF-ASSEMBLING OF ORGANIC SEMICONDUCTORS

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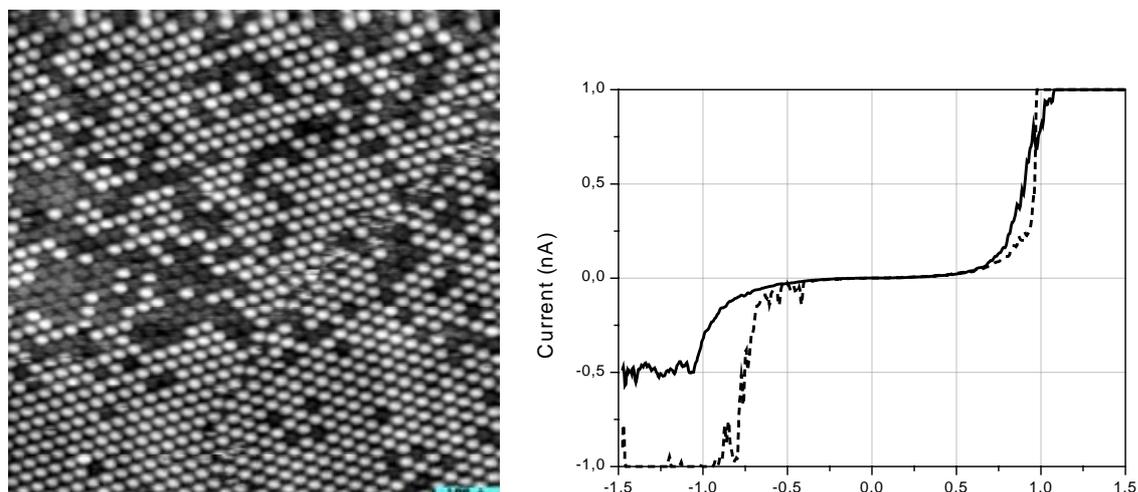
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Self-organizing molecular systems are in the focus of nanotechnology research because of their potential use in “bottom-up” approaches towards functional supramolecular devices. The construction of complex assemblies using molecular entities is a key point for the development of novel functional materials.<sup>[1]</sup> The ordered assembly of molecular materials, under ambient conditions, in nanoscale architectures will be also a crucial step for the future molecular scale electronics. In the field of organic materials, oligo- and polythiophenes are one of the most studied p-type organic semiconductors, not only due to their electron and photonic properties but also because their stability and shape-persistence, representing ideal “molecular wires”.<sup>[2]</sup> A novel class of these materials with an unique cyclic topology are the well-defined  $\pi$ -conjugated cyclothiophenes.<sup>[3]</sup> Due to their toroidal structure, they could represent intriguing “molecular circuits” which would additionally include sites for recognition and selective complexation.

In this presentation the analysis by scanning tunnelling microscopy and spectroscopy of hybrid structures containing linear or cyclic thiophene compounds physisorbed on metallic substrates will be presented. The self-assembling properties of the fully conjugated oligomers and macrocycles reveals a high crystallinity in the monolayer.<sup>[4]</sup> Due to complex formation 3D nanostructures of perfectly ordered p-type/n-type semiconductors can be grown on the metallic surface. By means of STM, we investigated epitaxy, interactions and dynamics of perfectly ordered 1:1 Thiophene-C<sub>60</sub> (Fullerene) complexes on HOPG.<sup>[5]</sup> Electronic properties were determined by scanning tunnelling spectroscopy (STS) measurements on the individual donor-acceptor structures. A rectifying behaviour is observed demonstrating that the C[12]T-C<sub>60</sub> complexes act as single molecule diodes.

**References:**

- [1] Maruccio, G. , Cingolani, R. and Rinaldi, R. *J. Mater. Chem.* **2004**, *14*, 542-554.  
[2] a) N. Aratani, A. Osuka, Y.H. Kim, D.H. Jeong, D. Kim, *Angew. Chem. Int. Ed.* **2000**, *39*, 1458. b) W.B. Davies, W.A. Svec, M.A. Ratner, M.R. Wasiliewski, *Nature* **1998**, *396*, 60.  
[3] J. Krömer, I. Rios-Carreras, G. Fuhrmann, Ch. Musch, M. Wunderlin, T. Debaerdemaeker, E. Mena-Osteritz, P. Bäuerle, *Angew. Chem. Int. Ed.* **2000**, *39*, 3481-3486.  
[4] Mena-Osteritz, E. *Adv. Mater.* **2002**, *14*, 609-616.  
[5] Mena-Osteritz E. and Bäuerle P. *Nature Mater.* (submitted)

**Figures:**

**Figure 1:** STM-Image of the crystalline hybrid pairs C12T-C<sub>60</sub> (left) and STS-curves for the complexed (solid) and non-complexed (dashed) macrocycle (right).