

Architecture vs. Function relationship in supramolecular nanomaterials for organic electronics

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Multifunctional materials are key in organic (opto)electronics. However, their practical use requires the optimization of the self-assembly of multimodular architectures at surfaces using non-conventional methods, their controlled manipulation and responsiveness to external stimuli, and the quantitative study of various physico-chemical properties at distinct length- and time-scales. My lecture will review recent results obtained in our laboratory in five different research themes:

(i) Development of novel processing and post processing methods to produce highly ordered supramolecular electroactive architectures. While solvent vapour annealing post-treatments can be used to form millimetre long crystalline fibers of the semiconducting perylene-bis-dicarboximide (PDI) or hexa-peri-hexabenzocoronene,[1] its combination with dipping made it possible to form PCBM single crystals with sizes of several tens of micrometers.[2]

(ii) Supramolecular scaffolding to control the position of functional units at surfaces and interfaces. This has been accomplished both using metallo-ligand interaction in anthracene incorporating molecular tectons,[3] and employing H-bonding between guan(ose)ine derivatives exposing oligothiophene moieties.[4]

(iii) Responsive interfaces which have been visualized on the sub-nm scale by Scanning Tunneling Microscopy (STM). We will show the first dynamer operating at surfaces, being based on guanine derivatives dynamic self-assembly.[5] We will also show prototypes of light-powered mechano-chemical switches operating at surfaces. Their bistable nature will be employed to develop optically modulable nanoscopic and macroscopic junctions as explored by conducting AFM and Hg drop based junctions.[6]

(iv) Scanning Probe Microscopies beyond imaging to gain direct and quantitative insight into electronics processes in multicomponent architectures including the Kelvin Probe Force Microscopy (KPFM)[7] quantitative mapping of the photovoltaic activity in electron acceptor/donor blends, on the hundreds of nanometers[8] and on the few nanometers scale.[9] Further, the electrochemical local reduction of graphene oxide with an AFM tip followed by the C-AFM study of the electrical properties of the manipulated architecture will be presented.

(iv) Supramolecular approaches to organic electronics allow improvement of the performance of devices. We will show some recent results we obtained like the tailoring of percolation pathways for charge transport in polycrystalline films for FETs. [10]

[1] (a) Adv. Funct. Mater., 2007, 17, 3791-3798 & 3687. (b) Small 2009, 5, 112.

[2] PCCP, 2010, 12, 4473

[3] (a) Angew. Chem. Int. Ed. 2007, 46, 245. (b) Adv. Mater. 2009, 21, 1131

[4] Adv. Mater. 2008, 20, 2433

[5] Angew. Chem. Int. Ed. 2010, 49, 1963

[6] (a) PNAS 2007, 104, 9937. (b) JACS 2008, 130, 9192. (c) Angew. Chem. Int. Ed. 2008, 47, 3407.

[7] (a) Adv. Mater 2006, 18, 145. (b) Acc. Chem. Res. 2010, 43, 4, 541-550

[8] Adv. Funct Mater. 2007, 17, 472

[9] (a) JACS 2008, 130, 780. (b) JACS 2008, 130, 14605

[10] JACS 2009, 131, 7055.