
Scanning Probe Microscopies beyond imaging: tailoring and unraveling the nanoworld

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Scanning Probe Microscopies are powerful tools for studying various physico-chemical properties of molecular based materials across multiple length scale, from the macroscopic scale down to the sub-nanometer scale. They also enable investigation of dynamic processes such as chemical reaction, molecular reorganization as well as dynamers operating on surfaces.

In my lecture I will review recent results obtained in our laboratory on the use of various SPM modes on supramolecularly engineered nanostructured material, with a particular attention on the unveiling and optimization of their electronic properties for technological application in organic (opto)electronics.

(i) From 2D crystal engineering of bi-component structures to supramolecular scaffolding. We employed Scanning Tunneling Microscopy (STM) at the solid-liquid interface to explore the mechanism of self-assembly of bi-component systems into discrete supramolecular assemblies, i.e. tunable porous supramolecular 2D arrays.[1] To this end we have operated in a low concentration regime in order to avoid phase segregation, i.e. adsorption of only one component on the surface. By exploiting the same approach we have visualized for the first time a main-chain bi-component supramolecular polymer, with a tunable rigidity, built up from ditopic molecular components bearing complementary H-bonding recognition groups.[2] The concentration controlled self-assembly was also used to form helical supramolecular architectures at the solid-liquid interface.[3]

The ability of molecular modules exposing molecular recognition units to undergo self-assembly into bi-component 2D architectures with a sub-nm precision is of great importance for their use as supramolecular scaffolds to position functions such as optically/electrically active units in space. This has been demonstrated both using metallo-ligand interaction in anthracene incorporating molecular tectons,[4] and by employing H-bonding between guan(os)ine derivatives exposing oligothiophene moieties.[5]

(ii) *Responsive interfaces which have been visualized on the sub-nm scale by STM.* We will show the first dynamer operating at surfaces, being based on guanine derivatives dynamic self-assembly.[6] We will also show prototypes of light-powered mechano-chemical switches operating at surfaces. Their bistable nature was exploited to develop optically modulable nanoscopic and macroscopic junctions as explored by STM and conducting AFM based junctions.[7]

(iii) *Scanning Probe Microscopies beyond imaging to gain direct and quantitative insight into electronics processes in multicomponent architectures* including in particular the Kelvin Probe Force Microscopy (KPFM)[8] quantitative mapping of the photovoltaic activity in electron acceptor/donor blends, on the hundreds of nanometers[9] and on the few nanometers scale.[10] Further, the electrochemical local reduction of graphene oxide with and AFM tip followed by the C-AFM study of the electrical properties of the manipulated architecture will be presented.[11]

References

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