MOLECULES AFFECT CHARGE TRANSPORT IN NANO-PARTICLE SELF-ASSEMBLIES, AT ROOM TEMPERATURE

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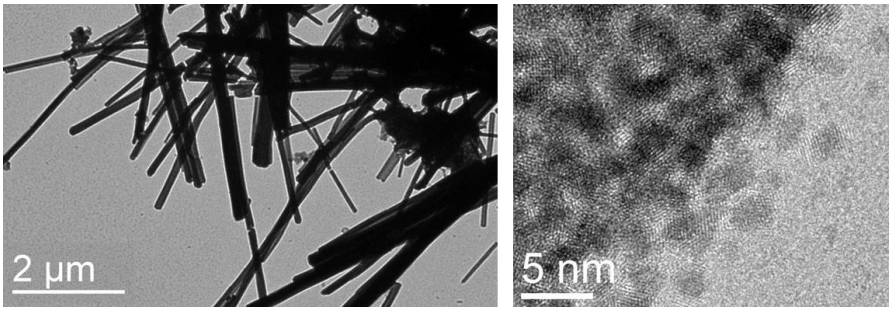
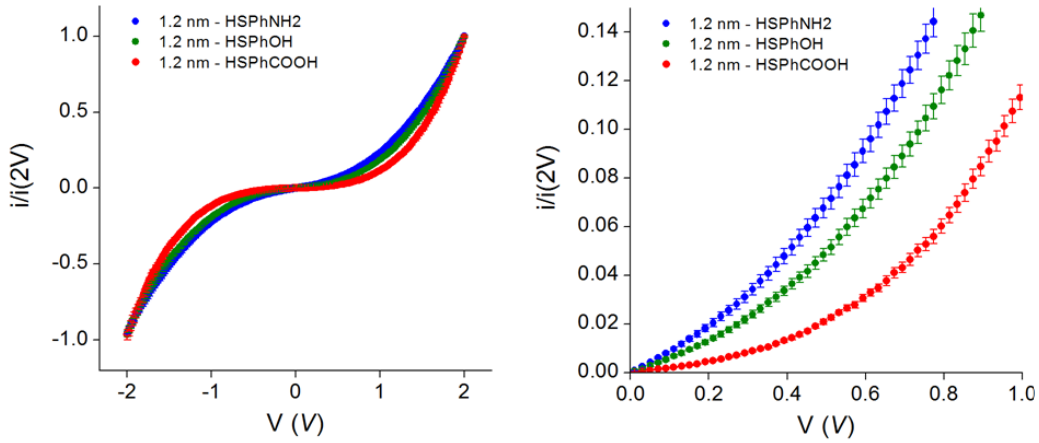
Understanding the parameters that control the transport of an electron through a molecule is a key point for applications in different fields: molecular electronics, solar cells, biochemistry, catalysis, etc. Within the scope of this project, we used metallic nano-particle self-assemblies as a tool to study the influence of the ligands (which stabilize the particles) on the electronic transport of the global assembly.

We first elaborated assemblies of platinum nano-particles with a size small enough to observe Coulomb blockade at room temperature. Such system gives us the opportunity to perform measurements on a large number of molecules, but addressing them individually (as only one electron "crosses" the molecules at a given time). We then confirmed experimentally that the distance between the particles affected the charging energy of the system, but we also proved that other parameters were also important, such as the size of the nano-particles and the dielectric constant of the molecules.

Our approach, based on a statistical analysis on a large number of measurements, showed the feasibility of performing meaningful charge transport measurements on non-ideal systems, i.e. not well organized, and with a large size distribution of the particles. We were indeed able to significantly distinguish an amine from a hydroxyl, or a carboxylic acid function, only by measuring an i(V) curve with a conductive AFM, and to rationalize the apparent trend, by analyzing the charging energy of the nano-particles.



Platinum nano-particle assemblies in the presence of mercaptophenol: regular TEM picture and high resolution TEM picture.



i(V) curves of the self-assemblies with aminothiophenol, mercaptophenol, and mercaptobenzoic acid, normalized at 2V: full scale and zoom on the low voltage region.