

Ordered hybrid assemblies of nanoparticles and molecules at surface

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Combining and ordering inorganic and organic compounds at a nanometer level has become a promising pathway for nanoelectronics, light harvesting, energy storage or sensing. After a short review of surface long-range ordered templates, I will present the model surface made of alumina thin film on Ni₃Al(111) substrate [1, 2]. In a second time, I will show the growth kinetics as well as structural and optical properties of two-dimensional hybrid nano-assemblies. There are made of a long-range ordered array of metallic nanoparticles (NPs) with perylene or fullerene molecules. We have observed different ordering mechanisms, depending on the molecule, driven by the periodic superstructure of the alumina ultrathin layer support, independently from the NP array or by forming a hybrid complex. For perylene, a decoupled system has been achieved for 1 nm diameter NPs and flat-lying molecules with a 2:1 perylene/NP relative ratio. At a larger NP size and perylene coverage, molecules tilt up on alumina and adsorb on NPs [3]. On contrary for fullerene, molecules adsorb on NP and strongly modify their plasmonic response, while at higher coverages molecules fill uncovered regions of the alumina film. Prospective results on the forming molecular bridge will also be discussed.

We show here that scanning tunneling microscopy and optical spectroscopies of vibronic and vibrational states provide a detailed understanding of the structural, electronic and optical properties as a function of NP size and molecular coverage. This versatile system allows forming various hybrid assemblies and opens the way to control organization and coupling of molecules and nanoparticles.

[1] N. Alyabyeva *et al.*, Appl. Surf. Sci. (2018), 444, 423 <https://doi.org/10.1016/j.apsusc.2018.03.025>

[2] N. Alyabyeva *et al.*, J. Phys. Chem. Lett. (2019), 10, 624 <https://doi.org/10.1021/acs.jpcclett.8b03830>

[3] N. Alyabyeva *et al.*, J. Phys. Chem. C (2019), 123, 19175 <https://doi.org/10.1021/acs.jpcc.9b04147>

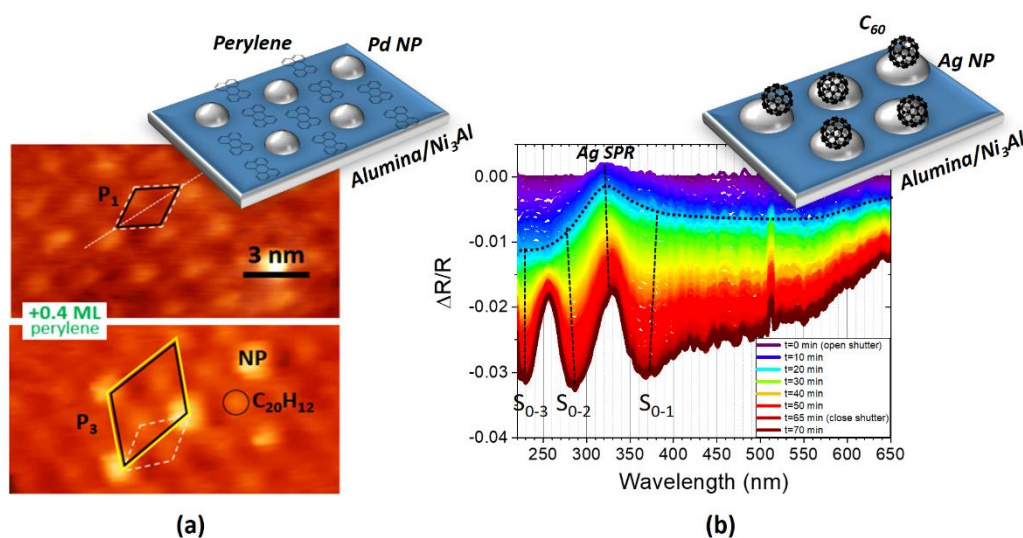


Figure 1: Hybrid assemblies of (a) Pd nanoparticles and perylene driven by the substrate, probed by scanning tunneling microscopy and (b) plasmonic Ag nanoparticles and fullerene driven by adsorption, investigated by surface differential reflectance spectroscopy.