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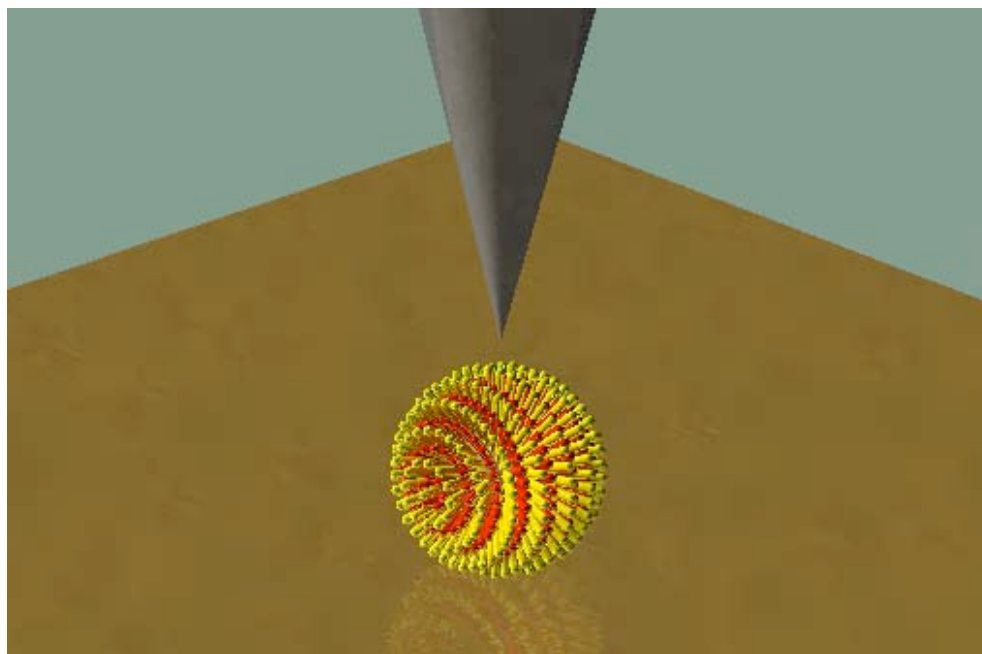
Supramolecular Material Science: from Nanomaterials to Lithography

Francesco Stellacci

*Finmeccanica Assistant Professor of Materials Science and Engineering
MIT*

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Auditorium of the Center for Imaging Science



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Abstract

It is known that specific molecules can spontaneously arrange on various surfaces forming two-dimensional poly-crystalline mono-molecular layers called self-assembled monolayers (SAMs). These organic coatings are used to impart targeted optical, electronic and biological properties to surfaces. Very often SAMs composed of more than one type of molecule (mixed-SAMs) are used to simultaneously impart multiple properties. Scanning tunneling microscopy (STM) studies have shown that, in mixed SAMs, molecules phase-separate in domains of random shape and size.

We will show that when mixed SAMs are formed on surfaces with a radius of curvature smaller than 20 nm they spontaneously phase-separate in highly ordered phases of unprecedented size. The reason for this supramolecular phenomenon is purely topological and can be rationalized through the “hairy ball theorem”. In the specific case of mixed SAMs formed on the surface of gold nanoparticles, the molecular ligands separate into 5 Å wide phases of alternating composition that encircle or spiral around the particle metallic core. This new family of nano-structured nano-materials¹ shows new properties solely due to this novel and unique morphology. For example, the particles’ solubility starts to depend on the ratio between the dimensions of the phases and that of the solvent molecules. More importantly, due to the ordered alternation of 5 Å wide hydrophobic and hydrophilic regions, surfaces coated with these particles show the ability of suppressing protein nonspecific adsorption, outperforming poly-ethylene glycol (PEG) the golden standard in this field.

Additionally, we will show how patterned DNA SAMs can be used as masters for a novel printing technique for organic materials called Supramolecular NanoStamping (SuNs). This method, like the DNA/RNA information transfer, uses the reversible assembly of DNA double strands as a way of transferring patterns from a surface to another. One of the main advantages of SuNs is that multiple DNA strands (each encoding different information) can be printed at the same time, thus allowing for a complex chemical pattern to be formed, much like Gutenberg movable type. The parallel printing of a pattern formed by multiple DNA strands will be presented.

Speaker Bio

Francesco Stellacci graduated the Politecnico di Milano in 1998 with a thesis on photochromic materials. He then moved to the University of Arizona as a post-doctoral scholar and worked on two-photon microfabrication of three dimensional metallic structures. In September 2002 he was appointed as Assistant Professor of Materials Science at MIT.