Self-assembled monolayers

Giorgos Stavrakakis

Dept. of Materials Science and Technology, University of Crete, Vassilika Voutes, Heraklion, Greece 700 13

The interactions between molecules and surfaces are some of the most exciting and widely studied aspects of modern surface science. One of the most remarkable molecule–substrate interactions is the spontaneous self-organization of atoms and molecules on surfaces into well-ordered arrays. In particular, the spontaneous organization (self-assembly) of surfactant molecules adsorbed on transition metal surfaces has been of growing importance over the past two decades. The field of self-assembly has grown rapidly since the discovery of these structures and their ability to modify the physical and chemical properties of a surface[1].

Self-assembled monolayers (SAMs) are typically formed from the exposure of a surface (metal, metal oxide, semiconductor) to molecules with chemical groups that possess strong affinities for the substrate or a material patterned on it (Fig.1). How well these assemblies order is a function of the nature of the chemical interaction between substrate and adsorbate, as well as the type and strengths of intermolecular interactions between the adsorbates that are necessary to hold the assembly together[1]. The use of self-assembled monolayers (SAMs) in various fields of research is rapidly growing as they offer promising possibilities. For instance, many applications in biotechnology require control over the spatial distribution of proteins or other biomolecules adsorbed on surfaces. Exposure of the patterned substrate to a protein-containing solution resulted in the irreversible adsorption of protein to the hydrophobic regions of the SAM. Proteins have been immobilized onto the surface containing patterned regions of a reactive functional group, provided that the complementary regions are resistant to the adsorption of proteins[2].

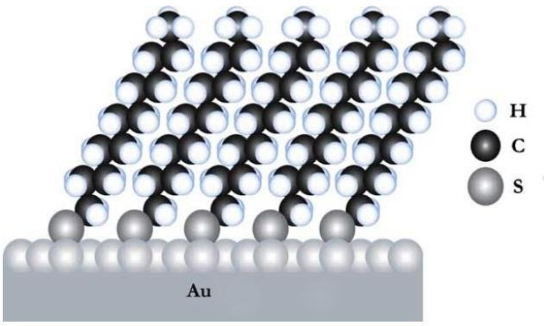

Fig. 1: Schematic of an n-dodecanethiolate monolayer self-assembled on an atomically flat gold substrate. The assembly is held together by the bonds between the sulfur headgroups and the gold surface as well as van der Waals interactions between neighboring hydrocarbon chains (Used under no permission from [1]).

These materials often exhibit optical, electrical, optoelectronical, mechanical, chemical, or other properties interesting from the applications point of view[3]. Thus, SAMs are found in applications such as molecular and biomolecular recognition, lithography resists, sensing and electrode modification, corrosion prevention, and other areas where tailoring the physico-chemical properties of an interface is required[1]. Finally, they are considered to be an ever evolving field of material science.

References:

[1]. *Smith, R.K., Lewis, P.A., and Weiss, P.S. (2004). Patterning self-assembled monolayers. Progress in Surface Science 75, 1–68.*

[2]. *Mrksich, M., and Whitesides, G.M. (1995). Patterning self-assembled monolayers using microcontact printing: A new technology for biosensors? Trends in Biotechnology 13, 228–235.*

[3]. *Schreiber, F. (2000). Structure and growth of self-assembling monolayers. Progress in Surface Science 65, 151–257.*