Nanoengineered Self-assembled Monolayers for Sensing Bioinspired Recognition

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Self-assembled monolayers (SAMs) have attracted tremendous attention due to their highly ordered structure, stability and rich terminal group chemistry and they offer very promising applications in development of biocompatible materials, solid-phase bioanalytical techniques and biosensors. Particularly, nanometer-scaled mixed self-assembled monolayers (SAMs) are better systems than pure SAMs in mimicking biomembranes because of the presence of segregated domain structures and variety of surface functionalities. In nature, the collective properties and biofunctionalities of these ensembles depend not only on the individual molecular unit but also on the organization at the molecular or nanoscopic level. It has been demonstrated that high-resolution nanofabrication of mixed SAMs with sub-10 nm precision can be achieved readily using either lithography or natural growth approaches.[1] These artificially engineered organic thin films with both desired surface chemistry and designed spatial distribution provide a unique scaffold to investigate bioinspired molecular recognition in the fields of biosensors and immunoassays. For example, HIV infection of CD4 negative cells is initiated by the binding of the viral envelope glycoprotein gp120 to galactosylceramide (GalCer), a glycosphingolipid that serves as the cellular receptor for viral adhesion. By constructing a series of GalCer nanostructures with various geometries via AFM-based lithography and using high-resolution AFM imaging as an *in situ*, real-time and label-free detection approach to directly monitor the subsequent binding of recombinant gp120 molecules to those engineered carbohydrate ligand nanostructures, the polyvalent interactions between HIV-gp120 protein and GalCer nanostructures are revealed both qualitatively and quantitatively and a better understanding of HIV viral infection process at single molecular level is gained.[2] In addition, our recent studies on advanced strategies to generate thiol-exposing SAMs[3,4] that can serve as highly selective bio-platforms for development of biosensors will be discussed.

References

1. *Yu et al.* A Nanoengineering Approach to Regulate the Lateral Heterogeneity in Mixed Self-Assembled Monolayers. *J. Am. Chem. Soc*. **2006**, *128*, 11574-11581.

2. *Yu et al.* Polyvalent Interactions of HIV-gp120 Protein and Nanostructures of Carbohydrate Ligands. *NanoBiotechnology* **2005,** *1*,201-210.

3. *Yu et al.* Nanografting versus Solution Self-Assembly of α,*ω*-Alkanedithiols on Au(111) Investigated by AFM. *Langmuir* **2008,** *24,* 11661-11668.

4. *Li et al.* Engineering the Spatial Selectivity of Surfaces at the Nanoscale Using Particle Lithography Combined with Vapor Deposition of Organosilanes. *ACS Nano* **2009,** 7*,* 2023-2035.