Engineering the Biology-Material Interface for Safer Medical Devices

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In this presentation, two different concepts of engineering the interface between artificial materials and biology will be demonstrated. The first example is an attempt to form synthetic bone materials, intended for use in medical devices as well as a model system to study bone mineralization, to shed light on *in vivo* bone formation mechanisms. In the second example, controlled surface topography and its impact on protein interaction with surfaces is in focus. Specifically, topographical alterations on similar length scale as proteins has shown to largely affect the interactions, giving us a tool to regulate how foreign materials are integrated with living tissue. This is for example of great interest in the development of medical devices, such as implants, and how they are accepted in the human body.

A novel synthetic approach, highly inspired by the architecture of natural bone, to design mechanically stable nanocomposites incorporating aligned apatite nanocrystals will be demonstrated.[1] To mimic the nanostructure of natural bone, we first combine molecular self-assembly and intermolecular crosslinking to create resilient polymeric matrices with long-range periodicity; then we employ compartmentalized mineral growth via a transient amorphous phase for the biomimetic formation of bone-like apatite. The nano-domains and their alignment has been investigated using 3D small angle X-ray scattering (3D-SAXS)[2] and the crystallization process has been studied using transmission electron microscopy (TEM).[3]

By using silica nanoparticles of various sizes immobilized onto surfaces, the nanotopographical effect on the classical immune complement activation through adsorption of IgG and the following binding of C1q, was examined.[4] In another example, using silica nanoparticles deposited as a gradient in nanostructure density on a surface, the initial attachment of bacteria with or without the presence of human fibrinogen was examined.[5] By using a parallel plate laminar flow chamber, we found a near-linear positive correlation between the adhesion of S. epidermidis with increasing nanoparticle density. However, if the nanostructured gradient was precoated with human fibrinogen the opposite relationship was observed, although the adsorbed amount of fibrinogen was found to be higher on nanostructured than on smooth surfaces. This latter observation correlated well with protein conformation studies using circular dichroism (CD), where the nanostructured surfaces preserved the protein secondary structure, similar to in solution, as compared to the smooth surfaces.

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