Contribution ID: **1193** Type: **Invited Speaker / Conférencier invité**

Functional nanostructured surfaces for biomedical applications

Tuesday 14 June 2016 08:30 (30 minutes)

Metals currently used for prosthetic reconstructions (e.g. titanium) enjoy a relatively good success rate, but their performance drops significantly in patients with compromised health status, and post-surgical infections still remain an important challenge. In addition, there are still no such metals that are able to respond to any deterioration of their relationship with the host tissue. To address these needs, different nanotechnology-based strategies have been exploited. Among these, the creation of nanoporous surfaces by simple yet efficient (electro)chemical treatments and the use of polymeric coatings, have emerged as a very effective approach to provide antibacterial properties, drug-delivery capacities and advantageous physicochemical cueing to cells. In this context, we investigated the effects of nanoporous surfaces generated by simple oxidative nanopatterning on the adherence of two common bacteria responsible of implant-associated infections and one yeast strain found in hospital settings. Nanoporous titanium surfaces are also very attractive for their capacity to act as metallic platforms for controlled drug release directly at the implantation site. In this context, we have loaded treated surfaces with Vancomycin, a commonly used antibiotic, and studied the elution profile engendered by the 3-dimensional network of nanosized pits. In order to adapt such technology towards the creation of 'smart'materials for in situ 'gated'release, we have employed a chitosan-poly(ethylene oxide) (PEG) hydrogel demonstrating a pH-dependent drug release. Such change has been associated with bone remodeling and infections as well as tissue inflammation. Nanoporous surfaces lend themselves to being an effective substrate to immobilize polymeric coatings because of their enhanced surface area and greater amount of binding sites. In this context, we employed a mussel-inspired polymer, poly(dopamine), and carried out extensive investigation of its biological in vitro effects to better understand its direct physicochemical cueing to adhering cells.

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Session Classification: T1-6 Nanostructured and Functional Nanomaterials (DCMMP-DIAP) / Nanomatériaux nanostructurés et fonctionnels (DPMCM-DPIA)

Track Classification: Condensed Matter and Materials Physics / Physique de la matière condensée et matériaux (DCMMP-DPMCM)