Structural Studies of Lipid Bilayers on Titania Surfaces by Means of Polarization Modulation Infrared Reflection Absorption Spectroscopy

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Titanium and titanium-based materials are used and tested as implants due to their high biocompatibility. The native oxide layer which grows on titanium surfaces is of great biomedical importance, since pure metallic surfaces are often toxic for a biological medium interacting with the implant surface. In a living organism the implant material is exposed to electrolytes, lipid cell membranes and proteins. The initial stages of adsorption are crucial for the biocompatibility of the implant.

For a detailed structural, conformational and hydrational analysis of an adsorbed or adsorbing organic layer on surfaces the polarization modulation infrared reflection absorption spectroscopy (PM IRRAS) can be used. This method requires a highly reflecting surface, limiting the application of metal oxides and semiconductors. Calculations of the reflectivity, the phase shift and the mean square electric field (MSEF) of the *p*- and *s*-polarized IR radiation show that some ultra thin metal oxide and semiconductor layers when deposited on a gold surface can be successfully applied for PM IRRAS. It was shown that the reflectivity, the phase shift and the MSEF in up to 20 nm thick titanium layers with its 3-4 nm thick native oxide layer are comparable to that on pure gold. The surface selection rule is fulfilled.

A lipid bilayer of 1,2-dimyristoyl-*sn*-glycero-3-phosphocholine (DMPC), serving as a model lipid membrane, was deposited using the Langmuir-Blodgett- and Langmuir-Schaeffer techniques on a titania surface. The transfer was done in liquid expanded (LE) and liquid condensed (LC) state and the structure of both lipid bilayers was compared. The structure of the bilayer in LE state is dominated by the interactions between the zwitterionic phosphatidylcholine polar head group and the titania surface. Due to the low surface coverage the intermolecular distances are large and provide much space for water of hydration. The positively charged choline group is tilted by 70° toward the surface and the negatively charged phosphate group has a small tilt of 15° to the surface normal. This opened structure corresponds to the B crystal structure of DMPC. In LC state, the intermolecular distances in the bilayer are reduced. The polar head group is weaker hydrated, the choline group has a smaller tilt (55°) and the phosphate group a larger tilt of 30° to the surface normal. This structure corresponds to the crystal structure A of DMPC.