1 year post-doctoral position starting from October-December 2019

Chemical and physical treatments of silicon nitride for dense and robust molecular grafting

Keywords: thin films, silicon nitride ; etching ; plasma treatment (PECVD) ; biofunctionalization

Workplace : Laboratoire de Physique de la Matière Condensée, Ecole Polytechnique, 91128 Palaiseau (France) and Institut Lavoisier de Versailles, 78035 Versailles	from October-December 2019
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Silicon nitride Si_3N_4 is a material commonly used in microelectronic and glass industry for its strong mechanical resistance and its properties as insulator and chemical barrier. One important issue is to modulate the physico-chemical properties of the layer by the grafting of organic molecules. Nowadays, silanization process is widely used to functionalize SiN surface through its oxide layer. However, the resulting layers are not stable in various media including water due to easy hydrolysis of silane bonds. During a PhD thesis in collaboration with Saint-Gobain Recherche, the native oxynitride layer was successfully removed by using wet etching solutions, allowing the grafting of molecules through hydrolysis resistant Si-C or N-C bonds. We demonstrated that a H_2 plasma combined with a treatment in hydrogen fluoride solutions leads to the etching of the oxynitride layer and the formation of Si-H and N-H bonds. From this non-oxidized surface, a monolayer of decyl chains was covalently grafted by photochemical hydrosilylation through stable Si-C and N-C bonds. However, the surface coverage remained quite low due to the presence of inert Si-F formed during the etching and blocking some anchoring sites.

The proposed research project concerns a novel two-step procedure. First, the Si_3N_4 etching will be performed in an alkaline solution (KOH) to avoid formation of Si-F observed in fluorinated solvent. Then, a H_2 plasma will be applied in order to form a majority of the desired Si-H bonds. As a proof of principle, hydrosilylation of undecylenic acid by microwave and its further post-functionalization with peptides will be achieved to demonstrate the potentiality of highly robust and dense optical biosensors. Two main techniques, XPS and IR-ATR spectroscopy will be mainly used to characterize and quantify the grafted monolayers.

Candidates profile: The successful candidate should have a PhD degree in chemistry, physics or materials science and demonstrate knowledge in surface chemistry, thin films, and chemical/physical spectroscopies. Experience with the XPS data treatment will be an advantage.