M2 Sciences des Matériaux et Nano-Objets (SMNO)

Sorbonne Université, ENS Ulm, Chimie ParisTech, ESPCI, l'École Polytechnique

Proposition de stage 2018-2019

Laboratoire : Laboratoire de Physique de la Matière Condensée
Adresse : Ecole Polytechnique, 91128 Palaiseau (France)
Directeur du laboratoire : Mathis PLAPP

Responsable(s) du stage : Anne Chantal Gouget
https://pmc.polytechnique.fr/spip.php?article123
Téléphone : 01 69 33 46 80 ; E-mail: anne-chantal.gouget@polytechnique.edu
2nd Responsable(s) du stage: Damien AUREAU ; Institut Lavoisier de Versailles, 78035 Versailles
http://ilv.uvsq.fr
Téléphone : 01 39 25 43 85 ; **e-mail :** damien.aureau@uvsq.fr

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

Projet scientifique :

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, silanisation 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.

In collaboration with Saint-Gobain Recherche (CIFRE thesis), we succeed to remove the native oxynitride layer by using wet etching solutions, allowing the grafting of molecules through hydrolysis resistant Si-C or N-C bonds. We demonstrated that a hydrogen 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 sucessfully 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.[1]

The objective of this internship is to develop a 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, a radical polymerization of styrene will be performed.

Techniques utilisées : XPS, PECVD (plasma-enhanced chemical vapour deposition), ATR (attenuated total reflexion) –FTIR spectroscopy ; colorimetric assay
Qualités du candidat requises : Background and/or motivation for surface science

Rémunération éventuelle du stage : 570 eur/net
Possibilité de poursuivre en thèse ? oui
Si oui, mode de financement envisagé : bourse doctorale

[1] M. Brunet, D. Aureau, P. Chantraine, F. Guillemot, A. Etcheberry, A. C. Gouget-Laemmel*, F. Ozanam*. Etching and chemical control of the silicon nitride surface. *ACS Applied Material and Interface* **2017**, 9, 3075-3084.