Titanium Deep Etching, from Lab to Industry: Plasma Processes Reproducibility and Advanced Characterization

Rim Ettouri*[1], Thomas Tillocher[1], Philippe Lefaucheux[1], Feriel Laourine[1], Bertrand Boutaud[2], Gwénaël Bécan[2], and Rémi Dussart[1]

[1]Groupe de Recherches sur l'Énergétique des Milieux Ionisés (GREMI) – CNRS : UMR7344, Université d'Orléans – 14 rue d'Issoudun BP 6744, 45067 Orléans Cedex 2, France
[2]MISTIC SAS – MISTIC – 75 Promenade du Verger, 92130 Issy les Moulineaux, France, France

Résumé

Reproducibility dimension in the development of plasma processes is increasingly a demand in research projects. As new materials are etched at the laboratory scale, a common challenge is to prove "wafer-to-wafer reproducibility" with respect to existing materials at this very early stage. The industrial scaling up of plasma etching processes is not such a trivial task and requires some understanding of the steps involved and the restrictions associated with industrial reality. It has been shown that the interactions between inductively coupled plasmas and the reactor walls are responsible for the lack of reproducibility of etching processes and drifts (1)–(3).
In this paper, we highlight the overall mechanism of reactor wall deposit formation during the plasma etching of bulk titanium to produce implantable Bio-MEMS (biomedical microelectromechanical systems). This research is aimed at controlling the contamination layer in the reactor, potentially with a conditioning plasma, allowing stable processing conditions and highly anisotropic etching profile to be achieved.

The investigations require an extensive characterization phase that focuses on the chemical microanalysis of the surface and the study of the topography. Focusing on the plasma-wall and plasma-surface interactions and their influence on the reproducibility of the etching process, we have identified the most important contaminants. A thorough analysis by the combined use of SEM+EDS and optical microscopy (OM) revealed that the use of fluorine-based plasmas results in the unavoidable deposition of fluorinated species on the walls.

If these results are useful in understanding the process from the point of view of fundamental physics, they allow, from an industrial perspective, to perform the processes under identical conditions and to obtain reproducible results over the long term.

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*Intervenant

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Mots-Clés: Plasma Etching, Titanium, Process Drift, Chamber Walls Cleaning, Conditioning, Characterization, SEM, EDS, OM