# Plasma characterization during etching of V2O3 materials

Tatiana Chancelle Mbouja Signe[1], Cédric Mannequin[1], Aurélie Girard[1], Christophe Cardinaud[1]

[1]*Institut des Matériaux de Nantes Jean Rouxel (IMN) , CNRS, Nantes Université, UMR 6502*
*2 rue de la Houssinière, 44322 Nantes, France*

mél: **Tatiana.SIGNE@cnrs-imn.fr**

Vanadium Oxides have gathered particular interest over the past three decades for their diverse applications as thermal insulators (glazing for smart windows) [1], catalysts (to facilitate oxidation reactions) [2], supercapacitors [3], memory devices [4], and neuromorphic networks [5] for the microelectronics industry. For the latter two applications, control and understanding of the manufacturing process is crucial to ensure optimum and reliable performances of the targeted microelectronic devices. In particular, the etching processes by cold plasma (also called Reactive Ion Etching) can downsize the material for its functionalization into a given device while maintaining the properties observed at the macroscale. These RIE processes must ensure compliance with the critical dimension of the pattern and limit the introduction of structural or chemical defects that could impede the performance or lead to a breakdown of the device. In the case of vanadium oxide, reports on RIE process are scarce and many opened questions have to be addressed: Which plasma chemistry to use to ensure the formation of volatile products, and for which plasma parameters? What plasma surface interaction mechanisms are involved and what are the surface states of vanadium oxides during/after the etching process? My PhD will try to answer these questions and consists of a joint investigation of the plasma characteristics and surface properties of vanadium oxide.

I investigate and characterize the electrical and chemical properties of the plasma through *in situ* diagnostics tools such as the Langmuir probe, Optical Emission Spectroscopy (OES), and later Mass spectrometry (MS). Regarding the plasma/surface interactions, I rely on *in situ* X-ray Photoelectron Spectroscopy (XPS) to investigate the surface chemical state and the overall composition of the oxides before, during, and after the plasma process. I also characterize surface morphology changes through Atomic Force Microscopy (AFM) or Scanning Electron Microscope (SEM). Finally, I can measure the etched depth through profilometry.

The first studies of XPS were performed on vanadium oxide ($V_2O_3$) in order to study the chemical composition of the surface of the material. Then we focused on the electrical characterization of argon (Ar), sulfur hexafluoride ($SF_6$), and oxygen ($O_2$) plasma using the Langmuir probe. Additionally, we utilized Optical Emission Spectroscopy (OES) to investigate the impact of process parameters on plasma properties.

**References:**

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