ENRICHING NANOINDENTATION WITH IN SITU ELECTRICAL MEASUREMENTS AND SEM OBSERVATIONS

Fabien Volpi*†[1], Morgan Rusinowicz , Chaymaa Boujrouf , Guillaume Parry , Muriel Braccini , and Marc Verdier

[1]Science et Ingénierie des Matériaux et Procédés (SIMaP) – Centre National de la Recherche Scientifique : UMR5266, Université Grenoble Alpes, Institut polytechnique de Grenoble - Grenoble Institute of Technology – 1130 rue de la Piscine, BP 75 38402 Saint Martin DḤères, France

Abstract

A nanoindentation set-up coupled to electrical measurements and integrated into an SEM will be presented. Its application to the understanding of the interplay between mechanical and electrical behaviors of materials will then be discussed.

First, it will be shown how electrical measurements can be used to monitor the contact area between the indenter tip and the sample during indentation. The case of ideal materials (oxide-free surface (1)) or real materials (with a passivating surface layer (2)) will be considered. The in-situ SEM configuration is used for the precise positioning of indents on a complex system (precision _˜100nm, Figure 1). The local mechanical properties will then be extracted accurately at a micrometer-scale (Figure 2).

Then, the interplay of mechanical and electrical behaviors of dielectric thin films will be addressed. First, we will show how a mechanical stress can modify the electrical conduction mechanism in a dielectric film (3). Counterintuitive observations will be fully explained numerically (by FEM analysis) by correcting the Poole-Frenkel conduction law with a strain-dependent factor. A threshold strain is identified as the keystone linking this strain-dependent conduction to the current line distribution within the dielectric. Finally, we will briefly show how an electrical stress can degrade the mechanical properties of dielectrics.

This presentation aims at demonstrating the strength of coupling electrical measurements to nanoindentation, either to process mechanical raw data or to understand the strong mechanical-electrical interplay in materials.

*Speaker

†Corresponding author: fabien.volpi@grenoble-inp.fr