PhD offer – Labex CEMAM

Development and application of a characterisation tool based on the local probing of mechanical, electrical and microstructural properties

Context

The increasing demand for multifunctionality has become a recurring challenge for a wide panel of application fields : microelectronics, microsystems, energy harvesting, structural applications,… One of the tracks to answer these rising needs is a smart association of materials with tailored geometries. The complexity of these new materials requires the development of higher performance characterisation tools. In that purpose, a **multifunctional characterisation instrument** is currently developed in SIMaP lab, mainly based on **electrical and mechanical coupling**. This set-up is tailored for advanced characterisations at the sub-micrometer-scale of **structural and functional materials displaying small-scale organisations**.

The heart of this characterisation device is a **nanoindenter** (Figure 1), coupled with **highly sensitive electrical test instruments**. Such a coupling is both a technical challenge and a breakthrough in terms of local characterisation. This electrically-functionalised nanoindenter will also be integrated in-situ in a new state-of-the-art **Scanning Electron Microscope** (SEM) equipped with EBSD (Electron Back Scattered Diffraction) and EDS (Energy Dispersive Spectroscopy) techniques (Figure 2).

Figure 1 : Nanoindenter (Nanomechanics Inc)

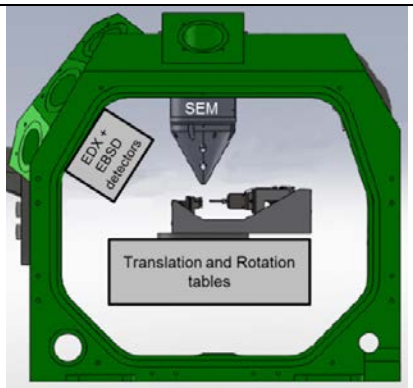

Figure 2 : Scheme of the nanoindenter integration in-situ with an SEM chamber

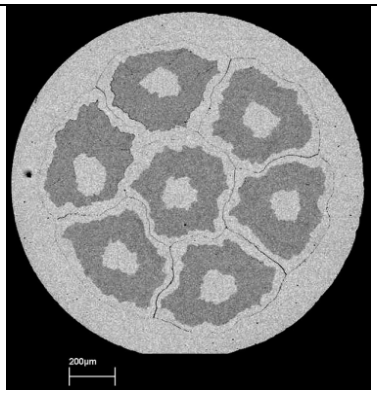

Figure 3 : Drawn wire of DSS alloy (from CEMAM / Ugitech)

PhD project

The PhD work will focus on both the **development and the application** of this state-of-the-art tool. Those two aspects will progress in parallel all along the 3 years.

- Instrumental development (1/3 of the PhD time)
  This characterisation tool is still under development. Thus the PhD student will participate to its set-up and optimization. In particular, the electrical functionalisation of the nanoindenter remains a challenging topic.
- Material characterisation (2/3 of the PhD time)
  All through the tool development, local mechanical and electrical characterisations will be carried out on dedicated materials (already available in the lab). As a starting point, some reference systems (gold nano-particles, aluminum thin films,…) will be used to assess the tool performances.

Then more complex materials (figure3) will be characterized, in-situ and/or ex-situ SEM. We expect our tool to enhance and refine the standard information usually extracted from nanoindentation tests (local stiffness, local hardness,…). The local nanoscale phenomena (taking place at the tip-to-sample interface) will also be discussed.

Required degrees and skills

- Required degree

  Master degree in "Materials science" or "Physics".

  Applications with Master degrees at the interface between "Instrumentation"/"System engineering" and "Materials science" will also be examined.

- Material science and characterisation

  A reliable formation in materials science is expected. General knowledge on materials mechanics would be beneficial, as well as a general knowledge on materials characterisation techniques.

- Instrumental development

  This part of the work will require good practical and technical skills. The ability to propose and assess "do-it-yourself" solutions will be essential.

- Other skills

  A high motivation for academic and applied research.

  Good English skills.

Salary

This PhD is funded by the CEMAM labex (http://cemam.grenoble-inp.fr/cemam/).

Net monthly salary : ~1400€.

Possibility to participate to Master-level teaching at the Université de Grenoble (especially at the Grenoble INP-Phelma engineering school). In that case, the net monthly salary reaches ~1650€.

Keywords

Material science / Nanoindentation / Instrumentation / Electrical characterisation / Mechanical characterisation / Scanning Electron Microscopy

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This project will take place at SIMAP lab (http://simap.grenoble-inp.fr/) in Grenoble (France).