Institut Matériaux Microélectronique Nanosciences Provence

Postdoc position at IM2NP (AMU CNRS Marseille)

Subject: Nanostructure and crystallization mechanisms in Phase-Change Materials for Advanced Embedded Memory Applications

Description:
As it was recently demonstrated by the INTEL OPTANE™ memory technology, Phase-Change Materials (PCM) are the most promising materials for new generations of Non-Volatile Memories (NVM). This is the result of their ultra-high scalability and short programming times lying in between volatile DRAM and Flash non-volatile memories. As a result, PCMs offer the opportunity to achieve Storage Class Memory which are at the forefront in order to achieve innovative brain-inspired computing devices and neuromorphic circuits. The principle of operation of PCM memories is to switch reversibly the PCM between an amorphous and a crystalline phase by means of electrical pulses application. Reading the state (amorphous or crystalline) is based on the huge and unique resistivity contrast between the two phases. Nowadays, the most promising PCM to target embedded applications (mobiles, automotive, micro controllers…), i.e. requiring high stability under temperature excursions, are multi-phased complex composition alloys $Ge_xSb_yTe_z$ (GST). The latter raise critical issues on the interplay between interfaces, composition, stresses or confinement and crystallization kinetics. Optimizing the phase change material is central to ensure the reliability levels of automotive applications. This work aims to study finely the optimized chalcogenides (typically GST) integrated in memory cells through original experiments to follow *in situ* the crystallization of thin films and the nanostructures of PCM in both amorphous and crystalline states. Coupling the measurement of the substrate curvature and the scattering of synchrotron x-rays makes it possible to monitor, in the amorphous phase and during the crystallization, the evolution of the stresses and the microstructure (deformations, nature of the phases, grain size, thicknesses, densities) as a function of temperature or as a function of time at constant temperature. First, the evolution of stress and microstructure will be studied in thin films and then in patterned structures. *In situ* measurements of curvature and X-ray diffraction will thus be carried out in the laboratory and on a synchrotron beamline. The beam time will be requested on French (SOLEIL, ESRF) but also foreign (SLS, PETRA III, MAX IV, ALS, APS) installations. Thirdly, a reflection will be undertaken to carry out *operando* diffraction measurements on dedicated structures. It will be a matter of measuring, by time-resolved diffraction, the crystallization of a memory cell during cycling.
This work will be performed in strong partnership with STMicroelectronics.

Candidate profile:
The ideal candidate holds a PhD degree in Material Sciences (or equivalent), has a solid background in physics, good communication skills and is proficient in written and spoken English. Knowledge of x-ray scattering (and possibly previous experience with synchrotron radiation) and programming skills will be highly appreciated.
Starting year: 2020
Laboratory: IM2NP (http://www.im2np.fr/)
Industry: STMicroelectronics, Crolles/Rousset – France (http://www.st.com)
Duration : 2 years (with 1 year possible extension).
Location: IM2NP-Marseille

Applications including a CV, two letters of recommendation and a letter of motivation should be sent by email to Prof. Olivier THOMAS (olivier.thomas@im2np.fr) and Dr. Magali PUTERO (magali.putero@im2np.fr)