In Grenoble, in the center of the Alps, LETI is an institute for applied research in micro and nano technologies, information and health technologies.
A privileged interface between the industrial world and academic research, every year it ensures the development and transfer of innovative technologies in various sectors via research programs using our technological platforms.

Research fields: phase-change memory, chalcogenide, materials science, structure, physics, atomistic simulations, AIMD/DFT

CIFRE PhD position at CEA-LETI, Grenoble, FRANCE

Understanding the structure and properties of metavalent phase-change materials based on innovative chalcogenide compounds for a technological breakthrough in embedded Phase-Change Memory

Overview and context

Owing to their high scalability, short switching time (~ns), Phase-Change Materials (PCM) are very promising for new generations of Non-Volatile Memories (NVMs). For high temperature embedded applications (ePCM), the most promising PCMs are multiphased complex composition alloys (Ge-rich GST with ST composition), which raise critical issues due potential unwanted Ge phase separation occurring at crystallization. In that context, this PhD project targets a breakthrough with the study of innovative very high temperature PCM compounds (data retention of the RESET amorphous state >> automotive criteria & soldering reflow thermal budget) without any parasitic phase separation upon crystallization. Recently, a Leti team has proposed a peculiar Ge-Se-Te composition that is remarkably stable (>250°C for 10 years) in the amorphous state but that also exhibits very interesting crystalline state properties that have not been reported before (no description of the atomistic or electronic structure). The aim of this PhD is to couple advanced structural characterizations (electron microscopy, synchrotron X-ray experiments …) with modern simulations (AIMD/DFT) to get an understanding and further master the properties of such new PCMs.

Work description

Depicting and understanding the origin of the unprecedented and unique electronic properties of the crystalline state of Ge(Sb)SeTe-based chalcogenide glasses is the key tool to find the best compromise between stability/switching speed/energy for ePCM. This PhD project aims at proposing alternative PCMs without any phase separation aiming at replacing ST GST alloy and opening a breakthrough in the field. For that purpose, the phD student will have an access to Leti clean room facilities for PCM thin films elaboration (200/300 mm industrial sputtering tools) and characterization (Raman, ellipsometry, XRD, XRR, WDXRF, resistivity, Hall…) as well as access to advanced characterization tools such as state-of-the-art STEM imaging and synchrotron radiation facilities through beamtime at ESRF or SOLEIL synchrotrons (XRD, XAS etc…). Besides, the structure results will be coupled to PCM test vehicles devices and AIMD/DFT calculations through the co-supervision of the PhD by theoreticians of Liège University.

The chalcogenide group of P. Noé at CEA-LETI is now internationally recognized for his expertise in chalcogenide field from materials science toward devices for memory, photonic, thermoelectric or spintronic applications. Its longstanding collaboration framework with JY Raty (Liège Univ., Belgium), one of the most recognized theoretician in the field, is a unique opportunity for this PhD project. The CEA is working with ST on PCM activities in frame of a bilateral program in which this CIFRE phD will take part.

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Academic level: Master2 or engineering diploma
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Starting period: End 2022