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Development of new metrology protocols of chalcogenide materials related to elaboration parameters

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Chalcogenide materials (based in S, Se and Te) have unique electrical and optical properties; they have the ability to change from amorphous to crystalline phase when an electric current is applied. This phenomenon makes them a reference in new applications such as electronic memories (Phase Change RAM and Conductive Bridge RAM) and in optronics (Photonics and photovoltaics applications). In order to industrialize these films, chemical composition, depth profile, surface and interfaces effects need to be well known and well controlled. Current techniques used in industry (such as EDXRF, TEM, RBS and TOFSIMS) can determine these parameters but they are destructive or time-consuming, so they are unproductive to be applied in an industrial in-line environment. X-ray techniques can provide precise and accurate measurements and at the same time they are non-destructive methods. For example, combined analysis by Grazing Incidence X-ray Fluorescence (GIXRF) with X-Ray Reflectivity (XRR) can provide depth-profile composition and density of multilayered samples.
In this work, metrology protocols based in x-ray techniques will be developed to characterize novel chalcogenide materials and their integration in complex technological stacks. Wavelength Dispersive X-ray Fluorescence (WDXRF) will be employed to study the chemical composition, while the combined analysis GIXRF/XRR and Angle-Resolved X-Ray Photoemission Spectroscopy (ARXPS) will be applied to investigate surface/interface effects and depth profile analysis. Furthermore, experiments with low-energy (35-1800 eV) and high-energy monochromatic x-rays (3-36 keV) will performed at the at the Metrology beam of SOLEIL synchrotron. The synchrotron-based metrology will complement laboratorial characterization in order to provide even more reliable measurements to better understand the chemistry of chalcogenide films and interfaces.
These protocols will be applied to chalcogenide films elaborated via magnetron sputtering. The sputtering parameters (working pressure, process temperature, power, and gas flow rate) will be evaluated to better understand the mechanisms of material deposition. Reactions at the interfaces will then be investigated so as to evaluate their impact on the local and average composition.

Key-words: Metrology protocols; X-ray techniques; XRF; XPS; Chalcogenides; Memory; Chemical composition.

Auteur principal: M. PESSOA, Walter (LETI CEA-Grenoble)

Co-auteurs: Mme ROULE, Anne (LETI CEa-Grenoble); M. NOLOT, Emmanuel (LETI CEA-Grenoble); Mme LÉPY, Marie-Christine (LIST CEA-saclay)

Orateur: M. PESSOA, Walter (LETI CEA-Grenoble)

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