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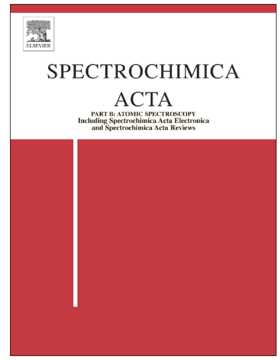

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Grazing Incident X-ray Fluorescence combined with X-Ray Reflectometry metrology protocol of Telluride-based films using in-lab and Synchrotron instruments

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Abstract

Telluride films are widely applied in data storage devices (advanced resistive memories, DVDs and Blue-rays disks), photovoltaic cells and infrared detectors. The properties of thin telluride alloys are deeply influenced by their chemical composition and compositional depth profile, whereas surface/interface effects may become preponderant in ultrathin films. The combination of X-ray reflectometry (XRR) and grazing-incidence X-ray fluorescence (GIXRF) is particularly adequate to probe these complex thin layered materials. In this paper, we evaluate the performances of Lab-based and synchrotron-based XRR/GIXRF strategies to characterize ultrathin (< 10 nm) amorphous titanium-tellurium films elaborated by Physical Vapor Deposition (PVD), and capped *in situ* with 5 nm-tantalum passivation layer. We highlighted the impact of the instrumental setup on the qualitative XRR and GIXRF data and on the quantitative information deduced from the combined analysis. Both synchrotron-based and Lab-based strategies were sensitive enough to track the impact of small PVD process changes on the chemical depth-profiles, and to unambiguously reveal undesired tantalum-tellurium inter-diffusion that was confirmed by X-Ray Photoelectron Spectroscopy.

Key-Words: GIXRF; XRR; XPS; Mass spectrometry; Tellurium; Thin films

1. Introduction

Tellurium is a chemical element from the group VI of the periodic table, also known as chalcogenide family. Telluride materials are widely applied in the development of data storage devices (e.g. advanced resistive memories, DVDs and Blue-rays disks). These applications rely on the ability of telluride alloys to change from amorphous to crystalline phase (reversibly) when an electrical, magnetic or optical signal is applied [1, 2]. Recently, telluride materials (such as GeSbTe, SbTe, TiTe, etc.) have received an increasing interest for Resistive Random Access Memories (RRAM), such as Phase Change Random Access Memory (PCRAM) and Current Bridging Random Access Memory (CBRAM), some of most promising candidates for the next generation of non-volatile memories. For example, compared to current flash, PCRAM features faster random access time, read and write throughput, as well as other characteristics such as high endurance and scalability to the deca-nanometer range [3].

The properties of telluride films are deeply influenced by their chemical composition and compositional depth profile. For example, the crystallization temperature of GeSbTe alloys (figure 1) can be tuned by increasing the Ge proportion, resulting in better thermal stability, and therefore, better data retention [4]. Surface/interface aspects must also be considered, not only