Contribution ID: **36** Type: **Contribution type**

X-ray Absorption Spectroscopy studies on GeTe based Phase-Change Materials

Wednesday, 9 June 2021 10:40 (20 minutes)

Phase-change materials (PCMs), mainly based on chalcogenide alloys based on compounds lying on the GeTe/Sb₂Te₃ pseudo binary line of the Ge-Sb-Te ternary phase diagram (namely GST alloys such as GeTe, Ge₂Sb₂Te₅ ⋯), are a promising and widely studied class of materials for the production of non-volatile Phase-Change Memories and innovative Storage Class Memories [1].
GeTe can be considered as a prototypical system of the PCM family. Therefore, this explains that it has been the subject of a huge number of studies aiming at describing its structure in order to unveil origin of the unique properties of PCMs. GeTe is also a building block of the so called Interfacial Phase-Change Memory (IPCM) where very thin layers of 0.7 nm of (GeTe)₂ are deposited alternatively with pseudo-2D Sb2Te3 layers by means of van der Waals epitaxy [2, 3].
One aspect that determines heavily the macroscopic behaviour of these materials in their amorphous state is the presence of peculiar and somehow undesired homopolar bonds like Ge-Ge. For this kind of studies, X-ray Absorption Spectroscopy (XAS) is an ideal experimental technique as it permits the analysis of the local environment of selected components of the alloy. Ge-Ge bonds are reported to play a major role in the amorphous phase of GST alloys where the presence of this anomaly has been related to be at origin of an increased crystallisation time [4]. In the case of GeTe films, a careful analysis of XAS data show that the role of Ge-Ge bonds is related to the resistance drift phenomenon that represents a major hurdle for the development of multi-level memories with PCMs [5].
In the case of structurally complex IPCMs the use of ab-initio calculated of XAS spectra from theoretical structures permitted to address the problem of intermixing between the GeTe and SbTe layers [6] as evidenced in a recent study [7].

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Session Classification: Session