Intermediate-Range Order in GeSbTe Studied by Anomalous X-ray Scattering

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ABSTRACT

We have studied the structure of four different Ge-Sb-Te phase changes materials (PCM) along the pseudo-binary line $(GeTe)_{1-x}(Sb_2Te_3)_x$ between $0 \le x \le 0.66$ by anomalous X-ray scattering (AXS). The data were analyzed with Reverse Monte Carlo modelling and show consistent developments of short- and intermediate-range order parameters (SRO and IRO, respectively). The description of the IRO is a specific advantage of AXS over comparable characterization methods, which have previously been used to describe the amorphous Ge-Sb-Te structure. On this length scale, we find a distinct Ge-based backbone network. The character of this network gradually changes from a more tetrahedral to a more octahedral arrangement (as it is found in the corresponding crystal structure) with increasing content of Sb₂Te₃ (see Fig. 1). Thus, the network gradually becomes more 'crystal-like' – which is an important factor when considering the impact of the structure on macroscopic material properties like the optical contrast or the increasing phase-change speed along the pseudo-binary line. It also correlates with the development of the optical dielectric constant $\varepsilon_r(0)$ of the amorphous phase (see Fig. 1).



Fig. 1: Ratio of octahedral vs tetrahedral arrangements around Ge atoms in Ge-Sb-Te (circles) and (extrapolated) dielectric constants (triangles) [1,2].

References:

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