I. Physikalisches Institut (IA)
Physik neuer Materialien
RWTH AACHEN UNIVERSITY

I. Institute Of Physics (IA)
Phase Change Materials
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Topic for a Master's Thesis (English)

„Characterization of Nanostructures and Evaporation Behaviors in IV - VI Alloys by Atom Probe Tomography"

IV-VI chalcogenides are very promising due to their unique properties and potential applications in many fields like phase change memory (PCM), thermoelectricity and photonics.[1] These applications would benefit from the characterization and tailoring of nanostructures. The nanostructures have been proven to be able to facilitate switching process in GeTe-Sb_2Te_3 superlattices, and their scattering effect on phonon transport is also one of the most effective methods for the enhancement of thermoelectric performance.[2] Therefore, characterization of the nanostructures of PCMs is of vital importance.

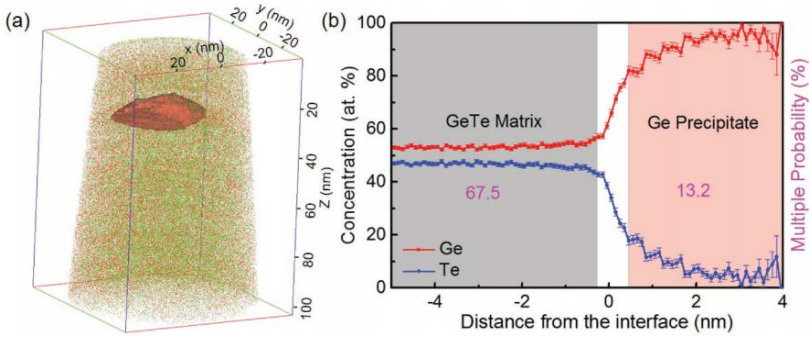

Fig.1 3D reconstruction of a crystalline GeTe sample.

Atom Probe Tomography (APT), which has the unique ability of performing 3D analysis, provides an opportunity to obtain 3D structural images on the near-nm scale and also 3D compositional images on almost ppm scale. Moreover, the applied high electric field during APT measurement can also help us to understand the field evaporation mechanism and bond breaking process. This bonding break process is related to the bonding mechanism inside the sample and is responsible for many unique properties in both phase change memory (large dielectric constant) and thermoelectric materials (anharmonicity). This unique technique provides us an effective way to distinguish different bonding mechanisms.[3]

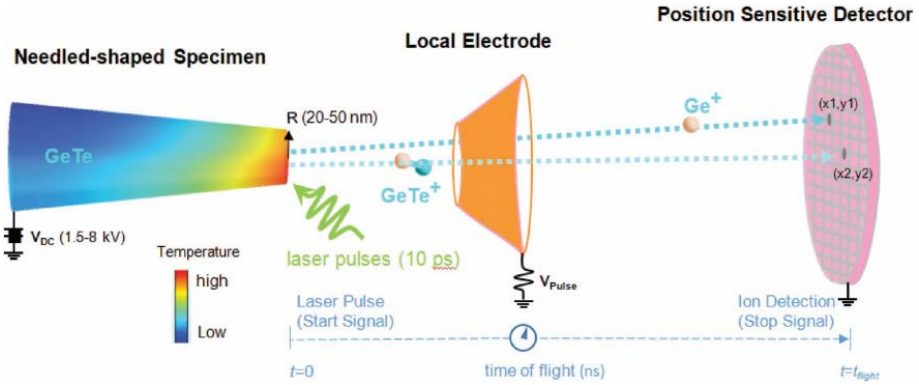

Fig.2 Schematic of atom probe tomography.

The scope of this thesis will be the investigation of the envolvement of nanostructures upon annealing, the laser-assisted evaporation behavior and the bond breaking process in APT. To achieve these purposes, both pure IV-VI samples and some alloys will be studied and many analytical techniques, such as XRD, FTIR, SEM/FIB and APT will be involved in this thesis. We are looking for a master student who is interested in advanced characterization techniques.

[1] Siegrist et al., *"Phase Change Materials: Challenges on the Path to a Universal Storage Device"*, Annual Review of Condensed Matter Physics (2012), DOI: 10.1146/annurev-conmatphys-020911-125105

[2] Simpson, R. E., et al. "Interfacial phase-change memory." Nature nanotechnology 6.8 (2011): 501.

[3] Zhu, Min, et al. "Unique Bond Breaking in Crystalline Phase Change Materials and the Quest for Metavalent Bonding." Advanced Materials 30.18 (2018): 1706735.

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