I. Physikalisches Institut (IA)
Physik neuer Materialien

RWTH AACHEN UNIVERSITY

I. Physikalisches Institut (IA)
Phase-Change Materials
Prof. Dr. rer. nat. Matthias Wuttig

Topic for a Master Thesis

„Fabrication and Laser-Switching of MBE-grown GeSnTe -PCM thin films“

Phase change materials (PCM) exhibit a stable amorphous and crystalline phase under ambient conditions. Reversible switching between the two phases allows the application of PCMs in chips for neuromorphic computing and photonic devices. Most of these phase change materials feature a newly proposed chemical bond type coined metavalent bonding (MVB). Typical PCM-devices feature various GeSbTe-stoichiometries, Sb_2Te_3 or GeTe. Another material class of high interest for PCM applications are GeSnTe alloys, which exhibit metavalent bonding and desirable switching characteristics. Furthermore, heterostructures of GeSbTe/Sb_2Te_3 were found to improve device efficiency by an order of magnitude. The usage of GeSnTe in heterostructures might offer exciting ways to improve PCM performance further.

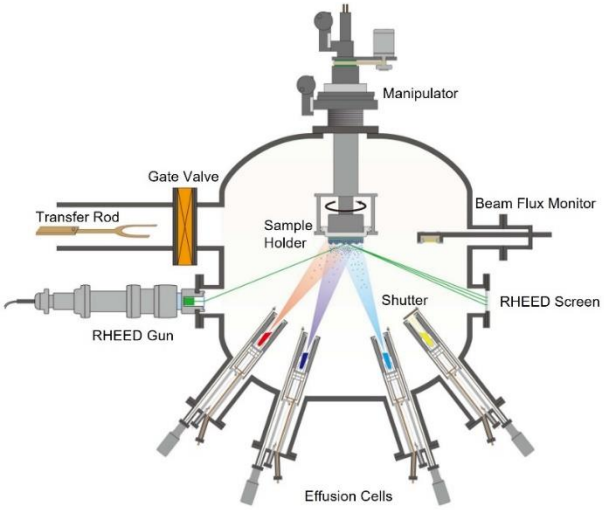

Fig 1: *Schematic of a typical MBE system with all major components similar to the MBE chamber at the Nanocluster in the Forschungszentrum Jülich. Adapted from [2].*

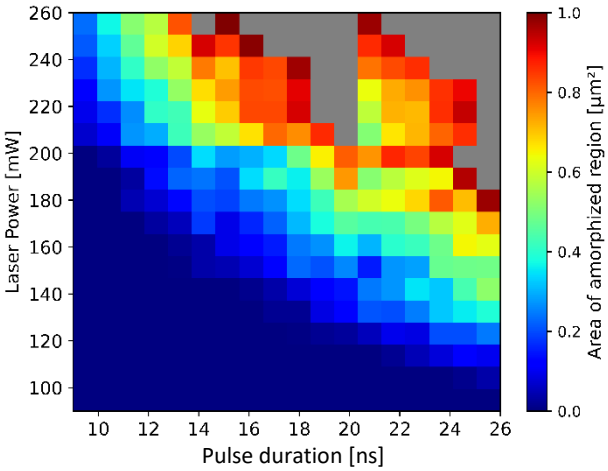

Fig 2: *Power-Time-Effect Diagram (PTE) of laser amorphization of GeSbTe-thin film used to characterize the switching efficiency.*

The goal of this work is the fabrication, characterization and laser switching of GeSnTe thin films and GeSnTe/Sb_2Te_3 heterostructures. The thin films are grown under ultra high vacuum in a Molecular Beam Epitaxy (MBE) setup in the FZ Juelich. Different stoichiometries of GeSnTe and varying heterostructures should be grown and tested with the Laser Switching Set-up.
Prior to this work, the general growth process of GeSnTe has already been optimized. The beginning of this project will therefore focus on incorporating GeSnTe in heterostructures and intensive structural characterization via XRD. Subsequently, the fabricated samples will be amorphized with a laser and trends in the amorphization processes will be analyzed regarding energy-efficiency and chemical bonding in the samples.

In the scope of this thesis the $(GeTe)_x(SnTe)_{1-x}$-samples will be fabricated by Molecular Beam Epitaxy (MBE) to achieve high quality films in the devices. Scanning electron microscopy (SEM) and x-ray diffraction (XRD) will be exploited to investigate the thin films. A laser switching set-up in combination with EBSD and microscopy will be employed to study the switching processes in the samples.

The experimental work on this thesis will be conducted both at the Forschungszentrum Juelich and RWTH Aachen.

If you are interested to work on this project in the innovative laboratories of the FZ Juelich, contact us!

[1] M. Wuttig and B. Kooi. „Chalcogenides by Design: Functionality through Metavalent Bonding and Confinement.“ Adv. Mater. (2020).

[2] M. Shimozawa *et al.* "From Kondo Lattices to Kondo Superlattices". Rep. Prog. Phys. (2016).

Lucas Bothe
l.bothe@fz-juelich.de