I. Institute of Physics
Physics of New Materials

RWTH AACHEN UNIVERSITY

Institute of Physics IA
Phase Change Group
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Bachelor Thesis in Physics

Linking Glass Dynamic and Crystallization Kinetics in a PC-related material

Phase Change Materials (PCMs) experience a large contrast in physical properties between an amorphous and the crystalline phase: In amorphous PCMs, optical reflectivity is low while electrical resistivity is high compared to the crystalline phase. Rapid phase switching is key ability for realizing phase change data-storage devices, such as Phase Change Random Access Memory (PC-RAM) and probably 3D-XPOINT. Crystallization kinetics however are strongly dependent on the amorphous phase in which crystallization takes place. To understand phases and their transitions in the amorphous phase, the thermal response is studied in calorimeters.

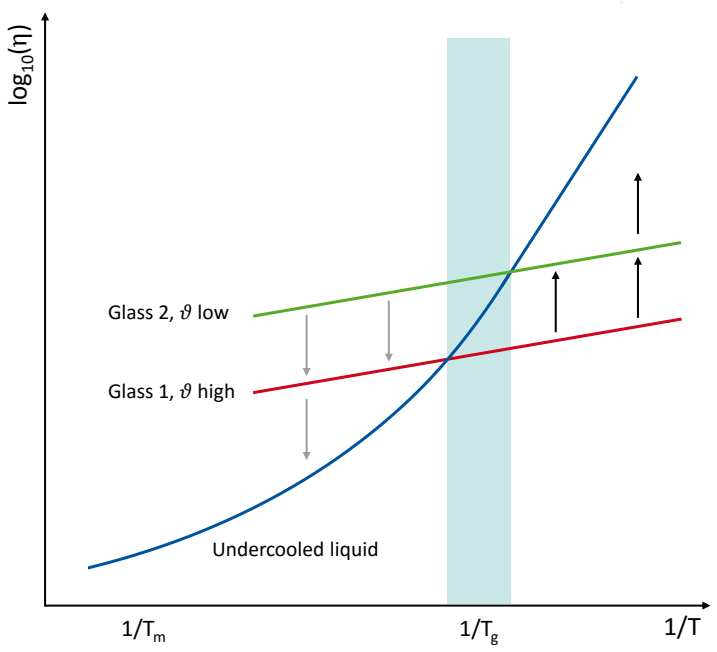

Figure 1: Viscosity of a liquid (blue curve) as a function of reciprocal temperature. While the UCL is in meta-stable equilibrium, the glass is not. Upon cooling from the melt, the temperature of glass transition is cooling rate ϑ dependent. When a glassy state (e.g. red curve) is annealed at $T < T_g$, it undergoes structural relaxation in order to resemble the UCL more as indicated by the arrows (black).

Despite very few crystal structures of a material, there is a continuum of amorphous phases as Fig. 1 demonstrates. These amorphous phases differ in physical properties like viscosity η, diffusivity D, Short and Medium Range Order (SRO and MRO). In principle there are two categories of amorphous phases: The Undercooled Liquid (UCL) and glassy phases. While the UCL is thermodynamically meta-stable, glassy states are non-equilibrium phases. Hence, only glassy phases experience a change in physical properties while heat treated by structural relaxation, as also depicted in Fig. 1. Since, e.g. the crystal growth velocity v_g is proportionally related to the Diffusivity D, structural relaxation of a glassy phase results in a change in η, D, SRO and MRO and subsequently influences crystallization kinetics. Moreover, phase transitions in the UCL regime have been reported recently for PCMs and related materials, which occasionally are trapped in glassy states.

In the scope of this Bachelor thesis, both glassy phase of a PCM-related material shall be manipulated and the thermodynamic difference in these manipulated glassy phases shall be detected by utilizing Differential Scanning Calorimetry (DSC). If possible, crystallization kinetics measurements will be conducted via microscopy methods, additionally. Based on the data obtained, the link between glass dynamics and crystallization kinetics in this material shall be unveiled.

Requirements for the candidate:

- Programming understanding, fast ability to learn MatLab
- Ability to work structured, independently and responsibly
- Profound knowledge on solid state physics

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