Laser-induced dynamics in PCMs: unravelling Ge rich-GeSbTe crystallization and amorphization mechanisms using short-pulse laser annealing, providing an opening for cycling studies.

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Phase Change Random Access Memory (PCRAM) using Ge-Sb-Te (GST) alloys offers a promising solution for advanced memory applications due to its reversible transitions between high resistive (amorphous) and low resistive (crystalline) phases triggered by electric or laser heating. These materials are attractive for their rapid crystallization, low power requirements, and data retention, leading to increased research focus [Noe18], [Noé16]. However, the use of PCRAM in critical sectors like automotive and aerospace is limited by the phase change temperatures of GST alloys, which are challenging to increase through germanium content modification, light element doping, and complex fabrication [Redaelli22].

Our study investigates the crystallization mechanisms of Ge-rich GST films under laser irradiation. The aim is to determine the effects of laser pulse duration from milliseconds (ms) to microseconds (µs) on the crystalline state and composition during phase transitions. Employing a laser setup with a quasi-continuous wave (QCW) laser at 1064nm, in-situ reflection, infrared transmission microscopy, and time-resolved reflectometry, we can study large-scale samples under conditions relevant to industry, including specific temperatures and annealing times, with the capability for multiple cycles.

We analyzed four distinct samples, each with variations in composition, thickness, and layer stacking of Ge-enriched and doped GST, prepared on Silicon substrates via industrial PVD deposition. These were scrutinized using HR-STEM and EDX pre- and post-irradiation. Our first findings with ms-scale irradiation are very promising for cycling studies, that are essential for assessing the durability and reliability of memory cells. Such research is crucial for future optimization of memory cell parameters [Pirovano04].