Fragility of chalcogenide liquids and its relevance for phase-change memory

A. Lindsay Greer
Department of Materials Science & Metallurgy University of Cambridge, Cambridge, UK.

Email: alg13@cam.ac.uk

Abstract:

The use of chalcogenide thin films in optical data storage is a well-established technology. Switching between glassy and crystalline states is achieved by laser heating. Writing is by melting of the originally crystalline material; the melted area is rapidly cooled into a glassy mark of relatively low reflectivity. Erasing is by crystallization of such marks. Current interest focuses on phase-change random-access memory (PC-RAM) in which similar switching is achieved by electrical Joule heating. In device operation, the switching must be fast. On the other hand under likely storage conditions, the switching must be sufficiently difficult to ensure non-volatility of the memory. The temperature dependence of the switching rates is thus a central consideration in this application, and that explains the interest in fragility. The speed of PC-RAM is limited by the rate of crystallization, and we examine in particular the links between fragility and the temperature dependence of crystallization rate. A variety of experimental and atomistic modelling studies will be reviewed. The nature of chalcogenides, in terms of their fragility and crystallization behaviour, will be set in the context of glass-forming systems in general. Some consideration will also be given to the relevance of switching kinetics for such applications as neuromorphic memory and non-von-Neumann computing.