

Phase Change Materials: The Importance of Resonance Bonding and Disorder

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Phase change media are among the most promising materials in information technology. They are already employed in rewriteable optical data storage, where the pronounced difference of optical properties between the amorphous and crystalline state is employed. This unconventional class of materials is also the basis of a storage concept to replace flash memory. In this application the material is rapidly and reversibly switched between the amorphous and crystalline state. Hence it is essential to understand the structure, bonding and the resulting material properties of both the amorphous and crystalline state. This talk will discuss the unique material properties which characterize phase change materials. In particular, it will be shown that the crystalline state of phase change materials is characterized by the occurrence of resonant bonding, a particular flavour of covalent bonding [1]. This insight is employed to predict systematic property trends [2] and to develop non-volatile memories with DRAM-like switching speeds potentially paving the road towards a universal memory [3]. Phase change materials do not only provide exciting opportunities for applications including ‘greener’ storage devices, but also form a unique quantum state of matter as will be demonstrated by transport measurements [4]. It is remarkable that in the crystalline state there is such a high degree of disorder that in some materials even localization is observed, leading to charge transport properties which closely resemble amorphous semiconductors.

[1] K. Shportko et al., *Nature Materials* 7, 653 (2008)

[2] D. Lencer et al., *Nature Materials* 7, 972 (2008)

[3] G. Bruns et al., *Appl. Phys. Letters* 95, 043108 (2009)

[4] T. Siegrist et al., *Nature Materials* 10, 202 (2011)