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Experimental challenges in observation of topological phases in chalcogenide and modified oxide glasses and amorphous materials

P Boolchand
University of Cincinnati, USA

Three topological phases of network glasses, flexible, intermediate and stressed-rigid are now widely recognized in chalcogenide and modified oxides. These are manifested as network connectivity is steadily increased in the 2 < <r> < 2.67 range. Here the mean coordination number <r>, serves as a measure of network connectivity, and can be tuned by chemical composition. Near <r> = 2.40, and over a small but finite range of <r> called the intermediate phase (IP), networks acquire unusual functionalities; they exhibit high glass forming tendency, acquire a vanishing enthalpy of relaxation at T_g to display square-well like thermally reversing windows, become isostatically rigid and stress-free. Furthermore, the fragility index (m) of chalcogenide melts displays a global minimum (m<20) for IP compositions. One then recognized that IP melts possess high viscosity and undergo slow homogenization. Raman scattering of dry chalcogenide melts encased in evacuated quartz tubes examined along the length of a melt column show that even 2 gram sized batches when reacted at 200-300°C above the liquidus take nearly a week of reaction time for observed line shapes to become identical or batch compositions to homogenize. In dry and homogeneous chalcogenides (Ge-Se, Ge-S and Si-Se) the IP boundaries are abrupt, while in heterogeneous ones these are usually smeared. In modified-oxides, traces of bonded water lead to a narrowing or even collapse of the IP. In dry and homogeneous glasses IP boundaries are sharp and these self-organization effects are reflected in a variety of physical properties.

Biography

P Boolchand has received his PhD in Physics from Case Western Reserve University in 1969. He is a Professor of Electrical, Computer Engineering and Physics at University of Cincinnati. He has held Visiting Positions at Stanford University, University of Paris and Katholieke University of Leuven. He has co-authored over 275 journal publications. He is Fellow of the American Physical Society, and recipient of the Stanford Ovshinsky Award.

boolchp@ucmail.uc.edu

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