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Surface Phenomena in Glassy Chalcogenides by Gas Sensing

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Abstract

The surface phenomena in glassy chalcogenides (GCh), including those caused by gas adsorption, are reviewed and discussed. A detailed quantitative analysis is made on experimental data taken on glassy and nanocrystalline chalcogenide based thin films of $As_2S_3Ge_8$ – Te system, physically grown in vacuum. Particularly the measurements of the frequency dependence of the AC conductivity of these films in the frequency range 5 Hz–13 MHz are reported, in both dry air and its mixture with a controlled concentration of different gases. The behavior of AC conductivity fits the generally accepted model of charge transport in disordered materials that implies both the extended states above mobility edges and the localized states in the gap, but the variation of the environmental conditions by applying of even very small amount (ppm) of toxic gases, dramatically influences the AC conductivity spectra. This is evidence that for some chalcogenide materials the surface phenomena disturb the energetic distribution of the states adjacent to the surface leading to modifications of the transport mechanisms by the surface. The modification of the surface transport mechanism by adsorption of gas species alters the physical parameters of the surface, i.e. the work function, the diffusion and the dipolar potential, the screening length, etc., which lead to variation of both surface and total electrical conductivity, impedance and its spectral distribution, as well as of electric capacity of functional structures based on these materials. The examples are given of the development of room temperature operating functional structures designed to detect nitrogen dioxide and hydrogen sulfide in dry and humid media via variation of their impedance or capacitance.