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On the Influence of Surface Phenomena Upon Charge Transport in Te-Based Glassy Semiconductors

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Abstract

The effect of surface phenomena caused by adsorption of NO_2, CO_2, and H_2O vapor on the charge transport in thin films of chalcogenide glassy semiconductors (ChGS) of the $As_2S_3Ge_8$–Te system has been studied. The investigations have been carried out by measuring the dynamic conductivity of these films in a large (5 to 10^7 Hz) frequency range, in both dry air and its mixture with controlled concentrations of the above mentioned gases at different temperatures. In addition to this, the temperature dependence of DC conductivity has also been measured for an unambiguous interpretation of the results. It is shown that depending on material's composition, the AC conductivity in dry air can either be frequency independent across the full range or be frequency independent until ≈10^4 Hz, with increasing $\sigma(\omega) \approx \omega_n$ ($n \approx 0.7$) at higher frequencies. This behavior demonstrates that for these glassy films there is a competition of several transport mechanisms, so that depending on frequency at normal temperatures the charge is carried: by free holes or by tunneling between localized states at either valence band edge or those near the Fermi level. An estimation has been made for the density of states at the Fermi level of $As_2S_3Ge_8Te_{13}$ that appears to be $N(E_F) \approx 1.3 \times 10^{21}$ eV^{-1} cm^{-3}. Changes of environmental conditions either in air humidification or application of even very small (ppm) concentration of NO_2 dramatically influence the spectra of dynamic conductivity that, on the other hand, remain

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nearly unaffected upon CO_2 vapor application. This is evidence that for some chalcogenide materials the surface phenomena disturb the energetic distribution of states adjacent to surface, changing the transport mechanisms.