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Impact of Adsorbed Gases on the Transport Mechanisms in $Ge_8As_2Te_{13}S_3$ Amorphous Films

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Abstract

It is shown that the gas adsorption in chalcogenide glasses results in modifications of transport mechanisms by the surface, along with formation of surface localized states. A detailed quantitative analysis is made on experimental data taking on glassy thin films of $Ge_8As_2Te_{13}S_3$, physically grown in vacuum. The measurements of alternating current (AC) conductivity of these films have been carried out in the frequency range from 5 Hz to 13 MHz, in both dry air and its mixture with a controlled concentration of nitrogen dioxide, at different temperatures. It was found that the changes of environmental conditions by applying of even very small (ppm) amounts of toxic gases, e.g. NO_2, dramatically influences the AC conductivity spectra. This is due to a sharp increasing of holes concentration in the valence band of an ultrathin layer adjacent to surface, which results in modification of the dominant mechanism of current flow. In a definite frequency range the charge transport by hopping via valence band edge localized states becomes negligible and the mechanism of conductivity via extended states becomes the main until frequencies $\omega > 10^5$ Hz, at which the mechanism of hopping via localized states in the vicinity of Fermi level becomes predominant.