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Impedance Characterization of Gas Sensitive Chalcogenide Films

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Abstract

The gas sensing performance of chalcogenide thin films, investigated by the method of impedance spectroscopy is reported and discussed in order to assess their use in future gas sensors operating at room temperature. Along with the traditional use of Te films for such applications, impedance spectra of quaternary As2S3Ge8 – Te alloys have been investigated in both dry synthetic and humid air, as well as in their mixtures with different harmful gases. To elucidate the effect of tellurium, the quaternary compositions As2Te13Ge8S3 and As2Te130Ge8S3 with increasing concentration of Te have been investigated along with pure tellurium films. The films have been prepared by thermal vacuum evaporation onto Pyrex or sintered alumina (Al2O3) substrates carrying pre-deposited platinum interdigital electrodes. As shown by AFM, SEM and X–ray analysis the phase/state of the films depends on the composition, nature of the substrate and growth rate. The morphology of the films grown on sintered alumina substrates appears to consist of interconnected islands and dots, which facilitate a solid-gas interaction. It is shown that impedance spectra, being strongly influenced by the gaseous

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environment are also strongly influenced by material composition and phase/structural state of the film. Analyses of these spectra in the Cole – Cole interpretation allowed to evaluate the characteristic frequency, time constant, resistance and capacity of the films in both dry air and its mixture with target harmful gases. Modification of the chemical composition via addition of As, S and Ge atoms leads to structural/phase transformations, along with the appearance of new mechanisms of charge transport that influence the gas sensing performance of the chalcogenide based films.