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Room temperature a.c. operating gas sensors based on quaternary chalcogenides

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Abstract

Impedance spectra of quaternary As–Ge–S–Te based alloys were investigated in both dry synthetic air and mixture with nitrogen dioxide in order to assess the use of these materials in future gas sensors working at room temperature (22°C). To elucidate the effect of tellurium, the quaternary compositions As2Te13Ge8S3 and As2Te130Ge8S3, with increasing concentration of Te have been considered along with pure tellurium films. Shown by AFM, SEM and X-ray analysis the nature of the films was predominantly amorphous but the morphology of the films grown on sintered alumina substrates appears to consist of interconnected islands and dots, which facilitate the solid–gas interaction. Analyses in Cole–Cole interpretation allowed evaluating the characteristic frequency, time constant, resistance and capacity of the films in both dry air and its mixture with NO2. It is shown that impedance spectra being strongly influenced by gaseous environment are also strongly influenced by material composition and phase-structural state of the film. Sensitivity spectra to nitrogen dioxide denote the competitive influence of carrier transport via states of allowed bands, hopping between localized states in the extended band tails or tunneling (variable range hopping) between localized states close to Fermi level. Impedance sensitivity being maximal for amorphous As2Te13Ge8S3 is assumed to be controlled by this competition of transport mechanisms.