The dynamic conductivity of glassy $As_2S_3Ge_8$ –Te films by NO_2 adsorption

Marina Ciobanu

marina.ciobanu@fiz.utm.md, *ciobmarina@gmail.com*

Bd. Dacia 41, Chisinau, Department of Physics,
Technical University of Moldova

Spectra of dynamic conductivity of glassy chalcogenides in the $As_2S_3Ge_8$ – Te system were investigated in both dry synthetic air and its mixture with nitrogen dioxide in the 5 – 10^7Hz frequency range. The investigations were conducted to clarify the influence of gas adsorption on surface mechanism of conductivity and abilities of these materials to be used in development of gas sensing devices operate at room temperature. To elucidate the effect of material composition, the quaternary alloys $As_2S_3Ge_8$ – Te, with increasing concentration of Te have been considered along with pure tellurium films. The films of different compositions were prepared by thermal vacuum evaporation onto sintered alumina (Al_2O_3) substrates with a priory deposited platinum interdigital electrodes. Shown by AFM, SEM and X – ray analysis the phase – state of the films depends on material composition, being pure vitreous for $As_2Te_{13}Ge_8S_3$, but vitreous with tracks of crystalline tellurium in other considered materials. The morphology of the films appears to consist of interconnected islands and dots, which facilitate the interaction with target (NO_2) gas. It is shown that spectra of dynamic conductivity, being strongly influenced by gaseous environment are also strongly influenced by material composition.

It was shown that addition of nitrogen dioxide to dry synthetic air strongly influences the general shape of dynamic conductivity spectrum of glassy $As_2Te_{13}Ge_8S_3$ films. The essential modification of dynamic conductivity spectra under gas (NO_2) adsorption gives evidence for a transition to another mechanism of current flow on the surface, which in a definite frequency range controls the whole charge transport. In pure synthetic air the dynamic conductivity increases with frequency increase and the conduction mechanism due to charge hopping between localized states in the gap, was assumed to be the main in the $10^3 < \omega < 10^5\ Hz$ frequency range. NO_2 additives in the environmental gas leads to nearly independence of dynamic conductivity on frequency until ~$3 \cdot 10^5\ Hz$, which means that the conductivity is realized via extended states, i.e. the band – to – band mechanism becomes the main. Such transition does not take place for all materials in question. It was found that in some compositions, the adsorption nitrogen dioxide does not change the whole aspect of the spectral distribution of dynamic conductivity. The spectrum appears to be independent on frequency, except of very high frequencies ($\geq 10^7\ Hz$), where the strong adsorption of acoustic phonons occurs [1]. The impact of NO_2 adsorption, amount only to a nonessential increasing of dynamic conductivity over the entire spectrum.

References

[1] N. F. Mott and E.A. Davis, Electron processes in non-crystalline materials, Clarendon Press, Oxford (1979).

Acknowledgements

This work was supported by DFG SCSD AS of Moldova, grant 15.817.02.29A .The authors express their gratitude to Dr. M. Enache at NCMST of TUM for SEM analysis and Dr. G. F. Volodina at IAF ASM for XRD analysis.