Charge transport peculiarities of amorphous Te films

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The charge transport in thin amorphous tellurium films was studied from investigation of temperature effect on both direct (DC) and alternating (AC) electrical conductivity.
The films were grown by vacuum thermal evaporation of pure tellurium (99.9%) on Pirex substrates and / or sintered alumina ceramics. The morphology, micro-structural and phase-state analyses were performed using scanning electron microscopy and X-ray diffraction, which have shown that the films were amorphous with insignificant crystals traces. The surface of the films grown on the glass substrates is continuous and smooth but those grown on Al_2O_3 consist of interconnected islands agglomerates separated by irregular spaces. Different metals, such as In, Au,and Pt, as well as the Ag pastes of different producers have been tested in order to realize the ohmic contacts, i.e. electrically transparent contacts. Thus, the symmetrical contacts from Pt and the Ag (Kontactol) paste have been identified as ohmic, being subsequently selected for electrical measurements. The measurements were carried out in a temperature range of 20-180^{0}Cand in a frequency range of 10^3- 10^6 *Hz*. The obtained results have shown that within the given temperature range, the DC dependence $ln\sigma$ - $10^3/T$ exhibits a single line, which corresponds to a single charge transport mechanism. This mechanism was identivied as charge transport via extended states above mobility edges and, according to theoretical model Mott and Davis [1] , can be described by the expression:

$$\sigma_{ext} = C\exp\left(-\frac{E_1}{kT}\right) = C\exp\left(-\frac{E_F - E_V}{kT}\right)$$

Based on this model, it was estimated the forbidden gap between mobility edges $E_g \approx E_F - E_V$, as well as the minimum metallic conductivity σ_{min} , that is the conductivity at the energetic level corresponding to valence band mobility threshold.

The AC investigations have shown that up to frequencies above 10^6 Hz, the dynamic conductivity of amorphous tellurium films increases with temperature increase, but practically does not depend on the frequency of the applied electric field that confirms the mechanism of electric charge transport via extended states, previously identified from DC measurements.

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References:

[1] N. F. Mott, E. A. Davis, Electron Processes in Non-Crystalline Materials, Clarendon Press, Oxford (1979).