Characterization of Grain-Boundary Barriers in CdTe Polycrystalline Films

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CdTe polycrystalline thin films are widely used for manufacture different optoelectronic devices such as solar cells and infrared detectors. It is generally believed that their properties are mainly determined by potential barriers at the grain boundaries(GBs). However, their crystalline structure and physical properties still remain unclear.

CdTe polycrystalline films were grown on sapphire substrates by a modified close spaced sublimation technique. The films with the average grain size ranged from ~10 up to ~400 μm were studied by measuring photoluminescence (PL) spectra, in-plain and transverse dark conductivity. For measurement of transverse conductivity films were sandwiched between buffer and cap layers of highly doped polycrystalline p-PbTe. The photoluminescence measurements were performed at 77 K under CW excitation using the 630 nm line of an He-Ne laser.

The correlation between the intensity of the dislocation-related radiation and density of GBs was observed in CdTe polycrystalline films. The most reasonable models of the dislocation-related photoluminescence in CdTe are the radiative emission through the dislocation core states or the states introduced by defect compexes with participation of Cd vacancies. The nonuniform distribution of deep defect inside the grains is proved by means of PL measurements at different excitation geometries.

The transverse conductivity is shown to be ohmic in the temperature range 200-400 K, whereas the in-plane is non-ohmic. The barrier height has been estimated to be ~0.2-0.25 eV. The measured values of intragrain and barrier resistance are comparable. Also, photovoltaic photoresponse measured in Schottky contacts prepared on the investigated films indicates n-type conductivity of GBs.

Based on experimental results possibility of modeling GBs by a dislocation network is discussed. Because the GB dislocations can serve as a getter for point defects, their non-uniform distribution seems to be inherent feature of CdTe polycrystalline films. Conclusions were made about optimal structure and electric parameters of CdTe polycrystalline films for the solar cell applications.