INFLUENCE OF OXIDATION ON THE THERMOELECTRIC PROPERTIES OF IV-VI THIN FILM STRUCTURES

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This report reviews the present status of our studies on the effect of the near-surface oxidation on the thermoelectric properties of IV-VI-based thin film structures.

It is known that the interaction with oxygen acting as an acceptor has a significant effect on the transport properties of lead chalcogenide crystals and thin films. There is specificity in the manifestation of oxidation in thin film structures, especially when the thickness of the oxidized layer is comparable with the thin film thickness and thus becomes an important parameter affecting the film properties. Practically in all works on the oxidation of lead chalcogenide films reported by now, the objects of studies were thick polycrystalline films (0.1 – 10 μ), and the varied parameters were the oxygen pressure or the duration and temperature of annealing.

In our works, the room-temperature dependences of the thermoelectric properties (the Seebeck coefficient, electrical conductivity, Hall coefficient, charge carrier mobility, and thermoelectric power factor) on the layer thickness (d=2-500 nm) for IV-VI -based (PbTe, PbSe, PbS, SnTe, GeTe) thin films, heterostructures and superlattices prepared by the thermal evaporation in vacuum onto (100) KCl or (111) mica substrates were obtained. Our studies showed dramatic property changes depending on d, including a change in the sign of the dominant carrier type from n to p in n-type films for d below some critical value depending on the compound species and charge carrier concentration in the target material. The thickness dependences of the thermoelectric properties were explained taking into consideration the existence of compensating acceptor states, which oxygen forms on the film surface, within the framework of a two-carrier model and/or a two-layer sandwich model that consider both n- and p-type carriers. The results of theoretical calculations were in a good agreement with the experimental curves. It was shown that the character of the thickness dependences of the thermoelectric properties, at least for $d < 100$ nm, does not reflect the true relationship between the layer thickness and these properties because of the oxidation taking place in thin films exposed to air. To obtain the true thickness dependences of the thermoelectric parameters, it is necessary to protect thin films from oxidation.

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