DR-32

SYNTHESIS OF FILMS OF $Sn_xPb_{1-x}S$ SOLID SOLUTIONS BY ION-EXCHANGE SUBSTITUTION

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Abstract. Lead sulfide thin films have been attracting much interest for many years due to their possible application in transistors, biosensors, photoresistors, and selective sensors.

Another advantageous material is substitutional solid solutions in the system PbS–SnS. It is deemed that, as their structure forms, inversion of the conduction bands of the components of the system is possible, entailing extension of the spectral range of material sensitivity to the long-wavelength domain.

As a result of 1.5-h-long chemical bath synthesis in an ammonia–citrate mixture at 353 K, PbS layers with good adhesion to a glass substrate were obtained, with their microimages being those presented in Fig. 1.

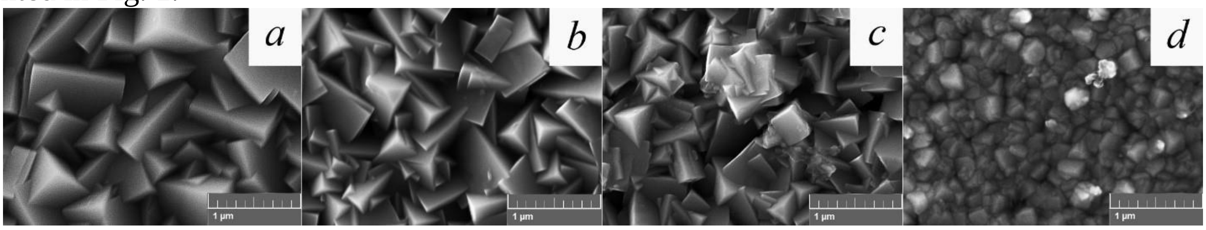

Figure 1. Micrographs of PbS films deposited (*a*) without adding ammonium halogenide and in the presence of (*b*) NH_4Cl, (*c*) NH_4Br, and (*d*) NH_4I

Lead sulfide films obtained without additives as well as those doped with chlorine Cl and bromine Br are dense layers with clear-cut faceting of crystallites which sizes are 0.2 to 1.0 μm. At the same time, I-doped films are formed by polyhedra with smoothed edges (100 to 350 nm).

As it is seen from Fig. 2, which shows electron microscope images of the layers, the base PbS film undergoes considerable changes after being modified in tin(II) salt aqueous solution at 363 K for 180 min. The sizes of microcrystallites of which the films are formed decreased significantly to the ranges of 100–600 nm (PbS: Cl, Br) and 50–100 nm (PbS:I).

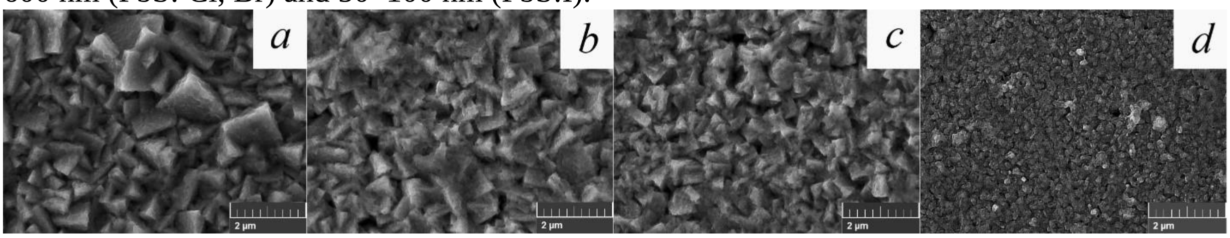

Figure 2. Micrographs of $Sn_xPb_{1-x}S$ deposited (*a*) without adding ammonium halogenide and in the presence of (*b*) NH_4Cl, (*c*) NH_4Br, and (*d*) NH_4I

X-ray diffraction revealed that, by means of the ion-exchange transformation of PbS films upon contact with tin(II) salt aqueous solution, films of supersaturated $Sn_xPb_{1-x}S$ solid solutions based on PbS with a NaCl structure (*B*1, space group $Fm\bar{3}m$) with the maximum content of the substituting component (tin) up to 22.2 at % are obtained.