New transparent conducting oxides. Progress in understanding cadmium-containing bulk and thin-film materials

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Abstract

An integrated bulk materials synthesis, film growth, characterization, and band structure investigation of known and new Cd-contg. transparent conductors is in progress. A study of the optical gap and thermopower in the $(1-x)CdIn_2O_4$-$(x)Cd_2SnO_4$ system reveals that change from a normal to inverse spinel for $x = 0 \rightarrow 1$ gives rise to a marked decrease in the fundamental gap, a different behavior than in the corresponding thin films. Pulsed laser deposition growth on MgO (111) of Sn-doped CdO yields epitaxial films with σmax = 42,000 S/cm, μ = 600 cm^2/Vs. Homogeneously doped $In_xCd_{1-x}O$ films exhibiting σmax = 17,000 S/cm, μ = 70 cm^2/Vs, and broader transparency windows than ITO are grown by chem. vapor deposition. Central to the properties of lightly doped CdO phases is the cubic microstructure for which ab initio calcns. reveal small conduction electron effective masses, a large shift of the CdO band gap with In doping, and a Cd 5s + In 5s mixing-induced gap.

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