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Thermoelectric Properties of Films and Monocrystalline Whiskers of Tellurium

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Abstract

Tellurium is an interesting semiconductor for thermoelectric applications because its thermopower is high (500 muV/K). Its figure of merit is low in the bulk because it has high thermal conductivity. However, in confined geometries, the phonon conductivity decreases due to phonon scattering. Therefore we have investigated the thermoelectric properties of Te films and whiskers. We report a study of the thermoelectric properties of Te films obtained by vacuum-condensation method on glass, polyamide, mica at various temperatures of condensation. The crystallographic structure of the films is characterized by the distribution function of the grain major axis. It is shown that the films condensed at 433 K possess the highest mobility. Te whiskers were grown from the paragas phase and they were single crystals in the form of hexahedral cylinder having cavities inside. When deposited on cold substrate, the cylinders had no cavities. The direction of the whisker crystal growth was always [0001] with respect to the whiskers length. It is shown that in films with the thickness of ~1 mum, the room temperature thermopower S is 330 muV/K and increases with temperature increasing (S = 450 muV/K at 450 K). The resistivity decreases with the temperature growth, as a result the power factor alpha 2 sigma increases by almost a factor of two. The 77 K electric conductivity of Te whiskers is 2-to-3 order-of-magnitude higher than in bulk crystals, presumably due to high structural perfection of whisker crystals. The thermopower in the range of 300 K is S = 400-750 muV/K.

Keywords: tellurium films, semiconductors, tellurium whiskers

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