Transport properties deviation of polycrystalline Bi_2O_2Se: Causes and solutions

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Bismuth oxyselenide (Bi_2O_2Se) is a promising thermoelectric (TE) material known for its high carrier mobility, non-toxic composition, and cost-effectiveness. However, its low intrinsic electrical conductivity necessitates doping to enhance performance. A major challenge is the significant variation in transport properties of bulk polycrystalline samples, even when synthesized using similar methods. This study examines the causes of these deviations and suggests solutions.

Through analysis of literature and synthesis of samples using different compounds and methods, we identified that impurities and foreign phases significantly impact the transport properties of undoped Bi_2O_2Se. Techniques such as powder X-ray diffraction (PXRD), scanning electron microscopy/energy dispersive X-ray spectroscopy (SEM/EDS), Raman spectroscopy, and ATR IR spectroscopy were used to detect these impurities.

To combat this issues, we propose a reproducible low-temperature solid-state synthesis process to produce high-purity Bi_2O_2Se. This method minimizes presence of high temperature associated secondary phases and ensures a consistent crystal structure, leading to improved and reliable transport properties. By refining synthesis techniques and controlling impurity levels, we aim to establish a standard for achieving consistent performance in Bi_2O_2Se.

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