Boosting ZT in Low-Temperature Thermoelectric Materials through Composite Strategies

Prof. Shih-Chen Shi

Department of Mechanical Engineering, National Cheng Kung University, Taiwan

This study optimizes Ag_2Se as a low-temperature thermoelectric material through mechanical alloying, secondary sintering, and composite engineering to enhance its thermoelectric performance. High-purity Ag_2Se was rapidly synthesized by mechanical alloying under 450 rpm and 10 min milling conditions. After spark plasma sintering at 573 K, the samples exhibited stable and superior thermoelectric properties with ZT values ranging from 0.75 to 0.95. Secondary sintering further increased the sample density to 99% and improved electrical conductivity, while grain refinement reduced thermal conductivity, resulting in enhanced ZT values of 1.6–2.4. Optimization of Ag-Se compositions revealed that $Ag_{56.6}Se_{43.4}$ achieved high electrical conductivity (1.3×10^5 S/m) and low thermal conductivity (0.1 W/mK). When introduced as a secondary phase into the Ag_2Se matrix, this composition significantly improved thermoelectric performance, achieving ZT values of ~8 at 20% addition. These results demonstrate that precise control of alloy composition combined with secondary sintering and composite strategies can markedly enhance the thermoelectric properties of Ag_2Se. The findings highlight its strong potential for low-temperature energy harvesting applications while improving material stability and practicality, advancing its prospects for industrial implementation.

==========

Experience:

(1) Invited Speaker, 2024 Taiwan-Japan Tribology Symposium (TJTS 2024).

(2) Invited Speaker, 2024 The 3rd Jurnal Pendidikan Teknologi Kejuruan (JPTK) International Symposium.

(3) Invited Speaker, 2023 The Kyutech-NCKU Joint Workshop

(4) Invited Speaker, 2023 Light Conference: International Conference on Optics in Materials, Energy, and Technologies.

(5) Invited Speaker, Japan-Taiwan Tribology Symposium 2019 (JTTS2019).