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# *Materials for Energy Harvesting: Advances in Silver Selenide Thermoelectrics*

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## Abstract

Materials science underpins the development of technologies that address pressing global challenges in energy, sustainability, and advanced applications. One compelling example is thermoelectric technology, which enables the direct conversion of heat into electricity without moving parts or emissions. Thermoelectrics can recover waste heat from industrial processes, transportation, and electronics, transforming otherwise lost energy into useful power.

Silver selenide ($Ag_2Se$) has emerged as a promising thermoelectric material for near room-temperature applications. Compared to conventional bismuth telluride compounds, $Ag_2Se$ offers advantages of lower toxicity, greater abundance, and superior mechanical stability, making it attractive for sustainable energy solutions. Recent research has explored flexible $Ag_2Se$ films for IoT and wearable devices, as well as bulk materials enhanced through doping, stoichiometry control, and nanostructuring.

Our group has advanced processing innovations using the cold sintering process (CSP), a rapid and efficient low-temperature densification method. CSP enables the formation of multi-scale hierarchical structures in $Ag_2Se$, enhancing phonon scattering, reducing thermal conductivity, and improving carrier transport through defect engineering. These strategies have yielded dimensionless figure-of-merit (ZT) values exceeding unity, with an average of approximately 1.0 from room temperature to 400 K, positioning bulk $Ag_2Se$ as a viable material for ambient energy harvesting.

These findings underscore how advances in materials design and processing can transform fundamental discoveries into practical energy solutions, reinforcing the central role of materials science in building a sustainable future.



***Keywords:*** *Energy Harvesting; Thermoelectric materials; $Ag_2Se$; Waste heat recovery;*


## Short Biography

**Supree Pinitsoontorn** received his D.Phil in Materials from Department of Materials, University of Oxford, UK, in 2008. He began his academic career as a lecturer in Physics at Khon Kaen University, Thailand, where he has continued to work and has been promoted to Professor of Physics. He has received several prestigious awards, including Newton Advanced Fellowship (Royal Society, UK 2016) and National Outstanding Researcher Award (National Research Council of Thailand, 2026). His research interests focus on advanced functional materials, such as thermoelectric materials, magnetic nanoparticles, geopolymers, and bacterial cellulose nanocomposites. His current work emphasizes the development of high-performance silver-based chalcogenide thermoelectric materials for converting waste heat into electricity. Professor Pinitsoontorn has authored more than 240 scientific articles and holds an H-index of 35 (Scopus).