

# International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

Balapur P.O., Hyderabad – 500005, Telangana, India



## A3-Waste Heat Recovery using Thermoelectric modules

### Overview

Unused waste heat is generated at all places like generators, automobile exhaust, and all industrial processes. One way of scavenging this waste heat into electric energy without any pollution is through thermoelectric (TE) technology, which is based on the conversion of waste heat into electric energy. Automotive waste heat recovery is the center of attraction for research as the world is currently facing numerous problems due to the increasing demand in energy for sustainable transportation. It is calculated that 33% of total fuel energy in automobiles is wasted as exhaust gas. Hence TE technology can play a vital role in automobiles by converting the waste heat into electricity. The solid-state devices based on the TE technology are known as thermoelectric generator (TEG). TEGs have no moving parts and have good reliability.

### Key Features

- Materials technology to fabricate P and N type bulk solids with ZT more than 1.5 and chemically and structurally stable up to 500°C, typical automobile exhaust temperature.
- Fabrications know how for making thermoelectric modules from the high ZT materials. Legs fabrication, Interconnects, bonding between leg and interconnects and packaging.
- Demonstration of TE module technology with more than 8 % efficiency to automobile manufacturer.

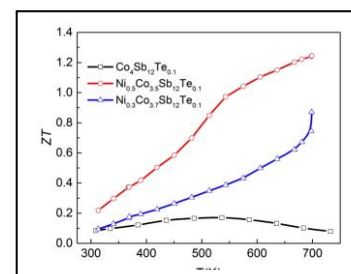
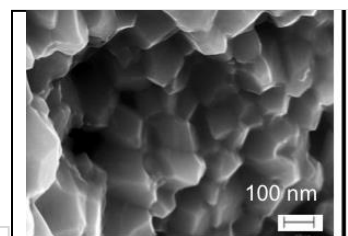


Figure of merit (ZT) vs T in skutterudites

### Potential Applications

- Exhaust heat recovery in automobiles
- Heavy industries: power generation from the waste heat



Nanocrystalline skutterudite

### Intellectual Property Development Indices (IPDI)

- Achievement of figure of merit  $\sim 1.3$  in skutterudite thermoelectric materials.
- Both n-type and p-type skutterudite thermoelectric material have been successfully fabricated.
- Scale-up and prototype module fabrication using skutterudite and PbTe systems are underway

Status	1	2	3	4	5	6	7	8	9	10
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### Major Publications

- Priyadarshini Balasubramanian, Manjusha Battabyal, Duraiswamy Sivaprahasam, Raghavan Gopalan, J. Phys. D: Appl. Phys 50 (2017) 015602.
- S Harish, D Sivaprahasam, M Battabyal, R Gopalan, J. Alloys. Comp., 667 (2016) 323.
- M Battabyal, B Priyadarshini, L Pradiptkanti, DK Satapathy, R Gopalan, AIP Advances, 6(2016)75308.

#### Centre for Automotive Energy Materials (CAEM)

IIT Madras Research Park, 7<sup>th</sup> Floor, Taramani, Chennai-600113

Tel : +91 44 66632817 / 66632812; Fax : +91 44 66632802

Email: sprakash[at]arci[dot]res[dot]in / manjusha[dot]battabyal[at]gmail[dot]com