# Development of thermoelectric generation system

R. Funahashi
National Institution of Advanced Industrial Science and Technology

We are facing serious problems for energy and environment. The demand of primary energy in the world was as much as 11,204 million ton of petroleum a year in 2004. It has spent a long time to appeal using up the oil. All oil deposits will be dried up about for 40 years in the present pace of consumption. But the amount of oil consumption will increase year by year. Nuclear power looks one of the strongest candidates for depetroleum. The “safety dogma”, however, is swaying after the huge disaster in Japan. In order to solve such energy problems, sustainable power generation systems; fuel cells, photovoltaic cells, concentrating solar power generation, wind-power generation, biomass, geothermal generation, and tidal power generation, are developing. The spread of new power generation, however, progresses very takes long.

The average total thermal efficiency of the systems utilizing this fuel is as low as 30 %, with 70 % exhausted to the air as waste heat. It is clear that improved efficiencies of these systems could have a significant impact on energy consumption. Electricity is a convenient form of energy that is easily transported, redirected, and stored, thus there are a number of advantages to the conversion of waste heat emitted from our living and industrial activities to electricity. Thermoelectric conversion is gathering attention, because it is the strongest candidate to generate electricity from dilute waste heat.

Oxide thermoelectric materials are considered to be promising ones because of their durability against high temperature, cost, no content of toxic elements, and so on. Many types of modules using p-type $Ca_3Co_4O_9$ and n-type $CaMnO_3$ have been produced. They show good generation power density higher than 4 $kW/m^2$. In order to enhance power generation and conversion efficiency, cascaded modules consisting of oxide and $Bi_2Te_3$ modules have been produced. A thermoelectric heat recovery system, which is composed of heat collection fins, cascaded modules, and water jacket for cooling, has been produced. A system includes 16 pieces of oxide/$Bi_2Te_3$ cascaded modules. The dimension of the system is about 300 mm squared. Power generation test was carried out using an incinerator. When the temperature of input gas was 1123 K, maximum power from the system reached 200 W.

The oxide and $Bi_2Te_3$ modules show good performance at temperature higher than 773 K and lower than 473 K, respectively. Thermoelectric materials possessing high thermoelectric figure of merit and oxidation resistance are necessary in the middle temperature range of 473-773 K. Silicides are the one of the strongest candidates. A new n-type silicide showing good oxidation resistance in air, will be talked.