CHAPTER 5

CONCLUSION

This thesis is focused on development of all process for fabrication oxide thermoelectric module and application at high temperature heat source. The oxide thermoelectric module were fabricated by using n-CBMO and p-CCO + Ag and silver paste connected TE materials. In addition, The Application in furnace TE module should be durability at high temperature and long life time for generation electricity.

THERMOELECTRIC MATERIALS

$Ca_{1-x}Bi_xMnO_3$ (x = 0.00, 0.01, 0.02, 0.03, 0.04, 0.05)

The Bi doping of $Ca_{1-x}Bi_xMnO_3$ for x = 0, 0.01, 0.02, 0.03, 0.04 and 0.05 ceramics were successfully synthesized by SSR and HP method. The crystal structure of all sample show single phase and orthorhombic perovskite structure. The lattice parameters and cell volume were increased with increasing Bi contents and increased density of all samples. The SEM image shows good compactness and connecting grain. Then   of all doped samples were decreased with decreasing Bi contents and showed metallic behavior. The thermal conductivity has been lowest at x = 0.03 of 3.6 W m^{-1} K^{-1} at 473 K. The highest dimensionless figure of merit = 0.065 at 473 K was increased more than un-doped $CaMnO_3$ about 3 time. The thermoelectric properties were improved by Bi doping, increasing carrier concentration, and using HP method could increase density of all samples.

$Ca_3Co_4O_9$ + Ag 10 %wt

The $Ca_3Co_4O_9$ + Ag 10 %wt ceramic was successfully synthesized by SSR and conventional sintering method. The crystal structure shown monoclinic structure or misfit-layer and exhibit anisotropic material. CCO + Ag has been exhibited anisotropic material due to the electrical resistivity is mainly determined by the resistivity in the ab-plane (ρ_{ab}) following grain orientation direction and addition Ag in CCO was increased mobility of the carrier scattering at the grain boundary. The S of all the samples increases with an increase in temperature in positive type indicated to p-type materials. The role Ag particle has been connected between cobaltite grains and agglomerated act as bypasses in carrier transports, which degrades of S. All the samples show similar transport behavior, metallic-like behavior below about 380K and semiconducting-like behavior above about 380K. The resistivity decreases significantly with increasing Ag content, Ag particle in material act to connections between cobaltite grains and increased mobility of the carrier scattering at the grain boundary will be reduced effectively. The ρ of CCO + Ag sample was decreased from CCO 65.47% at 473 K. The κ of all sample were decreased with increasing temperature. In addition, the κ in CCO + Ag sample exhibited high more than CCO due to effect of Ag dispersed between cobaltite grains not only reduces carrier scattering, but also contribute a good conductivity for phonon. The κ_e of CCO+ Ag was increased with increasing temperature because of ρ decreased. Then compared between κ, it was clearly the major of value got from the κ_l. The κ of CCO + Ag sample was decreased from CCO 20.11% at 473 K. The ZT value of CCO + Ag can exceed 0.038 at 473 K, which higher than CCO 2 time.

THERMOELECTRIC CELL AND MODULE

The TE cell 2 pairs had been generating maximum electrical power and open circuit voltage 5.71 mW and 80 mV, respectively. The TE module 32 pairs had been generating maximum electrical power, open circuit voltage and efficiency 68 mW, 1.27 V and ≈ 1.5 %, respectively. The matching load for TE module was nearly internal resistant of module so to decrease the internal resistant was important for improve performance of TE module. The R_I of TE module before test is 8.7 Ω at room temperature then TE was tested in 10 cycle at hot side 830 K. The R_I in all cycle non-significant change so stability were confirmed goodness joints all past in the module. The P_{max} and V_o shown stability for generation electricity in all cycle then the application in brick furnace was expected to stable and good working in long time.

THERMOGENERATOR APPLICATION

The thermogenerator generated electricity by using brick furnace heat source enough for charging battery 12V 7.5 Ah from 11.4 V in 3.5 h continues. Electric power of thermogenerator system were successful for using with lighting system load 15 W.

SUGGESTION

Thermoelectric materials

$Ca_{1-x}Bi_xMnO_3$ (x = 0.00, 0.01, 0.02, 0.03, 0.04, 0.05) samples should be improved density of sample and measured thermoelectric properties in high temperature.

$Ca_3Co_4O_9$ + Ag 10 %wt samples should be improved density of sample and measured thermoelectric properties in high temperature. In addition, should be improved ZT by doping other materials such as Bi, Fe etc.

Thermoelectric cell and module

The thermoelectric cell and module should be improved ohmic contract for reduce internal resistant and increased TE legs in module for increasing power density.

Thermogenerator application

The thermogenerator should be improved built in circuit board on system and cover all part for water resistant.