Fabrication of $Ni_{1-x}M_xO$ (M=Li, Na) and its thermoelectric properties

Yun LU, Mitsuji HIROHASHI and Hiroyuki YOSHIDA
Faculty of Engineering, Chiba University, 1-33, Yayoi-cho, Inage-ku, Chiba, 263-8522, Japan
E-mail: luyun@faculty.chiba-u.jp

Aim

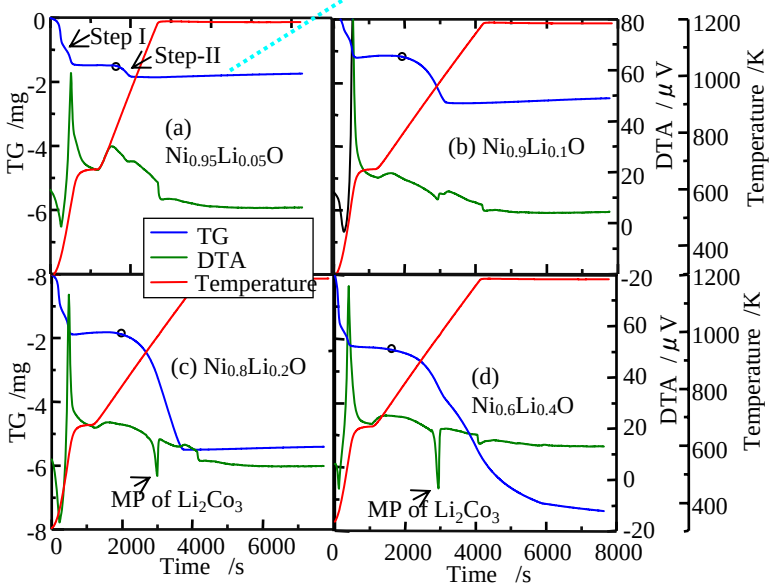
1. Analysis: The reactions and resultant compounds during sintering the powder mixture of NiO and Li_2CO_3 by DTA, TG and XRD
2. Measurement: Thermoelectric properties of the resultant compounds of $Ni_{1-x}M_xO$ (M=Li, Na)

Experimental

1. The start powder materials: 99% NiO, 99% M_2CO_3 (M=Li, Na)
2. The powders mixture of Ni:M = 0.95:0.05; 0.9:0.1; 0.8:0.2, 0.6:0.4
3. DTA, TG: 100 mg powder mixture → 40 K/min, 673K × 10 min → 10K/min, 1173 K × 1 h in air
4. Sintering: green compact with 40 × 4 × 1.5mm → 1173 K × 5 h in air → $Ni_{1-x}M_xO$

Results

Two decrease steps on TG line, Step-I (550~580 K), Step-II (~800 K)



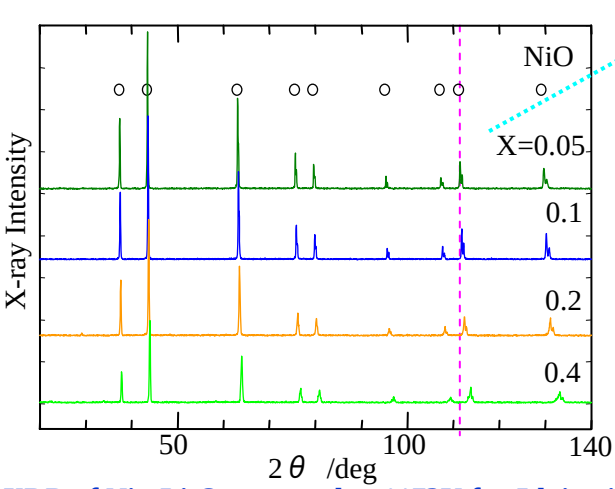
Thermal behavior of the powder mixture of NiO and Li_2CO_3

Step-II:

$0.25x\ Li_2CO_3 + (1-x)NiO + 0.125xO_2 \rightarrow Ni_{1-x}Li_xO + 0.25xCO_2\uparrow$

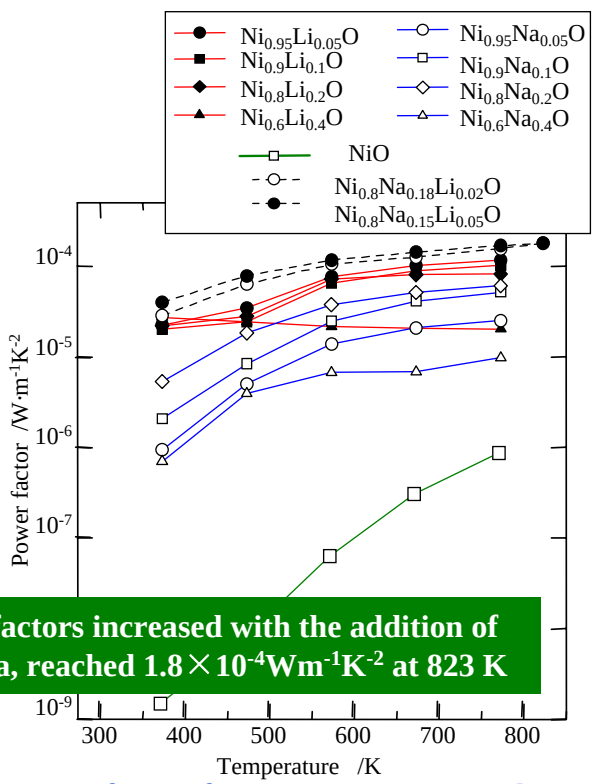
Calculated and measured weight decrease of the powder mixture at Step-II

x	0.05	0.1	0.2	0.4
Calculated weight decrease (mg)	0.39	1.6	3.9	5.5
Weight decrease at Step-II (mg)	0.38	1.5	3.7	5.1



The compacts show the same crystal structure with NiO, but shift to large angle with the addition of Li

XRD of $Ni_{1-x}Li_xO$ prepared at 1173K for 5 h in air



Power factors increased with the addition of Li or Na, reached $1.8\times10^{-4}Wm^{-1}K^{-2}$ at 823 K

Power factor of $Ni_{1-x}Li_xO$, $Ni_{1-x}Na_xO$ and $Ni_{1-x-y}Na_xLi_yO$ sintered at 1173K for 5h in air

Summary: There are two steps of weight decrease on TG of the powder mixture of NiO and Li_2CO_3. The formation of $Ni_{1-x}Li_xO$ is closely related with the Step-II from 800K. The crystal structures of $Ni_{1-x}M_xO$ (M=Li, Na) have the same one with NiO, but the peaks shift to large angle with the addition of Li. High performance of thermoelectric properties was obtained by adding Li or Na to NiO.