

# Thermoelectric Material Library via Laser Melting

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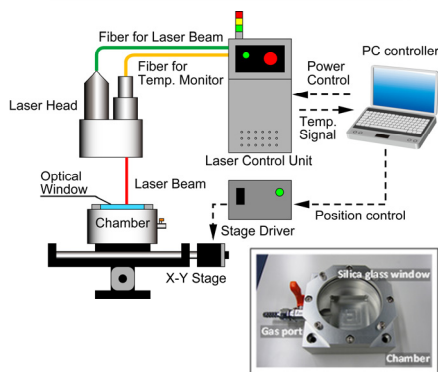
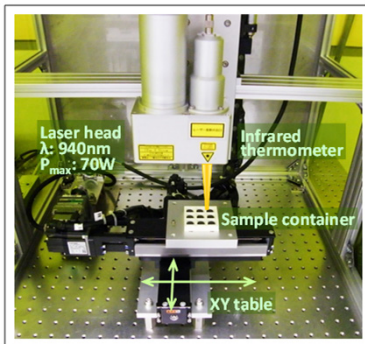
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## Research Highlights

- Rapid synthesis of thermoelectric compounds via laser melting is successfully applied to binary, ternary and quaternary systems.
- Thermoelectric properties of the compounds reasonably agree with literature.
- Process time of the laser melting requires 2-3 min/sample, and 20 samples/batch is available.

## Laser Melting System and Synthesized Compounds

### Laser Melting Apparatus



#### [Laser specification]

Semiconductor laser  
(Hamamatsu Photonics, LD-HEATER)  
Wavelength: 940nm±20nm (at 30W),  
Operation Mode: CW  
Laser Power: 0 - 70W  
Spot Size: 1.2mm (at WD of 90mm)  
Temperature monitoring range (two-color method): 200 - 800°C

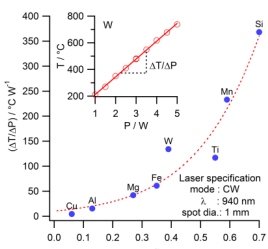
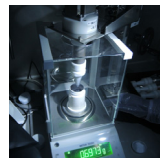


Fig. Heating characteristics of various metals illuminated by a laser diode. The inset shows the saturated maximum temperature (T) under continuous laser irradiation with a certain power (P). The slope (ΔT/AP) is plotted as a function of light absorptance (α)

### Process Flow of TE Library



**[Powder weighing]**  
Semi-automated weighing system (Alpha, Japan)  
Accuracy ±1 mg  
Process time within 1 min for 1 g weighing  
In globe box (PO<sub>2</sub> < 1 ppm)

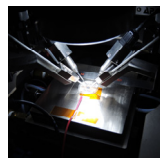
**[Installing]**  
Manual process  
Pelletizing into d 3 x h 5 mm<sup>2</sup> or pouring into Al<sub>2</sub>O<sub>3</sub> crucible (di:4.6mm)

Install pellets in the chamber  
Gas replacement or evacuation, if required

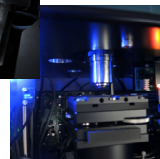
#### [Laser melting]

#### [Specimen mounting]

#### [Grinding and polishing]

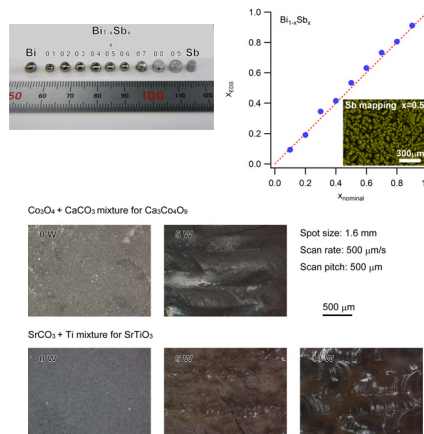


**[TEP measurement]**  
Thermopower and resistivity are measured using probe system. Base temperature is controllable with Peltier stage.



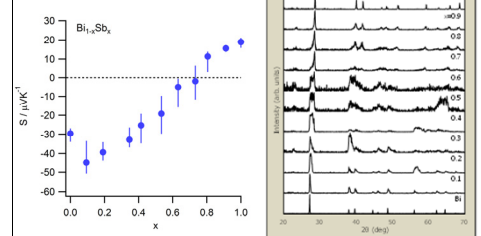
Thermal effusivity is evaluated using thermo-reflectance method (FDTR, Bethel Japan) after Mo sputtering.

### Laser melted materials (examples)

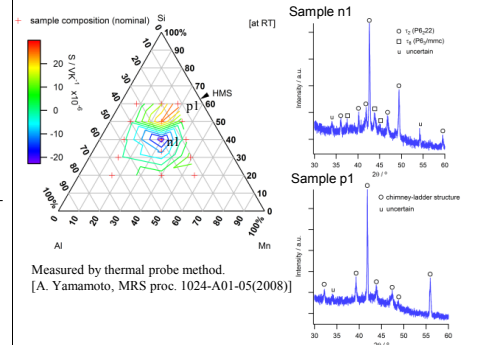


### Thermoelectric Properties

#### Bi-Sb



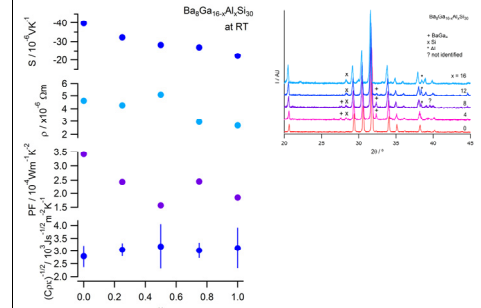
#### Mn-Al-Si



Measured by thermal probe method.

[A. Yamamoto, MRS proc. 1024-A01-05(2008)]

#### Ba-Ga-Al-Si (clathrate)



Reference  
Rapid synthesis of thermoelectric compounds by laser melting  
Y. Kinemuchi, M. Mikami, I. Terasaki, W. Shin, Materials and Design 106 (2016) 30-36

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