

Functional Material Search in Silicides

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Motoharu Imai

Managing Researcher, Research Center for Functional Materials

IMAI.Motoharu@nims.go.jp | https://samurai.nims.go.jp/profiles/imai_motoharu?locale=en



Background

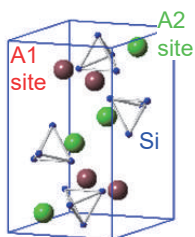
In order to achieve sustainable development of society, it is necessary to generate electricity by converting energy of renewable sources such as solar light and waste heat, instead of by using fossil fuel. It is preferable to synthesize the energy-conversion materials with high conversion efficiency from abundant and environmentally friendly elements.

Aim

Compounds of Si, the 2nd most abundant element in the earth crust, have potential to be the energy-conversion materials that meet the above requirements. I have studied Si compounds, silicides, with proper physical properties for solar-photovoltaic and thermoelectric materials. I have also searched new superconducting materials.

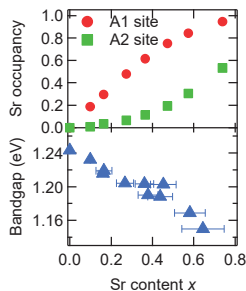
Advanced Research Topics

• Sr Substitution effect in the Zintl-phase solar-cell material BaSi_2



In BaSi_2 , Ba atoms occupy the specific crystallographic sites, A1 and A2.

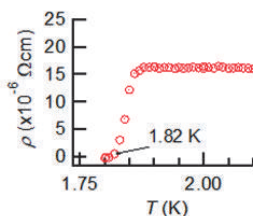
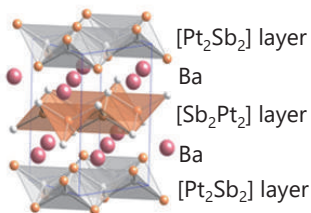
Sr substitution
→



Sr atoms preferentially occupy the A1 site.

Bandgap decreases with Sr content.

• Discovery of superconducting 122-type antimonide SrPt_2Sb_2 and BaPt_2Sb_2 : Related material with iron-based superconductors



Measurements of electrical resistivity, dc (or ac) magnetization, and specific heat

Superconducting critical temperature T_C

$T_C = 2.1$ K for SrPt_2Sb_2

$T_C = 1.8$ K for BaPt_2Sb_2

SrPt_2Sb_2 : The initially discovered superconducting antimonide related to iron-based superconducting materials

Publications

- M. Imai et al., Acta Mater. **148**, 492 (2018).
- M. Imai et al., Phys. Rev. **B 91**, 014513 (2015); Supercond. Sci. Technol. **26**, 075001 (2013).
- S. Ibuka et al., J. Phys.: Condens. Matter **28**, 165702 (2016).

Summary

- Crystal structure and electronic properties of Sr substituted BaSi_2 has been studied.
- Discovery of a new superconducting 122-type antimonide SrPt_2Sb_2 and BaPt_2Sb_2 related to iron-based superconductors

Research outcome

- Si-based materials for solar-photovoltaic and thermoelectric devices
- Si-based materials for light-emitting/receiving devices
- Superconducting materials with higher T_C