Science and Technology of Advanced Materials

Development of novel thermoelectric materials by reduction of lattice thermal conductivity

REVIEW ARTICLE

Author Chunlei Wan[1,2], Yifeng Wang[1,2], Ning Wang[1], Wataru Norimatsu[2,3], Michiko Kusunoki[2,3] and Kunihito Koumoto[1,2]

Affiliations [1] Graduate School of Engineering, Nagoya University, Nagoya, Japan
[2] CREST, Japan Science and Technology Agency, Kawaguchi, Japan
[3] EcoTopia Science Institute, Nagoya University, Nagoya, Japan

E-mail koumoto@apchem.nagoya-u.ac.jp chunlei.wan@gmail.com

Journal Science and Technology of Advanced Materials Create an alert RSS this journal

Issue Volume 11, Number 4

Citation Chunlei Wan *et al* 2010 *Sci. Technol. Adv. Mater.* **11** 044306
doi: 10.1088/1468-6996/11/4/044306

TOPICAL REVIEW

Abstract Thermal conductivity is one of the key parameters in the figure of merit of thermoelectric materials. Over the past decade, most progress in thermoelectric materials has been made by reducing their thermal conductivity while preserving their electrical properties. The phonon scattering mechanisms involved in these strategies are reviewed here and divided into three groups, including (i) disorder or distortion of unit cells, (ii) resonant scattering by localized rattling atoms and (iii) interface scattering. In addition, we propose construction of a 'natural superlattice' in thermoelectric materials by intercalating an *MX* layer into the van der Waals gap of a layered TX_2 structure which has a general formula of $(MX)_{1+x}(TX_2)_n$ (*M*=Pb, Bi, Sn, Sb or a rare earth element; *T*=Ti, V, Cr, Nb or Ta; *X*=S or Se and *n*=1, 2, 3). We demonstrate that one of the intercalation compounds $(SnS)_{1.2}(TiS_2)_2$ has better thermoelectric properties compared with pure TiS_2 in the direction parallel to the layers, as the electron mobility is maintained while the phonon transport is significantly suppressed owing to the reduction in the transverse phonon velocities.

PACS
72.20.Pa Thermoelectric and thermomagnetic effects
66.70.-f Nonelectronic thermal conduction and heat-pulse propagation in solids; thermal waves
63.20.D- Phonon states and bands, normal modes, and phonon dispersion
72.80.Ga Transition-metal compounds
72.20.Fr Low-field transport and mobility; piezoresistance

Subjects
Condensed matter: electrical, magnetic and optical
Semiconductors
Condensed matter: structural, mechanical & thermal

Dates
Issue 4 (August 2010)
Received 31 三月 2010 , accepted for publication 8 八月 2010
Published 20 九月 2010

in liquid media
Hidehiro Kamiya and Motoyuki Iijima 2010 *Sci. Technol. Adv. Mater.* **11** 044304

4. Processing of polysiloxane-derived porous ceramics: a review
B V Manoj Kumar and Young-Wook Kim 2010 *Sci. Technol. Adv. Mater.* **11** 044303

5. Progress in engineering high strain lead-free piezoelectric ceramics
Serhiy O Leontsev and Richard E Eitel 2010 *Sci. Technol. Adv. Mater.* **11** 044302

6. Electrode materials: a challenge for the exploitation of protonic solid oxide fuel cells
Emiliana Fabbri *et al* 2010 *Sci. Technol. Adv. Mater.* **11** 044301