Current trends in magnetic cooling at room temperature

Asaya Fujita*
Green Magnetic Material Research Center,
National Institute of Advanced Industrial Science and Technology (Chubu Center)
Anagahora 2266-98, Simo-Sidami, Moriya-ku, Nagoya, 463-8560, Japan

Recently, magnetic compounds undergoing a first-order phase transition are expected to realize room -temperature magnetic refrigeration, because the first-order transition is followed by a large magneto caloric effect (MCE).The $NaZn_{13}$-type $La(Fe_xSi_{1-x})_{13}$ system has attracted attention owing to its large MCE associated with a magnetic field-induced itinerant electron meta magnetic (IEM) transition. The MCE performance of this system is superior or comparable to those of other magneto caloric compounds such as $Gd_5Ge_2Si_2$, MnFe(As,P) and Ni-Mn-based Heusler alloys. One of the origins for occurrence of the first-order transition is a magneto structural transition, which is a discontinuous change of lattice structure followed bya magnetic phase change. This magneto structural transition is observed in $Gd_5Ge_2Si_2$ and Ni-Mn-based alloys. On the other hand, no structural change appears at the transition in MnFe(As,P) and $La(Fe_xSi_{1-x})_{13}$. Especially, only an isotropic volume change occurs at the IEM transition of the latter.

Owing to the itinerant character in $La(Fe_xSi_{1-x})_{13}$, the transition feature was controlled in terms of electronic-structure modification, together with magneto volume effect, which is another key feature of the itinerant-electron magnetism. For example, the Curie temperature T_C of the first-order transition is controlled around room temperature by chemical pressure induced by hydrogen absorption. In addition, transition hysteresis, which is one of the demerits in usage of the first-order transition, is reduced with maintaining MCE effect by combining the hole doping and volume reduction in the complex substitution of Al and Pr.

Introduction

Asaya Fujita (Dob: 1968 17th March) is a Japanese researcher of materials physics and engineering. He received his Ph.Din magnetism and magnetic materials from Tohoku University in 1997. After completing postdoctoral studies in the magnetic phase transition, he joined the faculty member of the materials science department at Tohoku University in 2000. His research on magnetic phase transition has opened the door to new usage of metallic magnetism for such as magnet strictive materials, magnetic sensors and magnetic refrigerants. At the present, from this April, he moved to a new position as the team leader of Analyses and Innovation team in the Green Magnetic Material Research Center, National Institute of Advanced Industrial Science and Technology. He is the author of more than 200 peer-reviewed publications in scientific journals and his h-index in 34. Especially, his PRB paper on magneto caloric effect of Fe-based system is cited 563 times. He is an elected member of Advisory Board of the international conference of magnetic cooling. He is now trying to serve to bridge the gap between magneto caloric materials research and magnetic refrigeration machines.