Novel magnetic materials for energy efficient technologies

Julia Lyubina and Oliver Gutfleisch

IFW Dresden, Institute for Metallic Materials,
P.O. Box 270016, D-01171 Dresden, Germany; o.gutfleisch@ifw-dresden.de

Human development has caused a depletion of natural energy resources and climate changes with non-predictable consequences. New energy concepts are required for the future of our industrial society resulting in e.g. an ever increasing emphasis on improving the efficiency of electricity transmission and utilisation and in the progressive replacement of oil-based fuels in transportation by electric motors. In this context, functional magnetic materials such as advanced permanent magnets, magnetic refrigerants, magnetic shape memory alloys and magnetorheological fluids and elastomers are in the focus of our research group at IFW Dresden. The talk will focus on the first two topics.

The major driver for research and development of permanent magnets is the need for maximised energy densities at various operating temperatures [1-4]. Recently, there is a much revived interest in various types of high performance permanent magnets based on rare earth intermetallic compounds (RPMs). This is triggered by e.g. the growing demand for traction motors in hybrid electric vehicles in which $Nd_2Fe_{14}B$ magnets with maximised energy density play a pivotal part. Recent developments in RPMs are reviewed in this talk. Emphasis is on the control of microchemistry, structure of grain boundary phases and internal interfaces which is crucial for the understanding of the magnetisation reversal processes. An outlook is given with regards to the possible processing routes [5] for the development of textured nanocomposites, which could be the next generation of permanent magnets.

Magnetic refrigeration based on the magnetocaloric effect (MCE) is a promising technology to replace the conventional gas-compression/expansion technique. Recent progress in the development of new magnetic materials, such as $La(Fe,Si)_{13}$, towards room temperature application is reviewed. The focus is on tailoring the operation temperature of these materials and the control of thermal and magnetic hysteresis by special processing [6, 7]. The unusual combination of features characteristic of first- and second-order phase transitions in the $La(Fe,Si)_{13}$-based compounds and ways to exploit in full the magnetocaloric potential of this material class are discussed.

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