Moscow International Symposium on Magnetism

29 June – 3 July 2014

Book of Abstracts

M.V. Lomonosov Moscow State University, Faculty of Physics

Main Topics

Spintronics and Magnetotransport
Magnetophotonics (linear and nonlinear magnetooptics, magnetophotonic crystals)
High Frequency Properties and Metamaterials
Diluted Magnetic Semiconductors and Oxides
Magnetic Nanostructures and Low Dimensional Magnetism
Magnetic Soft Matter (magnetic polymers, complex magnetic fluids and suspensions)
Soft and Hard Magnetic Materials
Magnetic Shape-Memory Alloys and Magnetocaloric Effect
Multiferroics
Magnetism and Superconductivity
Magnetism in Biology and Medicine
Theory

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TRANSFORMATION OF MAGNETOCALORIC EFFECT AND MAGNETIC PROPERTIES OF RAPIDLY QUENCHED RARE EARTH METALS

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The rare-earth metals (REM) are drawn attention due to their magnetic characteristics and the potential enhancement of these properties [1]. Terbium, dysprosium and gadolinium have been extensively investigated on both single crystal and polycrystalline over the last few decades due to its interesting magnetism, which includes high magnetocrystalline anisotropy, complex magnetic structure, and magnetostriction [1-2]. Stoichiometric they crystallises in a hexagonal closepacked crystal structure with $P6_3/mmc$ space group. In magnetic field less than critical value H_{cr} = 180 Oe in temperature range between Θ_1 = 225 K and Θ_2 = 235 K [1], Tb possess a helicoidal antiferromagnetic (HAFM) state. Below Θ_1 it has a ferromagnetic state and above Θ_2 it has a paramagnetic one. The HAFM state is suppressed by critical field H_{cr} and transforms to ferromagnetic one. Thus, in fields above H_{cr} a single magnetic phase transition from ferromagnetic to paramagnetic state is observed at Curie temperature (T_C) [1-2]. Similar behaviour of magnetic properties is demonstrated by Dy, however, the its critical filed is above 12 kOe and HAFM state exists in temperature range 86-179 K. For nanoscale REM curiously optical, electronic, magnetic, and catalytic properties can be expected because of significant increasing of surface area or crystallite boundary area. Because the Ruderman-Kittel- Kasuya-Yosida (RKKY) coupling is very sensitive to interatomic spacing, which varies drastically at the particle surface, deep effects are also expected in the magnetic properties of nanoscaled REM [1]. The aim of our work was to investigate magnetic properties and magnetocaloric effect (MCE) of rapidly terbium quenched (RQ) terbium and dysprosium.

It was estimated by analysing the powder XRD patterns by employing Rietveld refinement technique, that both polycrystalline and rapid quenching metals have hexagonal close-packed crystal structure and the lattice parameters are equal to each other. It was established by analysis of the AFM images, that average crystallite size is 108 nm for Tb-RQ and 110 nm for Dy-RQ and that there are a lot of crystallites with linear size less 100 nm. The results of structural investigations allow to conclude that the rapid quenching preserves crystal structure and drastically decrease the crystallite size.

It was found that spontaneous magnetisation and coercive force at T = 4.2 K decrease in both Tb-RQ and Dy-RQ. The maximum values of MCE in field 10 kOe are equal to 2.2 and 1.5 K for Tb and Tb-RQ, respectively. Compare to microcrystalline, Tb-RQ shows the decrease of T_C by 2 K and decrease of MCE maximum by 0.7 K. A significant decrease of phase transition temperature in RQ metals is associated with increase of the number of atoms at the surface of the crystallites having a smaller number of neighbours in the first coordination spheres. Increasing the number of surface atoms reduces the exchange interaction energy and thus to reduce the energy required for destruction of the magnetic order.

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