Magnetic Properties of $Pr_8Dy_1Fe_{60}Co_7M_3Ni_3B_{14}Zr_1Ti_3$ Bulk Alloys

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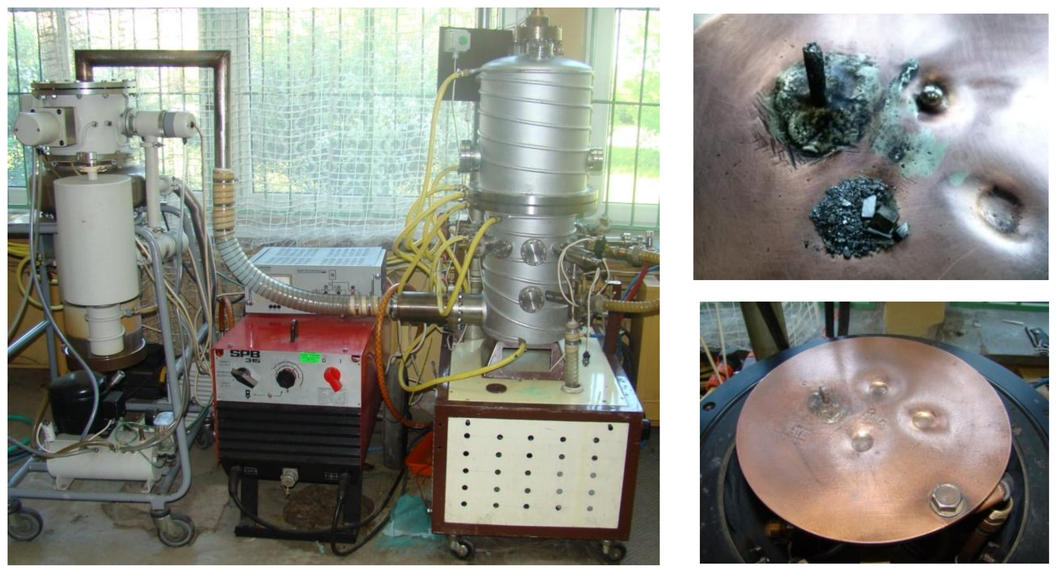
Abstract:

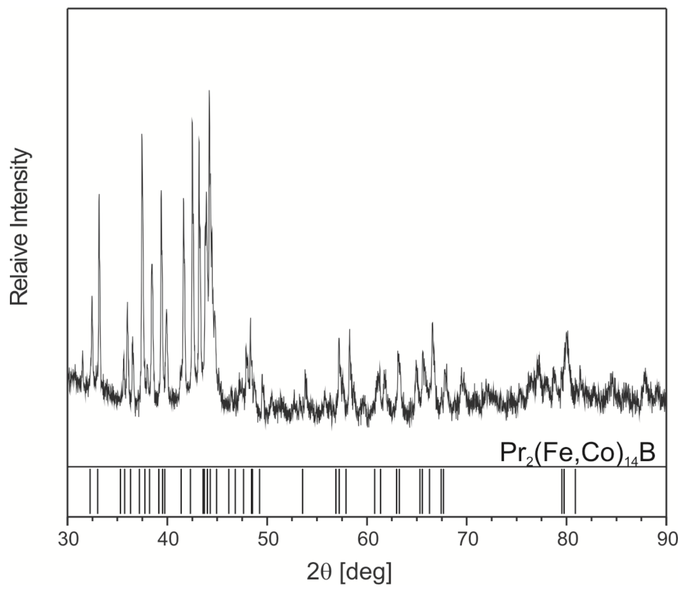
The goal of this paper is to present the magnetic properties of the Pr8Dy1Fe60Co7Mn3Ni3B14Zr1Ti3 alloy in the form of 3 mm outer diameter tubes in as-cast state. The samples were produced by suction-casting technique under Ar atmosphere. The structure was studied by X-ray diffraction. For the tested samples, major and minor hysteresis loops were measured at room temperature using LakeShore VSM 7307 in external magnetic field up to ~2T. Moreover, tests of recoil curves were carried out in order to determine the magnetization reversal processes in the tested materials.

The X-ray diffraction was used to determine phase constitution of all obtained samples. The magnetic parameters were determined from magnetic hysteresis loops measured in the external magnetic field up to 2 T at room temperature. In order to clarify the coercivity mechanism and the occurrence of possible interactions, recoil and remanence curves and Henkel plots were constructed.

Sample preparation and experimental techniques

Alloy ingots with nominal compositions of the $Pr_8Dy_1Fe_{60}Co_7Ni_{(6-x)}Mn_xB_{14}Zr_1Ti_3$ (where x = 0, 3, 6) were prepared by arc-melting under an argon atmosphere using high purity constituent elements with pre-alloyed Fe–B of known composition. Then the samples were homogenized by systematic re-melting. Subsequently, samples in the form of 3 mm outer diameter thin walls tubes were prepared by the suction-casting technique. The phase structure of the as-cast samples was investigated by X-ray diffractometry (XRD) with CuKa radiation (λ=1.54 nm). The room temperature major hysteresis loops, as well as sets of recoil curves were performed using a vibrating sample magnetometer (LakeShore VSM) in the external magnetic field up to 1600 kA/m, on specimens prepared from tubes. The series of recoil curves were obtained for the initially saturated samples and for the thermally demagnetized specimens.

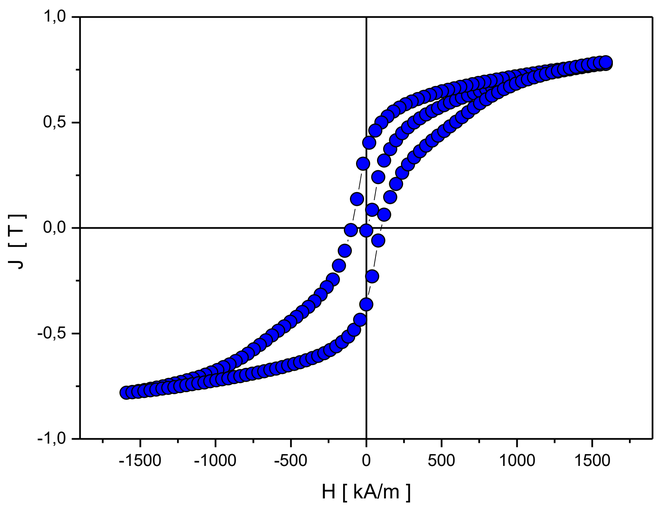




X-ray diffraction data for the as-cast $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloy in the form of thin walls 3 mm outer diameter tube

Lattice constants of recognized magnetic phase for $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloy tube calculaced by the Rietveld analysis

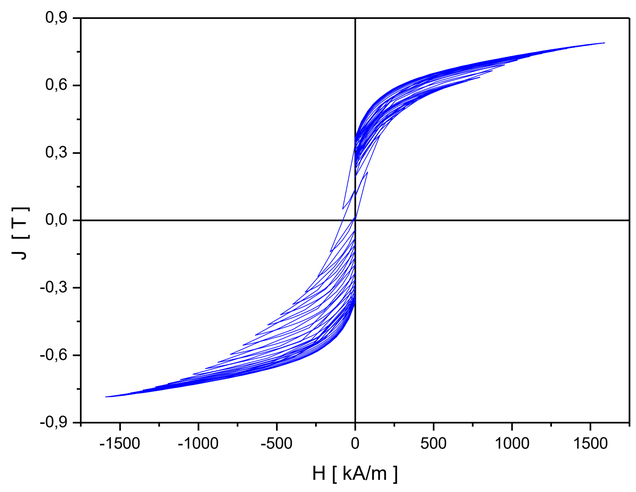
Sample	$Pr_2(Fe,Co)_{14}B$	
	a [nm]	c [nm]
$Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$	0,8779	1,2179



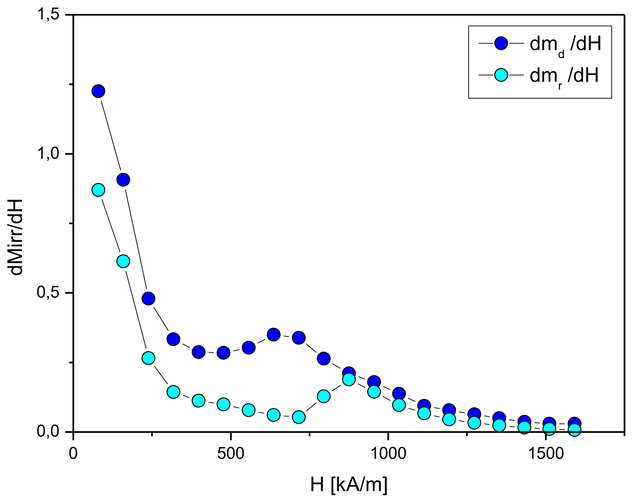
The hysteresis loop and initial magnetization curve measured for $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloy tube

Magnetic properties of $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloys in the form of 3 mm outer diameter tubes

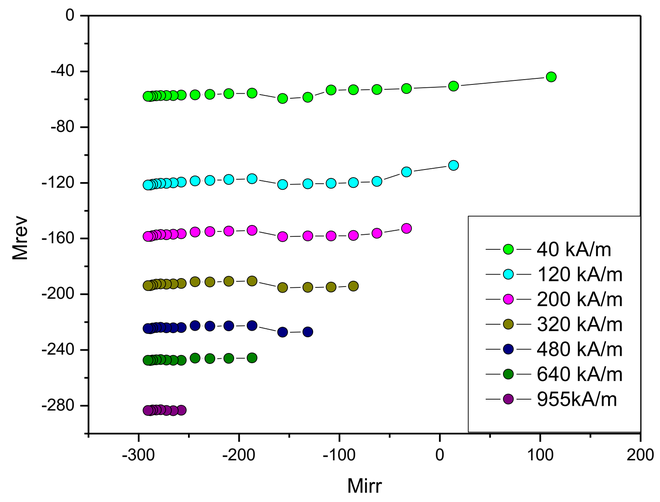
Samples tube 3mm as-cast	$_JH_c$	J_r	J_s	J_r/J_s	$(BH)_{max}$
	[kA/m]	[T]	[T]	[-]	[kJ/m^3]
$Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$	100	0.365	0.79	0.46	5.572



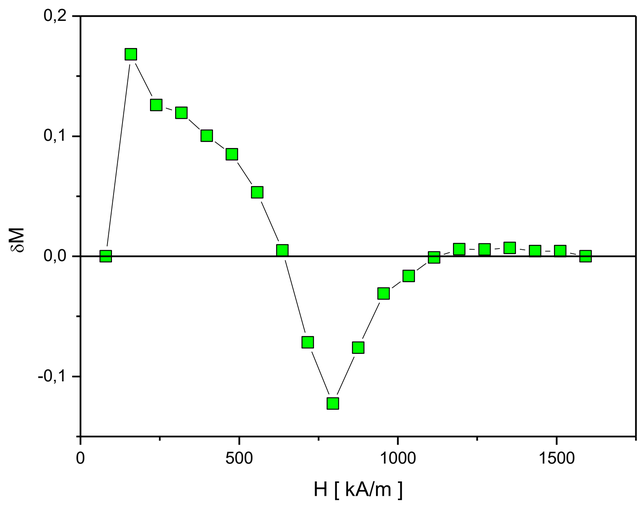
Recoil curves measured on demagnetized and initially saturated samples of the $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloy tube



Switching field distribution (SFD) of the $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloy tube



Plots of reversible part of magnetization M_{rev} as a function of irreversible magnetization M_{irr} for the $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloy tube



Henkel plots of the $Pr_8Dy_1Fe_{60}Co_7Ni_3Mn_3B_{14}Zr_1Ti_3$ alloy tube

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