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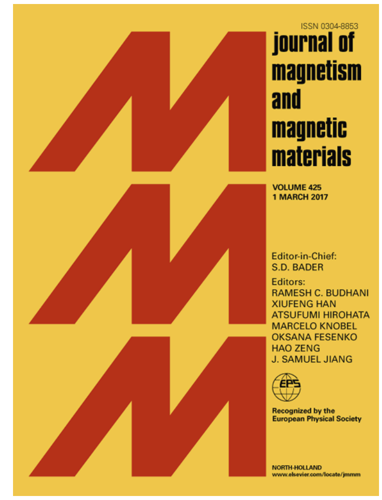

Research articles

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Peculiarities of the electronic transport in half-metallic Co-based Heusler alloys

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Abstract

Electrical, magnetic and galvanomagnetic properties of half-metallic Heusler alloys of Co_2YZ (Y = Ti, V, Cr, Mn, Fe, Ni, and Z = Al, Si, Ga, Ge, In, Sn, Sb) were studied in the temperature range 4.2–900 K and in magnetic fields of up to 100 kOe. It was found that varying Y in Co_2YZ alloys affects strongly the electric resistivity and its temperature dependence $\rho(T)$, while this effect is not observed upon changing Z. When Y is varied, extrema (maximum or minimum) are observed in $\rho(T)$ near the Curie temperature T_C. At $T \leq T_C$, the $\rho(T)$ behavior can be ascribed to a change in electronic energy spectrum near the Fermi level. The coefficients of normal and anomalous Hall effect were determined. It was shown that the latter coefficient, R_S, is related to the residual resistivity ρ_0 by a power law $R_S \sim \rho_0^k/M_S$ with M_S the spontaneous magnetization. The exponent k was found to be 1.8 for Co_2FeZ alloys, which is typical for asymmetric scattering mechanisms, and 2.9 for Co_2YAl alloys, which indicates an additional contribution to the anomalous Hall effect. The type of the temperature dependence is analyzed and discussed in the frame of two-magnon scattering theory.

Keywords: Heusler alloys; half metallic ferromagnets, resistivity, Hall effect

1. Introduction

Heusler alloys X_2YZ (where X and Y are transition 3d-elements and Z is an s- or p-element of the Periodic Table) that exhibit half-metallic ferromagnetism are potential candidates for application in spintronics [1, 2]. The main feature of the electronic structure of half-metallic ferromagnets (HMF) is the presence of an energy gap at the Fermi level in one spin sub-band and a metallic character of the density of states in the other [3, 4]. This can lead to 100% spin polarization of the charge carriers, which can be used for spintronic devices. The position and the width of the energy gap can vary quite strongly in different HMF. These parameters can be changed by

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