Anisotropic Magnetoresistance Effects in Epitaxial Thin Films of Mn$_2$VAl Full-Heusler Alloy

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Mn-based full-Heusler ferrimagnet, Mn$_2$VAl is an ideal source for spin injection because of its high spin polarization and low magnetization, however, the magneto-transport properties of the thin films have scarcely been reported. According to Kokado’s model, it will be possible to clarify the electron spin in charge of electric conduction through anisotropic magnetoresistance (AMR) measurements [1]. Therefore, AMR effects of Mn$_2$VAl thin films were investigated in this study.

A 50-nm-thick Mn$_2$VAl thin film was epitaxially grown on a MgO (001) single-crystal substrate using a magnetron sputtering technique. Details of structural and magnetic properties of the film were previously reported [2]. AMR effect was measured in the 10-300 K range using DC four-probe method of a Quantum Design physical properties measurement system. During the measurement, a 50-kOe magnetic field was applied to the sample, and current was applied to the stripe formed along the Mn$_2$VAl [110] direction.

Fig. 1 shows the AMR curves \((\rho(\theta) - \rho_{\perp})/\rho_{\perp}\) of the Mn$_2$VAl films. All the observed AMR signs were negative \((\rho_{\parallel} < \rho_{\perp})\). The density of states for the spin-up in Mn$_2$VAl shows the energy gap at the Fermi level [3]. Therefore, \(s_1 \rightarrow d_1\) is a dominant scattering process in Mn$_2$VAl. Fig. 2 shows Fourier coefficients for the cos \(2\theta\) \((C_{2\theta})\) and cos \(4\theta\) \((C_{4\theta})\) terms. In addition to the appearance of the conventional \(C_{2\theta}\), the \(C_{4\theta}\) also appeared, which was caused by the tetragonal distortion [4]. From this study, it was found that the prepared Mn$_2$VAl films were possible to possess half-metallicity.

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Fig. 1 AMR curves measured in 10-300 K range. Fig. 2 Fourier coefficients for the cos \(2\theta\) and cos \(4\theta\).