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Ferromagnetic-resonance properties of Ni_2MnGa magnetic shape-memory films

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Heusler alloy attracts currently an exciting interest, since it exhibits a ferromagnetic shape-memory effect (FSME). This property makes thin films of Ni_2MnGa promising candidates for the nano/micro electromechanical systems. In this work, we report our results of the structural and magnetic properties of nearly stoichiometric Ni_2MnGa films prepared by flash evaporation. Two distinct substrate temperatures (150 and 720 K) were chosen to achieve structures with different structural orders. The structural characterization of the films has been performed by using x-ray diffraction and the magnetic properties were investigated by using vibrating-sample magnetometer and ferromagnetic resonance. The ordered films exhibit almost the same magnetic and transport properties as those of crystalline bulk Ni_2MnGa with an evident martensitic transformation at 200 K. On the other hand, the disordered films behave as highly-resistive Pauli paramagnets, indicating, for the first time, that structural disordering in the ferromagnetic alloy leads to the loss of magnetism. The hysteresis loops, obtained at room temperature, show that the easy axis lies in the film plane. A temperature dependence of saturated magnetization shows monotonous increase as the temperature decrease. The temperature-dependent resonance field H_r was measured in the temperature range of 50 - 400 K. It was found that the perpendicular H_r increases with decreasing temperature while the in-plane H_r shows opposite tendency. The abnormality around 320 K indicates the phase transition between martensite and austenite. The resonance lnewidth of the films deposited on mica substrate increases sharply to a maximum in the perpendicular configuration and then slowly decreases as temperature decreases, which is quite different from the in-plane case and from the films on glass. The effect of orientation of applied field on H_r was examined at temperatures of 78 K and 293 K, showing that H_r gradually decreases as it rotates from normal to parallel with respect to the film plane. The fitted results of H_r are consistent with the experimental results.