Ferromagnetic shape memory films

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In the framework of our project Thin Ferromagnetic Shape Memory Films [1], we have recently shown that it is possible to fabricate films of Ni-Mn-Ga alloy, which show a clear sign of austenite to martensite transformation near the room temperature [2]. It may be regarded as a first step towards microelectromechanical structures in which substantial strain can be produced upon application of a magnetic field.

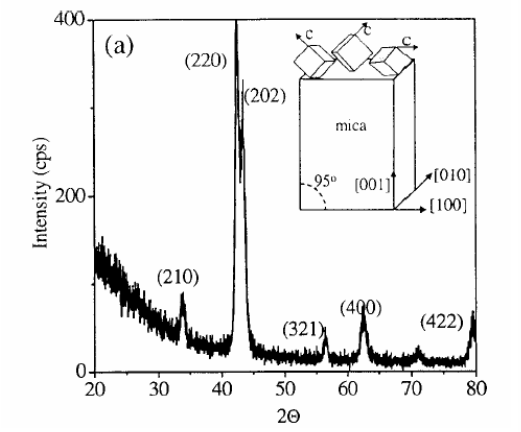

Fig. 1. Grazing-incidence XRD pattern of Ni_2MnGa film. A sketch of the (110) orientation of Ni_2MnGa grains on the mica surface is shown in the inset.

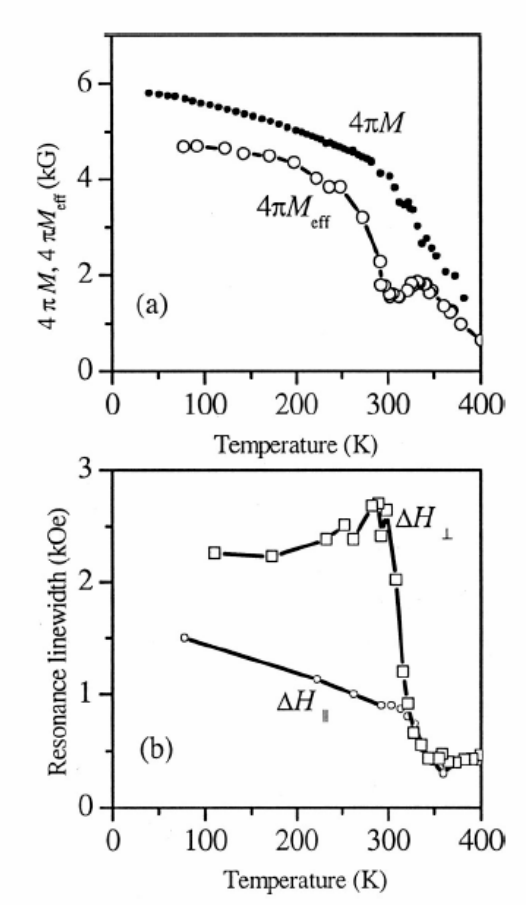

Fig. 2. (a) Temperature dependence of the saturation magnetization 4 πM (solid circles) and the effective magnetization 4 πM_{eff} (open circles) of Ni_2MnGa films deposited on mica. (b) Temperature dependence of the FMR linewidth for the in-plane (ΔH_{II}) and the out-of-plane (ΔH_{L}) configurations.

Off-stoichiometric $Ni_{49.3}Mn_{24.7}Ga_{26}$ polycrystalline films, deposited by a flash-evaporation technique on the heated mica substrates, show a martensitic phase transformation at 310 K. The applied technique enables preparation of the polycrystalline Heusler alloy films with a martensite phase at room temperature and a structure typical of well ordered Heusler alloy sublattices. At room temperature, the films have a tetragonal structure (a=b=0.598 nm, c=0.576 nm) close to the bulk Ni_2MnGa with c/a=0.96 (Fig. 1). The austenite to martensite transformation at T_M=310 K brings about an anomalous minimum in the effective magnetization and a strong increase in the ferromagnetic resonance linewidth in the martensitic phase just below the transformation temperature (Fig. 2). The results are discussed in terms of a qualitative model that combines the ferromagnetic resonance response with a specific microstructure of the polycrystalline Ni_2MnGa film.

[1] Grant KBN No. 4 T08C 045 25
[2] J. Dubowik, Y.V. Kudryavtsev, Y.P. Lee, Martensitic transformation in Ni2MnGa films: A ferromagnetic resonance study, J. Appl. Phys. 95, 2912 (2004)

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