Characterization of Heusler Alloy Thin Film, Cu_2MnAl and Co_2MnSi, Deposited by Co-sputtering Method

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Ferromagnetic Heusler alloys draw renewed interest because their half-metallic characteristics are advantageous to increase the transport signal in spintronic devices, such as MTJ. However, relatively high thin film processing temperature for acceptible magnetic properties is hardly compatible with MTJ. Recently, an exception was reported with $Co_2Cr_{1-x}Fe_xAl$ case. [1] So, we have investigated the relationship between structural ordering and magnetic properties, and how processing condition can be optimized.

Thin films of Heusler alloy, Cu_2MnAl and Co_2MnSi, are deposited on thermally oxidized Si substrate with various substrate temperatures and compositions, by co-sputtering method using 3 single element targets. Thin films are characterized by EDS, VSM, XRD, TEM, and electrical transport measurement. In general, magnetic properties and structures are strongly dependent on substrate temperature. The films fabricated at room temperature show paramagnetic behaviour and very fine crystalline feature in XRD pattern. Increasing substrate temperature, there appear polycrystalline features (superlattice peaks), accompanied with increase of M_s and $S(M_r/M_s)$. Also, the electrical resistivity implies that the electronic structures are heavily disturbed in the films fabricated at room temperature. These results suggest that structural ordering strongly affects the magnetic, electrical properties of Cu_2MnAl and Co_2MnSi. To understand the ordering process, annealing experiments have been performed for the film deposited at room temperature. Magnetic, structural properties are monitored with annealing temperature and time. To reach fully magnetized state of Cu_2MnAl, it takes ~20 minutes at the 200'C, but less than 3 minutes at 300'C.

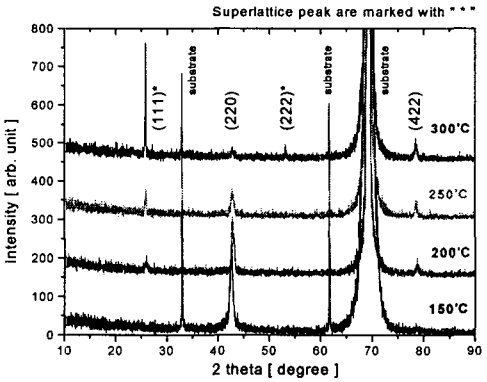

Fig.1 X-ray diffration pattern of Cu_2MnAl, deposited at different substrate temperature.

References

[1] K.Inomata, et al. Jpn. J. Appl. Phys. Vol. 42 (2003), L419