Combinatorial sputtering method: Producing L10-FeNi films with coercivity in excess of 1 kOe

G. Giannopoulos, A. Kaidatzis, V. Psycharis, and D. Niarchos
Institute of Nanoscience and Nanotechnology, NCSR Demokritos, Athens, Greece

Abstract: Combinatorial sputtering technique was used to deposit and characterize alloys with differentstoichiometries [1]. This approach is a revolutionary step forward in the development of new materials. It involves the development and application of new tools for systematic and parallel synthesis and characterization of binary and ternary systems, thus being a very effective way to explore variable alloys stoichiometry.

L10-type magnetic compounds, including FeNi, possess promising technical magnetic properties of both high magnetization and large magnetocrystalline anisotropy energy and thus offer potential in replacing rare earth permanent magnets in some applications. FeNiestimated order-disorder transformation temperature is around 320^{0}C, which is very low compared to the other $L1_0$-alloys. This results in very low diffusion of Fe and Ni atoms and makes the transformation extremely slow. This transformation can be enhanced either by the creation of vacancies, core-shell FeNi/$L1_0$-AuCu nanoparticles [2], or in the case of thin films by a strain mediated process [3].

In this work, we have employed a combinatorial sputtering process in order to study the conditions of fabricating the $L1_0$-FeNi phase and measure its magnetic properties. We have used Si(100) 100 mm waferssubstrates and deposited multilayers of the following type: Si/Cr(10 nm)/Cu_3Au(70 nm)/combi-CuAuNi/NiFe(40 nm), where combi-CuAuNi is a compositional spread layer of various stoichiometries deposited using combinatorial sputtering, to match the lattice constants of the $L1_0$-FeNi. The final deposition of FeNi was performed at 200^{0}C by co-sputtering Fe and Ni to a stoichiometry of 50/50 at%. We perform magnetic properties mapping of the multilayer by means of high-throughput polar Kerr effect magnetometry and we find that the coercivity increases from 0.3 kOe to 1 kOe as the Au content of the combinatorial interlayer decreases.

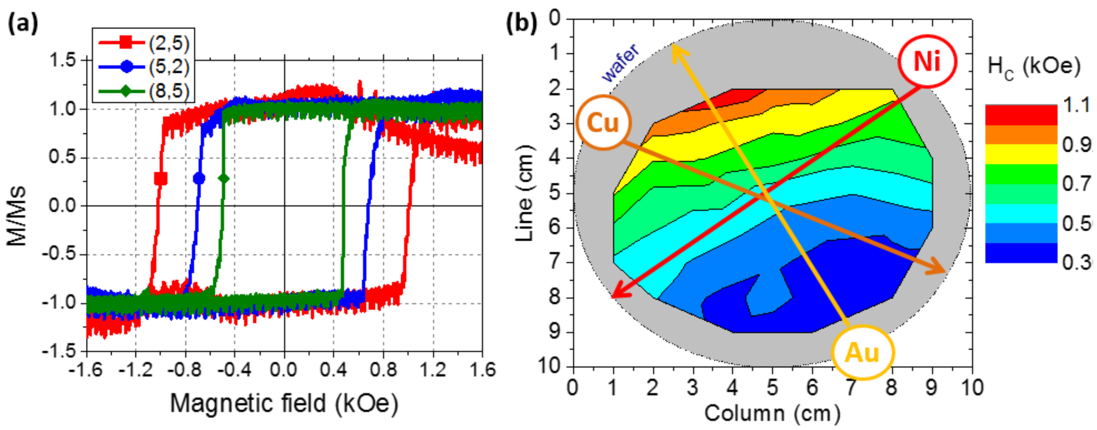

Figure 1 a. Representative hysteresis loops obtained by polar Kerr effect Magnetometry **b.** Map of magnetic coercivity across the wafer.

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