

## Electrodeposited L1<sub>0</sub> Alloys of Pt with Fe, Co and Ni

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The L1<sub>0</sub> magnetic alloys of platinum with iron-group elements are of great interest as potential high density storage media due to their high magnetic coercivity and anisotropy. Conventional vacuum deposition techniques have been widely used to obtain random fcc alloys, which are subsequently transformed to L1<sub>0</sub> by high temperature annealing. Unfortunately this process results in grain growth in addition to the desired phase transformation. The resulting grain size of approximately 100nm renders these materials useless for high density data storage, which requires small, ferromagnetically decoupled grains. It is proposed that the problem of grain growth may be circumvented by depositing the magnetic alloy into a template structure prior to annealing, thereby providing a constraint to the size and coupling of the magnetic features. Deposition into such high aspect ratio self-ordered structures as porous alumina membranes represents a promising approach. Template deposition of high coercivity material may also prove useful for novel MEMS actuators. Electrodeposition of magnetic alloys is a promising method of filling high aspect template structures, but presents many challenges, especially in the case of FePt.

We describe the electrochemical codeposition of alloys of platinum with iron group metals, and detail the precautions necessary when depositing FePt to limit oxidation of the Fe(II) solution. The process involves deposition from aqueous chloride solutions at potentials positive to the standard electrode potentials of the iron-group elements. In contrast, the potentials used were as much as 1V more negative than the equilibrium potential associated with the tetrachloroplatinate complex. The dependence of composition on deposition potential as measured by EDS and RBS was found to fit a regular solution model for alloying. The strongly negative enthalpy of mixing of platinum with iron, nickel, or cobalt accounts for the incorporation of the iron-group metals at underpotentials of up to 700mV. The concentration of chloro-platinate complex was two orders of magnitude less than that of the iron-group element, so that the alloy deposition rate was limited by the platinum reduction process. The composition of the alloy was found to be largely insensitive to the platinum concentration, further supporting the thermodynamic model. The surface roughness of the deposited alloys was in most cases less than 10nm for films up to 500nm in thickness, which was surprising given the large (~1V) overpotential for platinum deposition. (The platinum deposition rate appeared to be independent of potential for deposition conditions examined. This observation suggests that the reaction proceeds under transport control, which subjects morphological evolution to the Mullins-Sekerka instability)

Investigations of FePt films electrodeposited onto Cu(001) have revealed many promising traits. X-ray diffraction measurements reveal a transformation of

random fcc alloy to an oriented L1<sub>0</sub> structure upon annealing. The c-axes (the magnetic easy axis) of the L1<sub>0</sub> grains were found to orient perpendicular to the substrate plane, which is advantageous for perpendicular media. In addition, a degree of in-plane ordering was also evident, which is useful in maintaining a narrow switching-field distribution. A coercivity of over 10kOe was measured for the sample by Kerr Magnetometry. Efforts are in progress to investigate ternary magnetic alloys and template deposition.