

Electrodeposited L1₀ Alloys of Pt with Fe, Co and Ni

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Alloys of platinum with iron group metals have potentially wide ranging applications. For example, the L1₀ phase of FePt is a promising candidate for high density magnetic recording media, due to its exceptionally high magnetic coercivity and anisotropy. The robust electrodeposition method adumbrated below offers the possibility of reliable through-mask deposition of the type of arrays of magnetic pillars proposed as potential future magnetic media. An equally interesting application of such alloys involves their use as CO resistant catalysts. Recent reports suggest that CoPt and FePt alloys terminated with a thin layer of Pt perform catalytically as well as pure Pt, but are highly resistant to CO poisoning.

We describe the electrochemical codeposition of alloys of platinum with iron group metals. 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 tetrochloroplatinate 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)