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Near-substrate composition depth profile of d.c.-plated and pulse-plated Fe-Ni alloys

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The standard procedure during all destructive depth profile analysis methods is that the sample is sputtered and the sputtering front penetrates from the final surface of the sample towards the substrate. In the last few years, our group developed a method [1-3] that makes it possible to remove the sample from the substrate and perform the usual depth profile analysis of the electrodeposited samples from the substrate side. In this method, the initial surface roughness is about 1 nm; hence the depth resolution is very high. This so-called reverse depth profile analysis reveals the near-substrate composition changes with an unprecedented accuracy.
In this work, the composition depth profiles of d.c.-plated and pulse-plated Fe-Ni alloys have been investigated with the reverse depth profile analysis method. The sputtering was performed by a secondary neutral mass spectrometer. Since iron is preferentially deposited beside nickel and the achievement of the steady-state deposition condition takes time, the molar fraction of iron near the substrate is higher than during the steady-state deposition when d.c. plating is applied. The steady-state composition was achieved typically after depositing a 90-nm-thick alloy layer. In the pulse-plating mode, samples with nearly even composition could be obtained at a duty cycle of 0.2 or smaller, and a continuous change in the composition profile could be seen as a function of the duty cycle above this value. A constant sample composition was achieved with pulse-plating in a wide peak current density interval. The composition depth profile was also measured for a wide range of Fe^{2+} concentration. The different characters of the composition depth profile as a function of the deposition mode can be explained mostly with mass transport effects. The elucidation of the results is fully in accord with the kinetic models of anomalous codeposition and the general theory of pulse plating.

References:

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