Electrodeposition and Characterisation of Nickel-Copper Alloys.

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Previous investigations of electrodeposition of nickel-copper alloys deal largely with the properties of alloys of approx. 30 wt % Cu (Monel metal) [1] [2][3].Such alloys are of interest for their high strength, ductility and good corrosion resistance. These compositions are at the threshold for the disappearance of magnetism at room temperature. There has been renewed interest in the electrodeposition of the Ni/Cu alloy system [4-6] due in part to the GMR effect observed in NiCu/Cu multilayers system [5][6]. However very little is reported on the magnetic properties of the electrodeposited alloys particularly in the region of 0-10 % Cu. Here we investigate the electrodeposition of these alloys system and the effects of mechanical stirring and an applied magnetic field.

Deposition was carried out potentiostatically for 600 s at –1 V relative to Ag/AgCl using 1.14 M $NiSO_46H_2O$ and 0-0.04 M $CuSO_4$ solution. Boric acid was also used to maintain pH at 4.5. The working electrode was tantalum and was positioned parallel to the glassy carbon counter electrode.

The effect of the Cu^{2+} concentration of the electrolyte on alloy composition is shown in figure 1. The distinct morphology in each region is also shown. Two phases appear, copper rich and copper deficient. Rietvielt refinement of XRD data shows that these phases are in the ratio 2:3 for all samples where both are observed, i.e. those prepared with >0.015 M $CuSO_4$ in the electrolyte. Room temperature magnetisation data are shown in figure 2, where it can be seen that the values are lower than those for the bulk Ni-Cu alloy[7]. An unexpected rise in saturation magnetisation can be seen for alloys with ~2 wt.% copper. Anisotropic Magnetoresistance of the samples are shown in figure 3. Maximum AMR is observed at ~8 wt.% copper. The effect of the magnetic field is to slightly increase the copper concentration threshold at which the two-phase region is observed. MOKE measurements show little induced anisotropy by a 0.5 T field placed parallel to the electrode during deposition. Our results reflect the difference in growth modes of copper and nickel at -1 V. The reduced magnetisation can be explained by the presence of significant amounts of carbon in the electrodeposits.

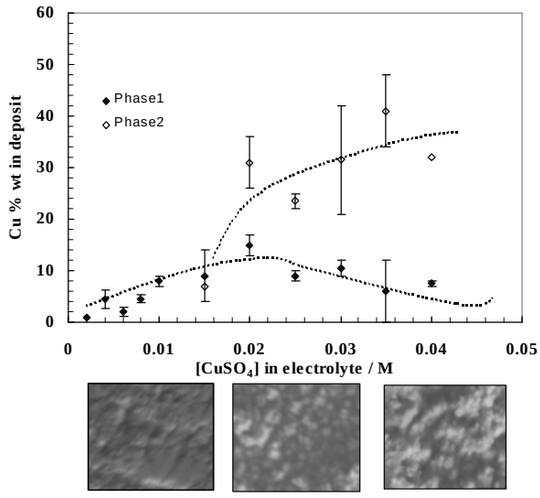

Figure 1. Effect of copper sulphate concentration on wt % of copper in alloy. SEM micrographs of particular alloys illustrate the two phases

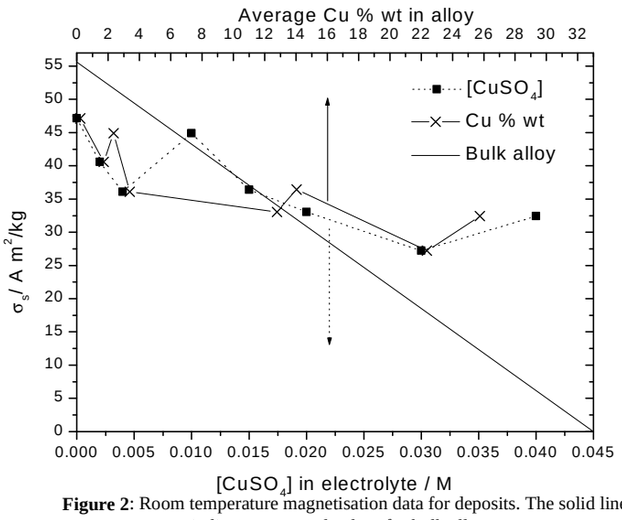

Figure 2: Room temperature magnetisation data for deposits. The solid line indicates expected values for bulk alloys.

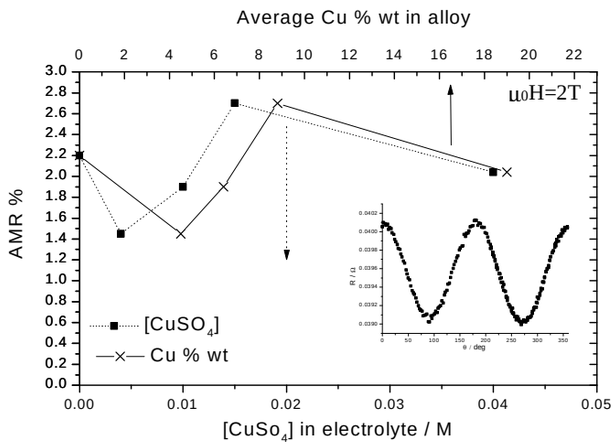

Figure 3: Anisotropic magnetoresistance of electrodeposited samples at room temperature. Insert shows typical resistance data

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