Annealing Study on CoFe Plated film properties

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As-plated CoFe films show high stresses in the range of 400~600 MPa, more than double that of the NiFe films which are normally 100~250 MPa depending on the plating conditions. High moment CoFe alloy films near 65wt%Fe show high stress of over 600 MPa in the as-plated state**.**

The high stress in the plated CoFe films makes integration of the CoFe films into magnetic recording heads very difficult and may affect the magnetic performance of the head. In this work, experiments were carried out to determine the effects of annealing conditions on the stress, magnetic and electrical properties of the plated CoFe alloy films. A series of wafers were DC plated with 2 μm of 60wt%Fe CoFe under identical conditions using a bath described in [1]. The annealing temperature, dwell time, and magnetic field orientation in the oven were varied in the magnetic annealing processes.

Fig. 1 shows the stress change of the CoFe films as a function of annealing temperature. Contrary to common belief that the film stress would increase [2], the results consistently showed that with increasing annealing temperatures over 225°C the tensile stress was reduced. The primary effect in reducing the tensile stress was determined to be the annealing temperature, with dwell time effects being secondary. It was found out that the magnetic field orientation during the magnetic annealing did not affect the film stress. The CoFe films showed improved soft magnetic properties when subjected to an easy axis annealing with reduced coercivities along both the easy axis and hard axis. Hard axis annealing on these CoFe films caused switching of easy and hard axis when the temperature is above 225°C.

Fig 2. shows the resistivity of the CoFe films as a function annealing temperature, which drops monotonically with the increase of annealing temperature. XRD analyses show that the mean grain size of the CoFe films goes up with the increase of annealing temperature, which correlates well with the reduction of resistivity of the CoFe films.

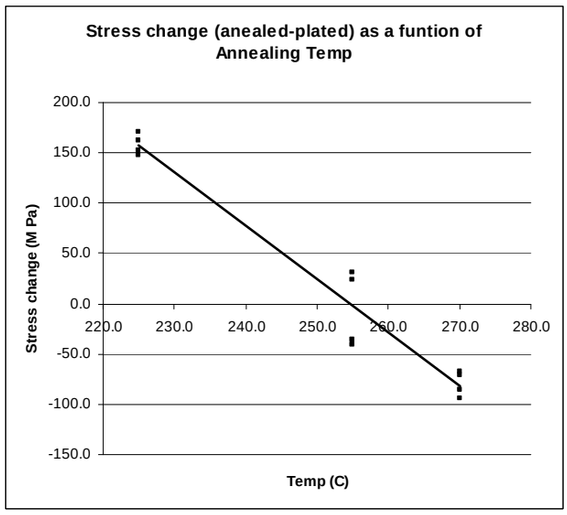

Fig. 1 Stress Change of CoFe DC plated films as a function of annealing temperature. Wafers were electroplated from CoFe baths under identical plating conditions.

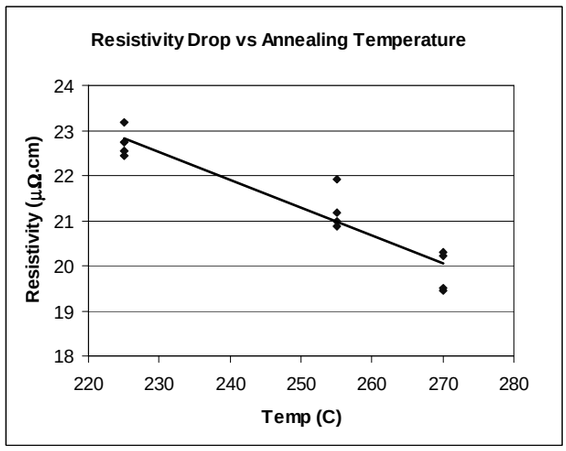

Fig. 2 Resistivity of CoFe DC plated films as a function of annealing temperature.

References

[1] C. Bonhôte, H. Xu, E.I. Cooper and L.T. Romankiw, ECS Proc. Vol. 2002-27, p.319, (2002).
[2] A. S. Kao, P. Kasiraj, J. Appl. Phys. 27, 4452 (1991).