High target utilisation sputtering for the development of advanced materials for magnetic data storage applications

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

(signature)..

Abstract

High target utilisation sputtering (HiTUS) is a relatively new thin film deposition technique that generates a high density plasma remotely from the sputter target. This method has been employed firstly to investigate FePt and FePtN thin films for high density data storage media applications and secondly to investigate the production of a GMR/PZT hybrid structure (multi-ferroism) for improvements to magneto-resistive read-sensor devices in hard disk drives and potentially for other novel multi-ferroic applications.

The magnetic and structural properties of FePt and FePtN films, prepared by the HiTUS method, on both silicon and glass substrates have been investigated before and after annealing at temperatures in the range of 300 to 800 °C. It is shown that during thermal annealing there is a degradation in magnetic properties of the FePt films at around 400 °C due to the formation of silicides as the thermal processing promotes the reaction of the film with the substrate. However, in the FePtN samples coercivity values continue to rise with annealing temperatures above 400 °C. XRD analysis confirms that silicide formation is suppressed in films containing nitrogen up to 800 °C. Using the HiTUS technique, there is evidence that $L1_0$ ordering of FePt has occured at annealing temperature of 400 °C with in plane and out of plane coercivities of 7180 Oe and 6300 Oe respectively.

Finally, it is shown that HiTUS is capable of depositing ultra thin multilayer GMR structures onto a variety of substrates; silicon, glass, flexible kapton film and PZT. It is interesting to find that the GMR ratio obtained on kapton film (14.39 %) is almost as high as that on silicon (16.15 %), with much scope for improvement. Multi-ferroic composite films consisting of the GMR multilayer structure $[Co(8\ \text{Å})/Cu(21\ \text{Å})]_{\times 20}/Co(12\ \text{Å})$ on PZT substrates were fabricated and magneto-electric coupling effects explored. It was found that AC voltages applied across the composite GMR/PZT structure produced a marked decrease in the coercivity of the GMR layer. However, DC voltages did not produce any measurable magnetic effects. Careful investigation revealed that the reduction in coercivity observed during AC measurements was, in fact, due to sample heating effects.

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