Platinum and Palladium in Magnetic Storage Applications

The 6th joint MMM/Intermag conference (Magnetism and Magnetic Materials/Intermag), was held in Albquerque, New Mexico, from the 20th to the 23rd June 1994. Thus this major combined magnetics conference covered most areas of magnetic research currently taking place worldwide. In this review some of the 17 papers presented on the topic of platinum and palladium in magneto-optical and perpendicular magnetic memory storage are discussed.

Magneto-Optical Memory Storage

In recent years platinum/cobalt multilayers have attracted a lot of interest, and much of the basic research into the properties of these multilayers has already been completed (1, 2). The work reported on platinum/cobalt multilayers at this conference was therefore concerned with improvements in the material properties required to enhance their potential as a second generation magneto-optical memory storage material.

It was reported by T. Suzuki, S. Iwata, H. Brandle and D. Weller from the IBM Almaden Research Centre, San Jose, California, that the wavelength at which the polar Kerr rotation peaked in platinum/cobalt multilayers could be altered by the addition of bismuth to the platinum layers. This property could then be used to match the peak in the polar Kerr rotation with the wavelength of the laser used to read the information from the multilayer. Unfortunately the shift in the peak was also accompanied by a reduction in the peak polar Kerr rotation obtained, thus reducing the benefit obtained from shifting the peak.

The subject of increased platinum/cobalt multilayer coercivity was reported by J. Miller, P. G. Pitcher and D. P. A. Pearson from the Johnson Matthey Technology Centre, Reading. The coercivity of their sputtered multilayers could be increased from 3.3 to 10.5 kOe by annealing the multilayers in air; this coercivity increase could be reversed by annealing the multilayers in a reducing atmosphere of 10 per cent hydrogen in nitrogen. The mechanism for the increase in coercivity was suggested to be the formation of cobalt oxide at the grain boundaries, which then acts as a magnetic domain pinning site. Similar results have been previously reported in both platinum/cobalt and palladium/cobalt (3) multilayers, but the coercivities obtained were smaller: 0.2 to 2 kOe for the platinum/cobalt multilayers and 0.5 to 3 kOe for the palladium/cobalt multilayers.

In first generation magneto-optical applications, improvements in the data writing speed can be obtained by reducing the external magnetic field which is required for data to be written, using a magnetic field modulated system. A reduction in the external magnetic field was achieved in work reported by S. Ohnuki and N. Ohta from Hitachi Maxwell, Japan, by the application of a platinum-cobalt alloy overcoat onto a TbFeCo magneto-optical storage layer. The 1 nm thick overcoat of platinum-cobalt alloy significantly reduced the magnetic field required to write information to the TbFeCo storage layer. Previously the same effect could only be achieved by using a platinum-cobalt alloy overcoat of 20 to 30 nm thickness, thus this 1 nm thick platinum-cobalt overcoat offers a more economically viable prospect.

Platinum-manganese-antimony alloys exhibit the largest known room temperature polar Kerr rotation and as a result have been studied as a potential magneto-optical memory storage material. However this polar Kerr rotation peaks at too large a wavelength for a second generation magneto-optical material, and the required magnetic properties have not yet been induced in this material. Improvements to the wavelength dependence of the polar Kerr rotation were reported by M. Takahashi, H. Shoji, Y. Hozumi and T. Wakiyama from Tohoku University, Japan, and Y. Takeda and Y. Itakura from Teijin Limited, Tokyo. They reported that they had reduced the wavelength at which the polar Kerr rotation peaked by reducing the platinum concentration in the alloy. A reduction in platinum concentration from 21 to 6 per cent resulted in the peak polar Kerr rotation moving from 633 to 528 nm without any alteration in the peak polar Kerr rotation of 1.0°. Unfortunately this alloy did not possess magnetic properties suitable for magneto-optical storage applications. However it was suggested that perpendicular magnetisation could be induced in these alloys by manufacturing samples having their *c*-axis perpendicular to the film plane, since in this material the direction of easy magnetisation is along the *c*-axis.

Perpendicular Recording Applications

The potential of palladium/cobalt multilayers as a material for perpendicular magnetic memory storage was demonstrated in a paper by B. M. Lairson from Rice University, Texas, and J. Perez and C. Baldwin from Censtor Corporation, San Jose, California. They compared palladium/cobalt multilayers with conventional cobalt-chromium alloys and found that the palladium/cobalt multilayers had a number of advantages, including the larger signal which is read back from the information stored when using palladium/cobalt multilayers. The multilayer properties of palladium/cobalt can be easily modified to match a particular data recording head, and the multilayers do not require the use of a high temperature deposition process to produce the desired properties.

Platinum-cobalt alloys were also reported to have potential as a future perpendicular recording media by T. Hikosaka, T. Komai and Y. Tanaka from Toshiba R. & D. Center, Kawasaki, who produced platinum-cobalt alloys with large perpendicular anisotropies and coercivities by sputter deposition.

They obtained these properties by adding oxygen to the high pressure (30 mTorr) sputtering gas to produce a material in which the platinum-cobalt alloy grains were separated by amorphous oxide boundaries. The oxygen rich boundaries magnetically help to isolate the grain, which produces the large perpendicular anisotropy and coercivity of the material.

Conclusions

The results presented at this conference showed that both platinum- and palladium-containing materials have potential applications as magnetic data storage materials, in both magneto-optical and perpendicular recording applications. The publication of the full conference proceedings will be split between the *Journal of Applied Physics* and the *IEEE Transactions on Magnetics* later this year. J.M.

References

1 S. Hashimoto, Y. Ochai and K. Aso, *J. Appl. Phys.*, 1990, **67**, (4), 2136

2 W. B. Zeper, F. J. A. M. Greidanus and P. F. Carcia, *IEEE Trans. Mag.*, 1989, **25**, (5), 3764

3 H. Yamane, M. Kobayashi, N. Maeno and K. Sato, *Japanese Appl.* 1/274,039; 1989

Pretreatment of Titanium for Platinum Plating

A variety of electrochemical processes make use of platinum plated titanium electrodes. Before an adherent coating can be deposited onto the titanium, however, the tenacious oxide layer must first be removed, this being especially important if the thickness of the platinum deposit is to be greater than 2 to 3 micrometres, as is generally required for industrial use.

In a recent article M. Pushpavanam and S. R. Natarajan of the Central Electrochemical Research Institute, Karaikudi, India, describe experiments carried out to identify a titanium pretreatment procedure that would facilitate the direct electrodeposition of platinum from a dinitrosulphato platinous acid (DNS) system at pH 2–3 (*Met. Finish.*, 1994, **92**, (6), 85–87, 157).

Eight different etchant compositions were considered in the experimental programme and their performance assessed in terms of deposit appearance and adhesion, performance under corrosion conditions and the initial substrate metal weight loss. Adherent platinum coatings up to 8 micrometres thick, with good corrosion resistance, were produced by direct deposition after the titanium substrate had been treated in a solution of sodium fluoride, hydrochloric acid and acetic acid; the optimised conditions being identified in the article. P.E.S.