Microsc. Microanal. 8 (Suppl. 2), 2002
DOI 10.1017.S1431927602100602



# TEM Microstructure Studies of Thin Film Magnetic Recording Media

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The remarkable increase in the magnetic recording density of computer hard disk systems (currently about 60% per annum) is achieved by microstructural control. Of particular importance are the grain size and orientation of the active cobalt alloy layer, the alloy content, and grain boundary segregation or separation effects. Since typical grain sizes are now close to 10 nm or so, it is clear that only transmission electron microscopy (TEM) has the capacity to study these effects in the necessary detail. This paper reviews some recent progress in this field.

TEM samples are prepared in both through-foil and cross-section orientations, although the former often contain most of the information for the magnetic technologists. High resolution (HREM) imaging is generally required for the grain size analysis [1,2] because of the lack of clarity in bright field images in identifying each individual grain. Segregation effects are studied with nano-probe X-ray energy dispersive spectroscopy (EDS), combined with HREM for direct grain misorientation analysis, and collaborative work using electron energy filtered imaging has also been successful [3,4]. The basic alloys are cobalt-chromium based with additions of tantalum, platinum and/or boron. Tantalum promotes the grain boundary segregation of chromium, platinum improves the magnetic coercivity and boron refines the grain structure significantly.

Fig. 1 shows low and high magnification views of a CoCrPtB alloy and Fig. 2a shows its grain size analysis in the form of a cumulative percentage plot. Such curves allow immediate derivation of the median volume, and can easily distinguish grain size distributions of materials with apparently similar averages [1,2]. Because of the uniformity of the microstructure, and indeed the magnetic properties across the hard disk, we have found that sampling only 100-200 grains yields a satisfactory analysis, a result obtained elsewhere on a study of sputtered aluminum thin film grains [5]. Data such as these are related to the experimental deposition conditions and the thin film magnetic properties.

Fig. 2b shows EDS analysis of grain boundaries in a $Co_{80}Cr_{16}Pt_4$ alloy. As found previously [6], the degree of chromium segregation is significantly lower for platinum-bearing alloys compared to tantalum bearing. Indeed for the latter, up to twice the nominal chromium composition can be accommodated at the boundaries [3,4,7], which noticeably improves the magnetic recording signal-to-noise performance. We are currently correlating segregation effects to grain misorientation. An earlier report [8] indicates that an important structural relationship exists.

In summary, TEM is essential for microstructural studies of such fine-grain, high performance magnetic thin films.

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[9] This work was supported by Komag Corporation, and has also benefited from prior support from Seagate Corporation, HMT Technology and IBM. One of us (JDR) acknowledges receipt of a NSF fellowship.

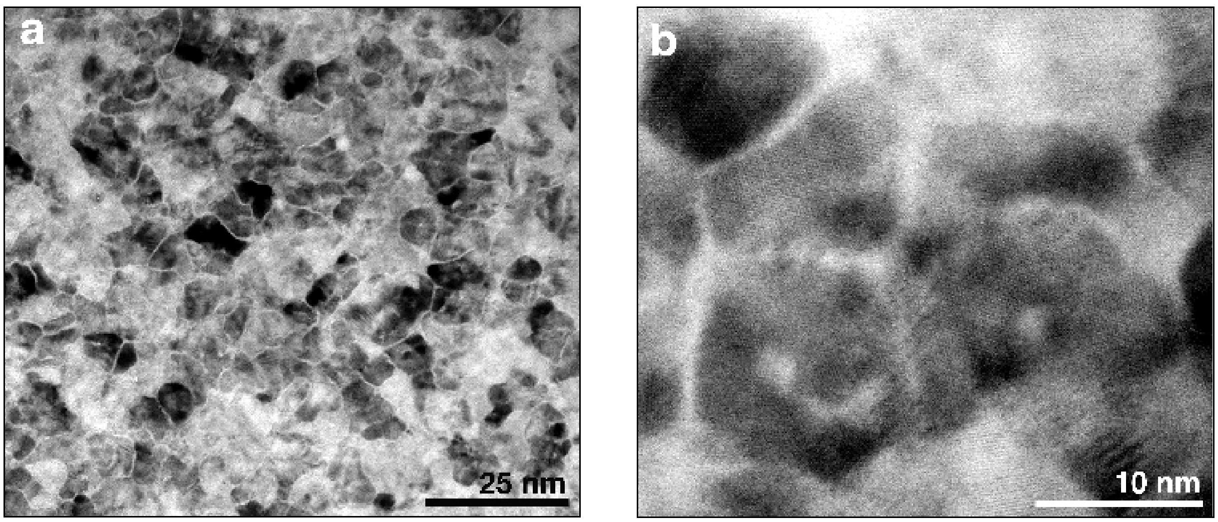


FIG. 1. (a) Bright field and (b) high resolution transmission electron microscopy images of a CoCrPtB alloy.

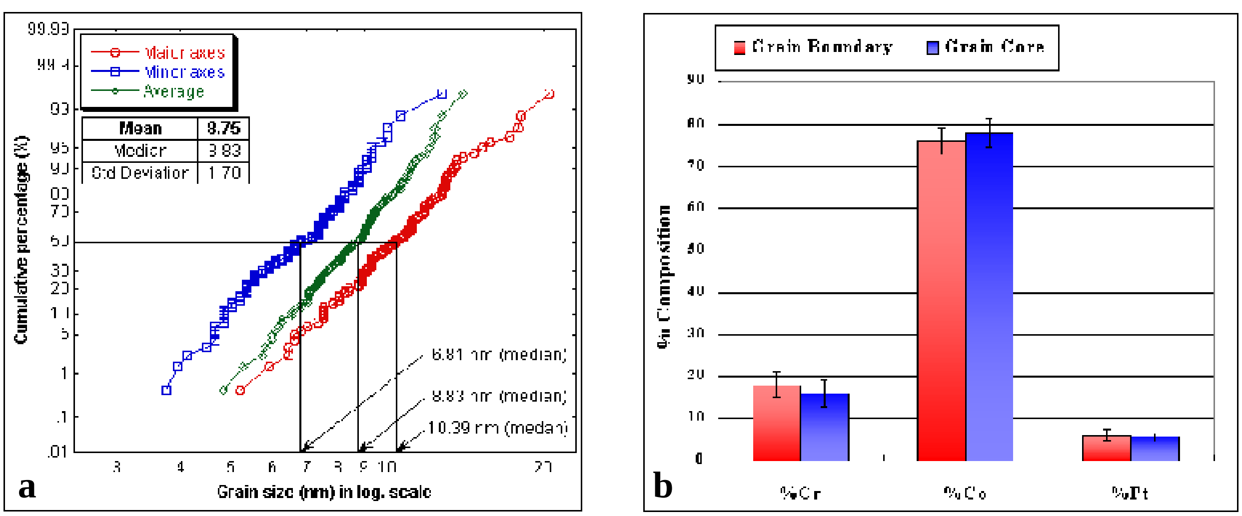


FIG. 2. (a) Grain size analysis of CoCrPtB alloy in the form of a cumulative percentage plot
(b) Comparison of grain boundary and grain core Cr, Co, and Pt composition in a $Co_{80}Cr_{16}Pt_4$ alloy.

https://doi.org/10.1017/S1431927602100602 Published online by Cambridge University Press