AXIC APPLICATION REPORT

Magnetic Film Applications Non-Destructive Composition and Thickness Analysis Using Combination EDS/WDS X-Ray Fluorescence Spectrometry

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Statement of Problem

In the manufacture of thin film recording heads a great deal of attention is placed on the composition of the films and the thickness as only slight changes greatly influence the magnetic properties, the aerodynamic characteristics, bonding properties and mechanical properties. These subject films are variations of permalloy over bonding films on $A1_2 0_3$/SiC substrates. Film thicknesses range to several microns with uniformity requirements in the range of .2% and compositional control to .1 Wt. %. As non destructive techniques must be utilized, XRF is one of the few existing possibilities for measuring both film thickness and composition simultaneously.

In a similar vane, the measurement of the films utilized in the manufacture of rigid magnetic disks also require a very tight process window to provide desirable magnetic characteristics while ensuring proper bonding to the aluminum based disks. Typical films include Ni as the bonding layer with subsequent layers of Cr and Co-Cr as the magnetic active layers and protective over layers. These layers are thin by design and again small compositional changes inflict large magnetic performance changes.

This paper deals with the measurement of these coatings for composition and thickness control in times which are reasonable in the production environment.

Film Analysis — Thin Film Recording Heads

The Axic 100 was used to measure the Ni-Fe layers for composition and thickness. A random matrix study was set up inside normally employed thicknesses and compositions. A single source calibration standard was determined from 1st order calculations and was analyzed to the following:

Ni/Fe Calibration Standard
80.5 Wt. % Ni
19.5 Wt. % Fe
36,000 Å Film Thickness

This standard was run 100 times with the following standard deviation:

19.5 Wt. % Fe ± 0.07 (3σ)
36157 Å ± 200 (3σ)
300 Sec. Data Acquisition time.

With this standardization data completed, 8 unknown samples were analyzed 5 times with the Axic 100 and reported as follows:

Sample I.D.	Wt. % Fe 3σ	Film Thickness Å 3σ	Wt. % Fe Measured by Microprobe
#1	18.77 ± 0.03	35310 ± 65	18.75
#2	17.69 ± 0.03	41776 ± 70	17.70
#3	17.97 ± 0.02	31601 ± 63	18.00
#4	17.59 ± 0.03	44169 ± 71	17.60
#5	18.75 ± 0.03	30163 ± 66	18.75
#6	18.31 ± 0.03	42942 ± 55	18.30
#7	19.83 ± 0.03	30627 ± 73	19.80
#8	19.45 ± 0.02	43050 ± 70	19.45

*Each sample was rotated 90° between measurements and repositioned on the same target area.

It has been demonstrated that film thickness is readily measured to ± 75 Å (or within 0.2%) and film composition is measured to within ± 0.03 Wt. %.

Thin Film Measurements — Hard Drive Disks

There are a number of coatings present on hard drive disks which require precise measurement. Nickel, which is used either in a pure form or containing a percentage of phosphorus, is normally used as the bonding layer. Chrome and cobalt-chrome layers are used in bonding and active magnetic layers. Protective and lubricate layers are also incorporated in these structures. EDS/WDS XRF is readily used for the measurement for each of these layers, however, this paper will be limited to the magnetically active layers.

System calibration disks were employed with 3 thicknesses of Cr and Co-Pt layers as well as 3 compositions of Co-Pt. These calibration standards were each measured 10 times and are reported as follows:

Average of Three Measurements
Cr and Co-Pt over Ni on Al

Sample I.D. Given Thickness	Cr Layer Thickness Å 3σ Measured	Co-Pt Thickness Å 3σ Measured
2500 Å Cr, 360 Å Pt	2503 ± 10	358 ± 5
320 Å Co-Pt	———	321 ± 5
360 Å Co-Pt	———	363 ± 5
2500 Å Cr, 320 Å Co-Pt	2497 ± 10	319 ± 5
3500 Å Cr	3501 ± 10	———
3500 Å Cr, 360 Å Co-Pt	3504 ± 10	357 ± 5
3000 Å Cr, 340 Å Co-Pt	2997 ± 10	342 ± 5
3500 Å Cr, 320 Å Co-Pt	3503 ± 10	318 ± 5

The Cr film thickness in the Cr, Co-Pt stacks was measured to ± 10 Å and the Co-Pt layer to ± 5 Å

The standard deviations in the films measured are well within the statistical process control window for magnetic and bonding films in the thin film head and disk drive industries. Combined WDS/EDS XRF is a most reliable method for measurement of these films.

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