

A PERPENDICULAR MAGNETIC RECORDING MEDIUM BY ALUMITE

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Magnetic properties of electrodeposited alumite media for perpendicular recording were investigated. By means of the pore widening process enabled to realize the coercive force less than 1000 Oe. Mössbauer spectra suggested that the direction of magnetization of the processed alumite was almost perpendicular to the surface.

1. Introduction

Efforts have been paid to develop extensively the perpendicular recording techniques proposed by Iwasaki [1]. Sputtered Co–Cr films occupied the central position in the investigation of the perpendicular recording media [2]. Beside this film, a number of films such as sputtered film of Cr–Co–Rh [3], Co–V [4], Fe–Cr [5], evaporated Co–Cr [6], Co–O [7], electrodeposited Co film [8] and electroless deposited Co–Ni–Mn–Re–P film [9] have been reported as candidates for perpendicular recording media. Ba-ferrite films have been investigated by both coating [10] and sputtering [11] techniques. It has been known that alumite films containing electrodeposited ferromagnetic metals and alloys exhibit the magnetic anisotropy which makes the easy direction of the magnetization perpendicular to the film plane [12]. This anisotropy is concerning the needle-shaped micropores developed along the axes of the oxide cells which are grown perpendicularly to the plane. The process for making similar substance to the above material has been widely used as a process for coloring or coating aluminum surface. Unfortunately no successful attempt has been reported for making a perpendicular recording medium by this anodic oxidation technique. By the conventional anodic oxidation method, the magnetic alumite film obtained have ever exhibited too high coercive force for magnetic recording now of interest. This is because of the fact that the diameter of the pore is too small, 200 Å. Recently we found a new way to widen the diameter of the pores to depress the coercive force to a value adequate for perpendicular recording.

This paper describes the magnetic properties in the relationship to the perpendicular recording of the magnetic alumite film made by this new anodic oxidation method.

2. Specimens

Perpendicular magnetic recording media examined in the present study were alumite films electrodeposited in a iron sulphate bath. Prior to the electrodeposition

process, 4% Ma–Al alloy substrate plates were subjected to an anodic oxidation process. Special attentions were paid for the 99.99% purity of the aluminum raw material in order to ensure the formation of oxide layer with regularly developed hexagonal cells with pores to be mentioned later. The anodic oxidation process was performed in 3% oxalic acid bath at 20°C as usual. Each cell had a pore whose diameter D_p was a few hundred ångström. This diameter was too small to realize the coercive force less than around 1000 Oe. In the present experiment, a special process was introduced in order to widen the pore diameter. In this process, a 1% phosphoric acid bath at 20–40°C employed. In fig. 1 is shown of the electron scanning micrograph of the oxide layer of 4–10 μm in thickness thus obtained with a well developed hexagonal close packed cell structure. In the same figure, (b) is the schematic structure of the same oxide layer.

By the aid of the special current, which was a direct current superposed by an adequate amount of alternating ones, electrodeposition was made in an iron sulphate bath at 40–60°C. Transmission electron microscopic observation revealed that a thin needle like electrolytic iron column fulfilled each pore in the cell from its bottom. As several of the specimens, 5.25 inch wide circular alumite disks with 4 μm thick were prepared by

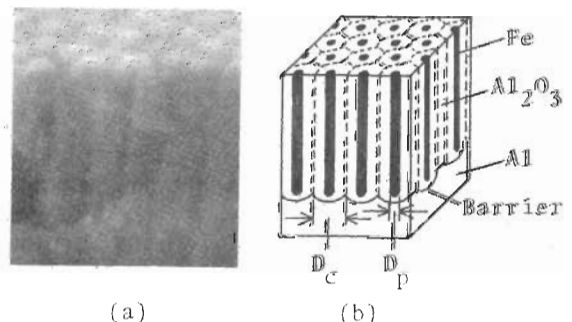


Fig. 1. (a) An electron scanning micrograph of oxide layer of 4–10 μm in thickness; (b) its schematic structure.

polishing their surface carefully. Most of these specimens exhibited 400–1400 Å cell diameter D_c and 200–1200 Å pore diameter D_p .

3. Experimental results and discussions

Magnetization of the circular films cut out from the magnetic alumite media were examined by a vibrating sample magnetometer. Typical hysteresis curves uncorrected for the demagnetizing effects are shown in fig. 2a. The coercive forces H_{\perp} and H_{\parallel} are shown in fig. 2b. From fig. 2a, it is concluded that the magnetization orients perpendicularly to the films and after the demagnetization field correction, the rectangular shape which is desirable for the perpendicular recording is obtained. It is noted that H_{\perp} depended only on the pore diameter D_p and not on the cell diameter D_c as shown in fig. 2b. The coercive force below 1000 Oe suitable for perpendicular recording was obtained in the films with pore diameter D_p larger than 400 Å.

Mössbauer spectroscopy was carried out on a film. In fig. 3 is shown of a typical result showing two weakened lines indicated that the most part of the magnetization is oriented perpendicularly to the film. The effect of strong perpendicular anisotropy was also

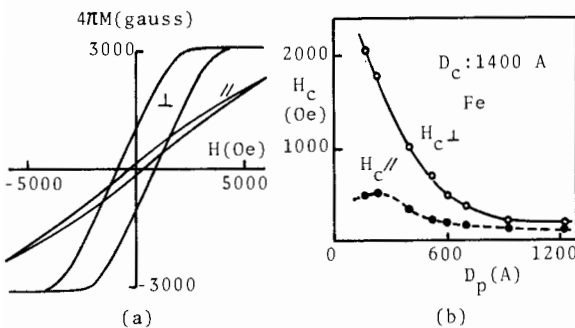


Fig. 2. (a) Typical hysteresis curves of an alumite film without the correction of demagnetizing effects. D_c and D_p are 1180 and 450 Å, respectively; (b) the perpendicular coercive force H_{\perp} and parallel coercive force H_{\parallel} of the films with 1400 Å D_c .

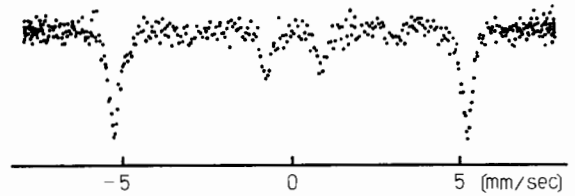


Fig. 3. A Mössbauer spectrogram of a film.

observed as a hump at high bit density characteristics by using a ferrite ring head with a gap length of 0.5 μm . The bit density D_{50} was 42 kBPI in this preliminary disk testing. This bit density characteristic was better than any other available longitudinal oriented Co–Ni–P plated disk of good quality.

4. Summary

The large coercive force exhibited in the conventional alumite processed in iron sulphate bath could be reduced by introducing an additional process named as pore widening before electrodeposition. Less than 1000 Oe coercive force related to the pore diameter greater than 400 Å. Shape of hysteresis loops, Mössbauer lines, as well as D_{50} showed suitable features for the perpendicular recording process.

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