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Fabrication of a multitrack, thin-film head

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Consumer Products Research Center, Hitachi Limited, Yokohama, Japan

Thin-film magnetic heads with a high track density of 25 tracks per 3.81 mm have been fabricated. The write current density is the same as that of the conventional sendust audio head. The head consists of a two-layer, high aspect ratio coil, formed by the reactive plasma etching method, and spin-coated PIQ varnish layers as the insulation layers to provide a smooth surface for subsequent coil layers and the Ni-Fe alloy layer.

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INTRODUCTION

A multi-track head for a PCM recorder is required to satisfy the following conditions:

1) electrically compatible with LSI.
2) defacement resistant.
3) good write efficiency.
4) mass production oriented.

These conditions differ from those of a thin-film head for computers. A multi-track head directly driven by LSI requires the write current per write head unit to be less than 50mA/track. Therefore, the multi-turned head is preferable for reducing the write current. Structures[1.2.3.4.5] for multi-turned heads can be divided into two types; one is a spiral monolayer and the other is a multi-layered coil. To achieve high track density and reduce magnetic loss in the magnetic yoke, the multi-layered type is suitable. As the number of coil turns increases, the electrical resistivity of the coils increases. Therefore, the electrical power increases at a fixed write current (I^2R). The coil shape with wide section is suitable to reduce the electrical resistivity. So it is important to have a low resistance, multi-turned and multi-layered coil to fabricate the thin-film multi-track head for a PCM recorder.

HEAD DESIGN

The number of tracks and the track width of the multi-track head for the PCM recorder are arranged in conformity with the tape width, tape speed, and format of signal processing. The configuration of Hitachi thin-film multi-track head for the PCM recorder is as follows; the tape width: 3.81mm, the number of tracks: 25 tracks, the track width: 60μm, the track pitch: 140μm, the number of the coil turns: 5 turns.

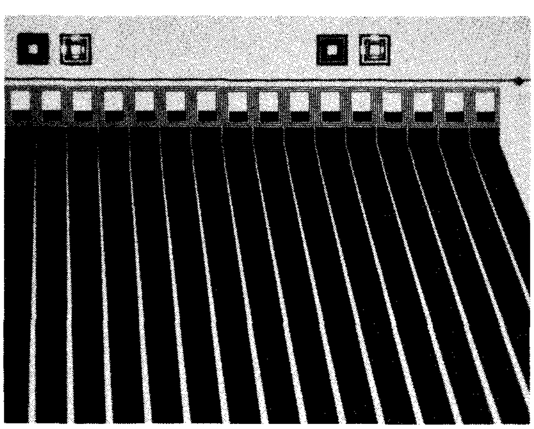

Fig. 1. Photograph of a photomask for the fabrication of the multi-track head.

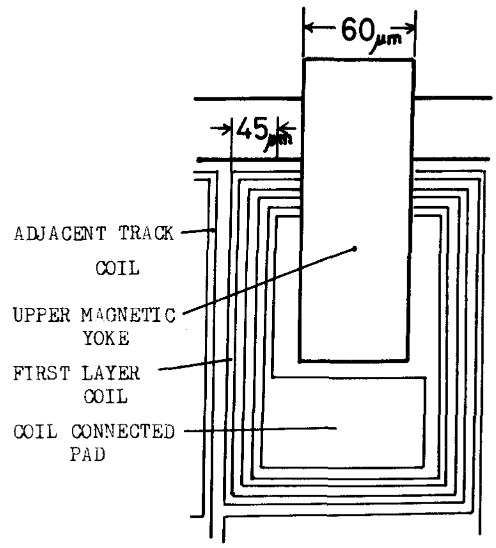

Fig.2 The schematic presentation of the five turn coil. The first layer has three turns and the second layer has two turns.

A photograph of a photomask for the fabrication of the multi-track head and the schematic presentation of the 5 turns coil are shown in Fig. 1 and Fig. 2. The five turns can be divided into two layers. The first layer has three turns and the second layer has two turns. The fabrication process for our multi-track head has two advantages. First, the coils with the square section are formed from 5μm thick evaporated aluminium film by the reactive plasma etching method to reduce the recording current and the coils resistance. The second advantage is the use of the polyimide resin, *PIQ as the insulation layer to provide the smooth surface for the subsequent second coil layer and the Ni-Fe alloy layer. (*PIQ is produced by Hitachi Chemical Co. Ltd. as an insulation layer for LSI)

FABRICATION OF THE THIN FILM HEAD

Figure 3 shows the fabrication process for the thin-film, multi-track head arrays. Fotoceram (CORNING) is chosen as the substrate. The Ni-Fe alloy (2μm) was sputtered on the substrate to form the lower magnetic yoke. After that, the head gap is formed by the sputtered insulater (SiO_2). Then the aluminium layer is evaporated to a 5 μm thickness. The aluminium coil pattern is formed by the reactive plasma etching technique.

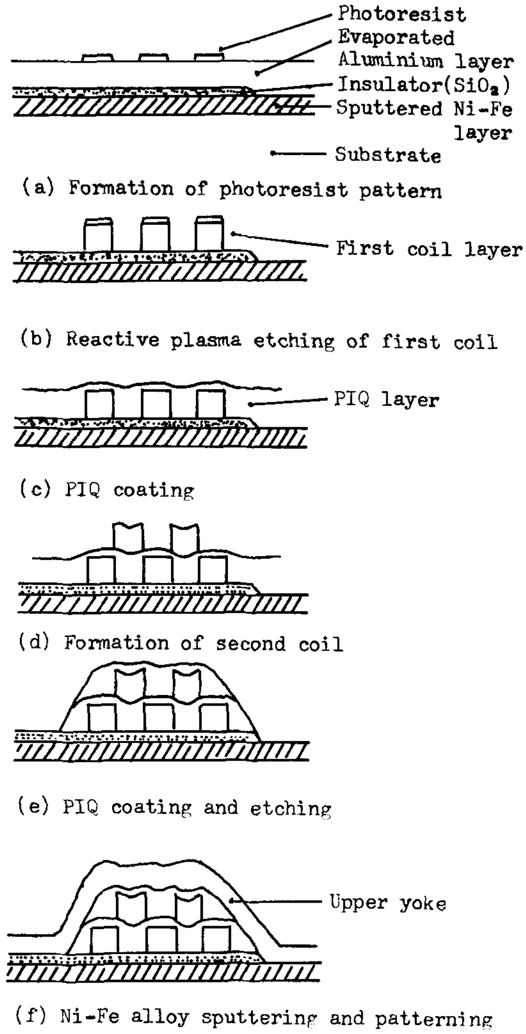

Fig. 3. The fabrication process for the thin film head arrays.

The etching conditions are as follows:

Apparatus:	ANELVA DEM 451
Photo resist:	AZ 1375 (4μm)
Etchant:	BCl_3, CF_4, O_2
Power density:	0.36W/cm
Gas pressure:	0.14 Torr

Figure 4 shows a schematic sketch of the reactive plasma etching apparatus used for the formation of the coils.

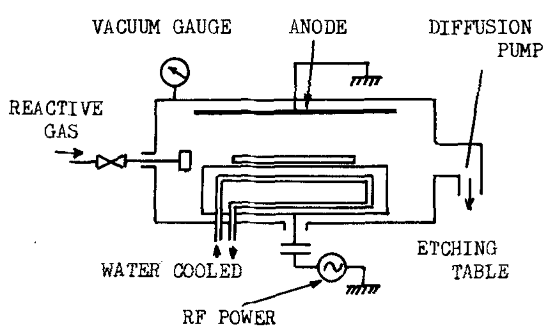

Fig. 4. A schematic sketch of the reactive plasma etching apparatus used for formation of the coils.

The most appropriate etching condition were studied. The gas pressure has an important effect upon the shape of the coil section. Figure 5 shows the dependence of the

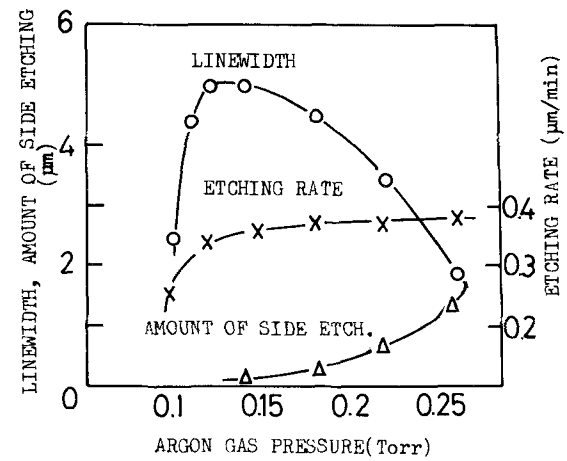

Fig. 5. The dependence of the linewidth of the coils, the amount of the side etching and the etching rate on the partial pressure of the argon gas.

linewidth of the coil, the amount of the side etching and the etching rate on the partial pressure of the argon gas. In the high argon gas pressure region, the side etching becomes evident and consequently the linewidth becomes narrow. On the other hand, in the low argon gas pressure region the linewidth of the coil is narrowed because of the damage of the photoresist bombarded by argon ions. The coil formed by the reactive plasma etching method is shown in Fig. 6.

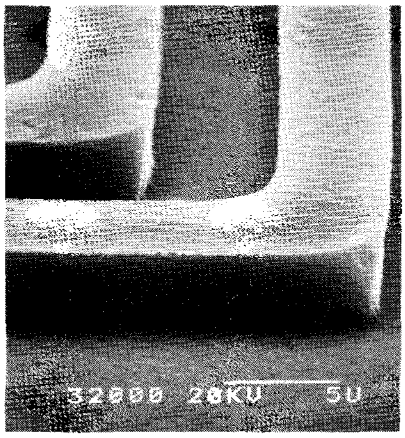

Fig. 6 Photograph of the aluminium coil formed by the reactive plasma etching method.

The coils have a 4μm to 5 μm step. So it is difficult to form other layers on them, such as the second layer and the upper magnetic yoke layer. Therefore, the PIQ varnish is spin coated and cured at 350° C as the insulation layer to provide the smooth surface for subsequent layers. The smoothness of the spin coated PIQ vanish layers is observed in the scanning electron microscope (SEM). The rotation speed of the spinner and the viscosity of the PIQ is adjusted to get thinner PIQ varnish layers on the coils and a flat surface. Figure 7 shows relationship between the thickness of the PIQ layers on the coils and the rotation speed of the spinner. Figure 8 shows the relationship between the viscosity of the PIQ varnish and the amount of winding surface. From these results we find that multi-coating of PIQ varnish is suitable to form the PIQ layer with a thin, flat surface. The

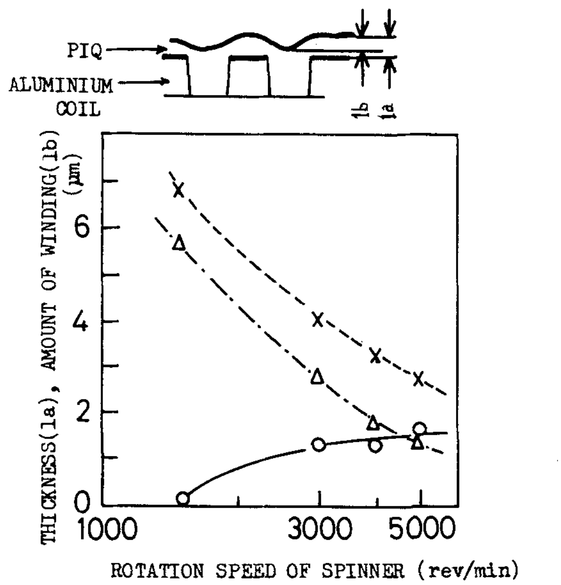

Fig. 7 The relationship between the thickness of the PIQ layers on the coils and the rotation speed of the spinner.
- - - - - - - - thickness on the flat surface.
—·—·—·—·- thickness on the coils.
———— the amount of the winding.

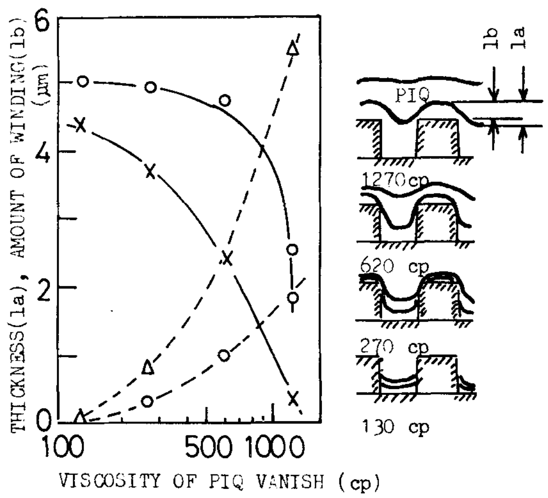

Fig. 8 The relationship between the viscosity of the PIQ varnish and the amount of the winding.
—o—o— amount of the winding (the first time).
—x—x— amount of the winding (the second time).
---△---△--- thickness of the PIQ layer on the coil (the first time).
---o---o--- thickness of the PIQ layer on the second time).

PIQ varnish is applied three times under different conditions. The amount of the winding at the surface is less than 1μm and the thickness of the PIQ layer on the coil is less than 2.5μm. The second coil layer is formed by the same method as that of the first layer. The etching speed of the aluminium is five times faster than that of the PIQ varnish. The PIQ varnish is spin coated again as the insulation layer of the second coil layer to provide the smooth surface for subsequent Ni-Fe alloy layer. Then the Ni-Fe alloy (4μm) is sputtered to form the upper magnetic yoke. The upper magnetic yoke is formed by the ion milling method (VEECO MICRO ETCH SYSTEM). With these method we have fabricated the multi track head with 25 tracks, each has a two layer, 5-turn coil. A photograph of the cross-section of the fabricated head is shown in FIG.9.

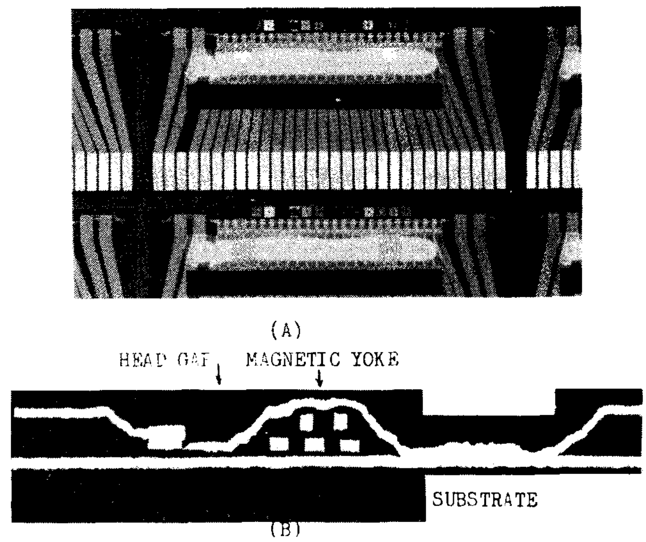

Fig. 9 Photograph of the fabricated head (A) and the cross-section of the head (B).

HEAD CHARACTERISTIC

The performance of the Hitachi multi-track head for the PCM audio recorder was evaluated with a magnetic tape for VTR. Figure 10 shows the relationship between the M.O.L. (maximum output level) and the recording wave-length. It shows that the write efficiency of the head is the same as that of the sendust audio head.

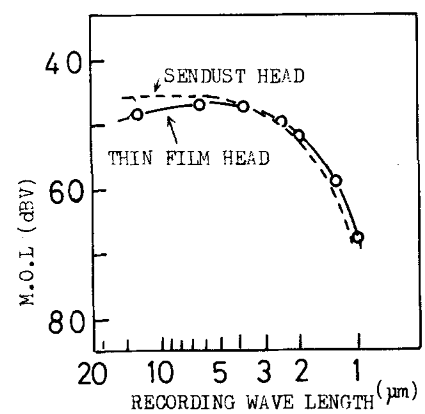

Fig. 10 The relationship between the M.O.L. (maximum output level) and the recording wave-length.

REFERENCES

1) M.Hanazono, K.Kawakami and S.Narishige, IEEE Trans. Magnetics, MAG-15, 1616 (1979).
2) J.P.Lazzari, IEEE Trans. Magnetics, MAG-14, 503 (1978).
3) W.Berghof, H.H.Gatzen, IEEE Trans. Magnetics, MAG-16 ,782 (1980).
4) R.E.Jones,Jr., IBM Disk strage Technology, Feb. pp 6 (1980).
5) Y.Miura, Y.Takahashi, IEEE Trans. Magnetics, MAG-16, 779 (1980).