Description

Background of the Invention

This invention pertains to film type magnetic transducer heads and more particulary to an improved transducer structure that enables intermediate testing.

In current film type transducer head designs, two layers of magnetic material are deposited on a substrate with an insulating layer separating the magnetically permeable layers except at a back gap to form a yoke with a closed magnetic path extending from the transducer gap at the pole tip portions. A substantially flat, modified spiral coil extends through the insulating material which separates the yoke layers and also isolates the coil convolution from the layers forming the yoke. The center pad of the coil is electrically connected by a jumper that is formed with the second layer of the yoke material. Thin film magnetic heads of this design are shown in U.S.-A-4,190,872 and 4,219,854. This design functions well, but is subject to some fabrication limitations that tend to compromise the yield of devices from the fabrication process. Principally, the device cannot be tested until the second permalloy layer is applied, at which time the testing becomes more complex, and the opportunity to rework failing coils no longer exists. J.P.-A-5860420 discloses another structure of a film magnetic head in which the winding of the coil is composed of two conductive layers separated by an insulating layer, the center pad of the coil being electrically connected to the output by a connecting member deposited at the same time as the first conductive layer of the coil. However, with this structure, no test can be performed insofar as the two conductive layers are not connected together.

The most difficult test is for shorted turns whereby the winding is effectively reduced by one convolution; that is an eight, turn coil has become a seven turn coil. As the number of turns increases this problem will become progressively more difficult to detect. If it were possible to test coil immediately after the conductor turns have been deposited and isolated, the procedure could be simplified, and it would also be possible to rework most of devices to full specification requirements rather than discarding the transducer that is then almost fully processed.

Summary of the Invention

The method of the present invention allows the continuity and coil convolution separation to be tested as soon as the coil forming conductive copper material is applied. Testing at this stage of fabrication makes it easier to identify single shorted turns and also enables defects to be identified when it is possible to rework or replace the coil and thereby enhance the yield of good devices from the process. At this stage of fabrication a selective etchant may be applied that removes the copper conductor coils without damage to the underlying insulation or permalloy elements. This enables the conductive coating, masking, copper electroplating and mask removal to be repeated to create a winding that meets device specifications without compromising prior process steps or requiring the discarding of a completed device that does not have other defects.

The object of the invention is to provide a method as defined in claim 1.

Brief Description of the Drawings

Figure 1 is an enlarged plan view of a film transducer incorporating the invention.

Figure 2 is a further enlarged partial sectional view taken along line 2-2 of figure 1.

Detailed Description

As shown in figures 1 and 2, a thin film (transducer) head is formed on a ceramic substrate 10. A pair of permalloy pole pieces 12 and 13 form a yoke 14 with a back gap region 32 where the yoke members contact one another and a transducer gap 16 defined by the thickness of the gap material 17. The electrical terminal 19 is formed on the substrate 10. A continuous coil, copper winding 22 extends through the yoke 14 and over the terminal strip 19 being separated from the yoke by the insulating layers 23 and 24 and from the terminal strip 19 by the insulating layer 23 except in the electrical contact region 27. The convolutions of winding 22 extend from the enlarged terminal strip 19 to the enlarged central terminal end pad 21. Although figure 1 is shown enlarged, it will be appreciated that the dimension A in the pole tip region is typically less than a thousandth of an inch and the other dimensions of the transducer head assembly are in practice correspondingly smaller than the enlarged dimensions of the illustration.

The transducer head is formed on the non-magnetic ceramic support 10 which in the usual embodiment is the trailing edge and rear air bearing surface 30 of a slider element. The initial layer is a permalloy material that is applied to limited areas to form the yoke layer, which includes pole tip portion 13 and back region 15, and the terminal 19. The yoke layer, including back region 15 and pole tip 13 underlies the upper yoke layer, which includes back region 18 and pole tip 12 and has the same shape and dimensions as such upper yoke layer 14 except for the somewhat increased width of the pole tip region adjacent the air bearing surface 30. The transducer gap 16 is established by a thin layer 17 of non-conductive, non-magnetic material which overlies the entire transducer surface with the exception of the electrical contact area 27 and the yoke back gap 32 with the thickness controlled to establish the proper transducer gap dimension between pole tip regions of the yoke portion 12 and 13. The first insulation layer 23 is then applied which electrically isolates the coil 22 from the yoke back region layer 15 and the terminal strip 19 except in the yoke back gap region 32 and the electrical, contact area 27. The insulation 23 is also excluded from the pole tip region 13. The

transducer assembly as partially fabricated has a metal coating applied to the surface sufficient to make the surface conductive, is then masked using photoresist techniques to define the configuration of the coil 22 and the conductive layer that forms the continuous coil 22 as applied by electroplating copper on the exposed unmasked areas. The mask and underlying metal coating is thereupon removed. The coil 22 should form continuous convolutions from the electrical contact area 27 to the enlarged terminal surface 34 without electrical interruption or shorting between convolutions that would electrically reduce the number of turns in the coil.

At this stage of fabrication the coil 32 is testable using the terminal strip 19 and the enlarged electrical contact area 34 at the end of the coil. At this time it is possible to rework defective coils using a selective etchant which dissolves only the copper coil layer 22, 34 without damaging the permalloy pole piece 13, gap materials 17 or insulation 23. An etchant that provides this function is a 20 per cent solution of ammonium persulfate having a Ph of 8. After removing the defective copper layer the surface can be remetalized with copper, masked with photoresist material, exposed, developed an plated with copper to reestablish the coil convolutions and extended surface electrical contact area 34.

Following the intermediate electrical testing and any necessary reworking, the remaining fabrication steps occur. The insulation layer 24 is applied followed by the final permalloy yoke layer 12, 18.

Claim

The method of making a film transducer head on a substrate comprising the steps of:

simultaneously depositing a substantially coplanar first yoke layer (13, 15) and an electric terminal strip (19) on said substrate;

applying a layer of gap material (17) which defines the transducing gap at the pole tip region (12, 13);

applying a first electrical insulating layer (23) over said yoke layer and said electric terminal strip;

applying a coil (22) with a first portion of each convolution overlying said yoke between said pole tip region (12, 13) and a back gap region (32), a second portion of each convolution overlying said electric terminal strip and an inner terminal end (19) in electric contact with said electric terminal strip;

applying a second insulating layer (24) which overlies said coil; and

applying a second yoke layer (18) which overlies said first yoke layer to form a transducer gap at the pole tip region (12, 13) and extends to the back gap region (32) where it is in intimate contact with said first yoke layer, this method being characterized in that it further comprises the step of:

testing said coil for continuity and shorted turns before applying said second insulating layer (24) reworking or replacing said coil when said step of testing said coil indicates a coil discontinuity or a shorted turn, by removing the coil material using a selective etchant that does not impair the underlying layers of material previously applied.

Patentanspruch

Methode zur Herstellung eines Film-Transducerkopfes auf einem Substrat, die folgende Schritte aufweist:

gleichzeitiges Abscheiden einer im wesentlichen koplanaren ersten Jochschicht (13, 15) und eines elektrischen Kontaktbandes (19) auf dem genannten Substrat;

Aufbringen einer als Luftspalt fungiereden Schicht (17), die den Wandlerspalt im Bereich der Polenden (12, 13) definiert;

Aufbringen einer ersten elektrischen Isolierschicht (23) auf der genannten Jochschicht und dem genannten elektrischen Kontaktband;

Aufbringen einer Spule (22), wobei ein erster Teil jeder Windung das genannte Joch zwischen dem genannten Polendenbereich (12, 13) und einem hinteren Spaltbereich (32) überdeckt, ein zweiter Teil jeder Windung das genannte elektrische Kontaktband überdeckt und ein inneres Kontaktband (19) mit dem genannten elektrischen Kontaktband in elektrischer Verbindung steht;

Aufbringen einer zweiten Isolierschicht (24), die die genannte Spule überdeckt; und

Aufbringen einer zweiten Jochschicht (18), die die genannte erste Jochschicht überdeckt, um einen Wandlerspalt im Polendenbereich (12, 13) zu bilden, und sich bis zum hinteren Spaltbereich (32) erstreckt, wo sie in innigem Kontakt mit der genannten ersten Jochschicht steht, wobei diese Methode weiter durch folgenden Schritt gekennzeichnet ist:

Prüfung der genannten Spule auf Durchgang und kurzgeschlossene Windungen vor dem Aufbringen der zweiten Isolierschicht (24);

Nacharbeit oder Auswechseln der genannten Spule, wenn der genannte Prüfschritt ergibt, dass die Spule eine Unterbrechung oder eine kurzgeschlossene Windung aufweist, und Entfernen des Spulenmaterials mittels eines selektiven Ätzmittels, das die darunterliegenden, vorher aufgebrachten Materialschichten nicht angreift.

Revendication

Procédé de fabrication de tête de transducteur à couches minces sur un substrat, comprenant les étapes consistant:

à déposer simultanément une première couche (13, 15) formant culasse, sensiblement dans un même plan, et une bande (19) formant borne électrique sur le substrat;

à appliquer une couche de matière (17) d'entrefer qui définit l'entrefer de transducteur à l'endroit de la région terminale polaire (12, 13);

à appliquer une première couche (23) d'isolation électrique sur la couche de culasse et sur la bande formant borne électrique;

à appliquer un bobinage (22), une première

transducer assembly as partially fabricated has a metal coating applied to the surface sufficient to make the surface conductive, is then masked using photoresist techniques to define the configuration of the coil 22 and the conductive layer that forms the continuous coil 22 as applied by electroplating copper on the exposed unmasked areas. The mask and underlying metal coating is thereupon removed. The coil 22 should form continuous convolutions from the electrical contact area 27 to the enlarged terminal surface 34 without electrical interruption or shorting between convolutions that would electrically reduce the number of turns in the coil.

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Following the intermediate electrical testing and any necessary reworking, the remaining fabrication steps occur. The insulation layer 24 is applied followed by the final permalloy yoke layer 12, 18.

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The method of making a film transducer head on a substrate comprising the steps of:

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applying a coil (22) with a first portion of each convolution overlying said yoke between said pole tip region (12, 13) and a back gap region (32), a second portion of each convolution overlying said electric terminal strip and an inner terminal end (19) in electric contact with said electric terminal strip;

applying a second insulating layer (24) which overlies said coil; and

applying a second yoke layer (18) which overlies said first yoke layer to form a transducer gap at the pole tip region (12, 13) and extends to the back gap region (32) where it is in intimate contact with said first yoke layer, this method being characterized in that it further comprises the step of:

testing said coil for continuity and shorted turns before applying said second insulating layer (24) reworking or replacing said coil when said step of testing said coil indicates a coil discontinuity or a shorted turn, by removing the coil material using a selective etchant that does not impair the underlying layers of material previously applied.

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Methode zur Herstellung eines Film-Transducerkopfes auf einem Substrat, die folgende Schritte aufweist:

gleichzeitiges Abscheiden einer im wesentlichen koplanaren ersten Jochschicht (13, 15) und eines elektrischen Kontaktbandes (19) auf dem genannten Substrat;

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Aufbringen einer Spule (22), wobei ein erster Teil jeder Windung das genannte Joch zwischen dem genannten Polendenbereich (12, 13) und einem hinteren Spaltbereich (32) überdeckt, ein zweiter Teil jeder Windung das genannte elektrische Kontaktband überdeckt und ein inneres Kontaktband (19) mit dem genannten elektrischen Kontaktband in elektrischer Verbindung steht;

Aufbringen einer zweiten Isolierschicht (24), die die genannte Spule überdeckt; und

Aufbringen einer zweiten Jochschicht (18), die die genannte erste Jochschicht überdeckt, um einen Wandlerspalt im Polendenbereich (12, 13) zu bilden, und sich bis zum hinteren Spaltbereich (32) erstreckt, wo sie in innigem Kontakt mit der genannten ersten Jochschicht steht, wobei diese Methode weiter durch folgenden Schritt gekennzeichnet ist:

Prüfung der genannten Spule auf Durchgang und kurzgeschlossene Windungen vor dem Aufbringen der zweiten Isolierschicht (24);

Nacharbeit oder Auswechseln der genannten Spule, wenn der genannte Prüfschritt ergibt, dass die Spule eine Unterbrechung oder eine kurzgeschlossene Windung aufweist, und Entfernen des Spulenmaterials mittels eines selektiven Ätzmittels, das die darunterliegenden, vorher aufgebrachten Materialschichten nicht angreift.

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Procédé de fabrication de tête de transducteur à couches minces sur un substrat, comprenant les étapes consistant:

à déposer simultanément une première couche (13, 15) formant culasse, sensiblement dans un même plan, et une bande (19) formant borne électrique sur le substrat;

à appliquer une couche de matière (17) d'entrefer qui définit l'entrefer de transducteur à l'endroit de la région terminale polaire (12, 13);

à appliquer une première couche (23) d'isolation électrique sur la couche de culasse et sur la bande formant borne électrique;

à appliquer un bobinage (22), une première

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partie de chaque spire recouvrant la culasse entre la région terminale polaire (12, 13) et une région arrière (32) d'entrefer, et une seconde partie de chaque spire recouvrant la bande formant borne électrique et une extrémité intérieure formant borne (19) en contact électrique avec ladite bande formant borne électrique;

à appliquer une seconde couche isolante (24) qui recouvre le bobinage; et

à appliquer une seconde couche (18) de culasse qui recouvre la première couche de culasse pour former un entrefer de transducteur à l'endroit de la région terminale polaire (12, 13) et qui s'étend jusqu'à la région arrière (32) d'entrefer où elle est en contact intime avec la première couche de culasse, ce procédé étant caractérisé en ce qu'il comprend, en outre, l'étape consistant:

à soumettre le bobinage à des essais relatifs la continuité et aux court-circuitage des spires avant d'appliquer la seconde couche isolante (24) et à procéder à la réfection ou remplacement du bobinage quand l'étape des essais du bobinage indique une discontinuité de bobinage ou un court-circuitage de spire en enlevant la matière constituant le bobinage à l'aide d'un décapant sélectif qui n'altère pas les couches sous-jacentes de matière précédemment appliquées.

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