

Description

This invention relates to a magnetoresistive read transducer for reading information signals from a magnetic record medium.

Magnetoresistive (MR) transducers are capable of reading data from a magnetic surface at great linear densities. An MR sensor detects magnetic field signals through the resistance changes of a read element made from a magnetoresistive material as a function of the amount and direction of magnetic flux being sensed by the element.

Numerous MR sensors have been developed, and these known MR sensors have been effective to meet previous requirements.

Japanese published unexamined patent application 57-198528 describes a MR head in which the MR element is separated from a magnetic biasing layer by an insulating layer. However, the track width T_w , over which the head is responsive to magnetic excitation, is determined by the physical spacing between signal pickup conductors.

U.S. -A- 4,504,880 discloses an integrated magnetic recording head which includes an inductive write head and an MR read element. The MR read element is in electrical contact with two spaced conductors, so the effective track width of the MR read element is defined by the spacing between these conductors.

U.S. - A- 4,568,906 discloses a magnetic field sensitive element suitable for measuring magnetic field gradients in which the active part of the magnetic field sensitive element is defined by connection conductors which are in electrical contact with the magnetic field sensitive element.

EPA 0265798, an intermediate document falling within the scope of Article 54(3), discloses an MR transducer with a non-magnetic intervening layer, such that only the end regions of the MR element experience a longitudinal bias, leaving the central region of the MR element in a single domain state with a transverse bias.

The drive towards increased recording density has led to the requirement for narrower recording tracks and increased linear recording density along the tracks. As the track width becomes smaller it becomes progressively more difficult to adequately define the track width by the distance between spaced conductor elements.

The invention seeks to provide a small MR sensor in which the trackwidth is adequately defined.

In accordance with the invention, a magnetoresistive (MR) read transducer comprises a layer of insulating or high resistivity material in contact with and extending over part of a magnetoresistive element, said material having a sufficiently high resistivity that it defines and is sub-

stantially coextensive with an active region of said magnetoresistive elements, a first conductor extending over and in electrical contact with the magnetoresistive element, and overlapping one edge of the layer; and a second conductor extending over and in electrical contact with the magnetoresistive element, and overlapping the opposite edge of the layer and spaced from the first conductor. Upon connection of the conductors to a signal sensing means, the signal sensing means determines the resistance changes in the MR element as a function of the magnetic fields which are intercepted by the MR element over an effective track width defined by the distance between the edges of the layer of insulating material.

How the invention can be carried out will now be described by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a plan view of a known magnetoresistive sensor;

Fig. 2 is a section on line 2-2 of Fig. 1;

Fig. 3 is a plan view of a magnetoresistive sensor embodying the invention, prior to lead deposition;

Fig. 4 is a section on line 4-4 of Fig. 3;

Fig. 5 is a plan view of the magnetoresistive sensor of Fig. 3, after lead deposition; and

Fig. 6 is a section on line 6-6 of Fig. 5.

A typical known magnetoresistive (MR) sensor is shown in Figs. 1 and 2 to illustrate the problem which the present invention seeks to solve. An MR element 10 is deposited on a suitable substrate (not shown), and the assembly may also have one or more bias layers and/or nonmagnetic layers (not shown). The active region 12 of the MR element 10 is the central area that is not covered by electrically conductive leads 14, and the active region produces an MR output signal in response to magnetic excitation. The conductive leads 14 electrically short the area of the MR element 10 that they cover thereby rendering it magnetoresistively inactive. The area of the MR sensor covered by the conductive leads 14 produces little output in response to magnetic excitation so these areas define passive regions 16.

The known MR sensors depend on the accuracy of placement of the conductive leads 14 to define the active region 12 and therefore the effective trackwidth for the sensor. As the MR sensors have become smaller, the physical tolerance on the placement accuracy of the conductive leads becomes a proportionately larger percentage of the trackwidth. An additional uncertainty which introduces an additional problem of trackwidth definition and control is the edge profile of the conductive leads. The tapered edges of the conductive leads cause a problem in the definition of the active region and hence the effective trackwidth.

An MR sensor structure embodying the present invention can provide improved trackwidth definition and control. In the embodiment of the invention shown in Figs. 3-6 of the drawings, the MR element 20 has an insulating layer 22 between the MR element 20 and the conductive leads 24. This insulating layer 22 defines the effective trackwidth so that the geometry of the conductive leads 24 is no longer important.

The insulating layer 22 may comprise either a dielectric material or a high resistivity material. So long as the resistivity of the material is sufficiently high to cause the great majority of the current to flow through the MR element 20, then the material may be used for the track defining layer 22.

The track defining insulating layer 22 is preferably deposited as a full film covering the entire MR element 20, and subtractively etched to form a layer having a predetermined width as shown in Figs. 3 and 4. The etching process exposes the areas of the MR element 20 that are to be the passive regions 26, and the predetermined width measured between edges 28 and 30 defines the active region. The predetermined width can therefore be chosen equal to the desired trackwidth. The conductive leads 24 are then fabricated on top of the insulating layer 22 (Figs. 5 and 6), so that intimate contact is made between the lead 24 and the area of the MR element 20 from which the insulator has been removed and so that each lead 24 extends to contact one of the edges 28 or 30 of the insulating layer 22. The lack of contact between leads 24 and MR element 20 caused by the insulating layer 22 defines the active region, or the electrical trackwidth, which is defined by the current path available through the conductive leads 24.

Upon connection of the conductor leads 24 to a signal sensing means 32 (Fig. 5), the signal sensing means 32 determines the resistance changes in MR element 10 as a function of the magnetic fields which are intercepted by the MR element 10 over an effective track width defined by the distance between the edges 28 and 30 of the layer of insulating material 22.

In this embodiment the geometry of the conductive leads 24 is not important, and, so long as they are not shorted, their dimensions are not constrained. Note that the tapered edges of the conductive leads 24, as shown in Fig. 6, has no bearing on the trackwidth definition.

In practice, the insulating layer 22 can be a true insulator, such as sputtered alumina, or a material of sufficiently high resistivity to define the track width. Since the layer is preferably deposited as a full film and then subtractively etched, the material must be capable of being selectively etched without any adverse impact on the MR element 20 or any other components of the struc-

ture. Therefore, the major considerations for selecting a material for insulating layer 22 are its dielectric strength, resistivity (higher resistivity being better), and etch control. In a specific embodiment, a layer about 100nm thick of sputtered alumina was chosen since it has sufficient dielectric strength, can be selectively etched with excellent control, and is compatible with other components of the assembly.

As stated above, application of this invention removes the need for the conductive leads to have well-controlled geometries. This relaxation expands the techniques that can be used for lead fabrication. For example, lift-off using a bilayer method can be used since the tapered edges no longer cause concern with track definition. The taper simply extends on top of the insulating layer as shown in Fig. 6. Since the insulating layer acts also as a protective layer to the MR element, other lead fabrication techniques are now possible. One technique now possible is defining the leads by subtractive ion milling, since the insulating layer has sufficient etch resistance to protect the MR element. Chemical processes such as electrodepositing the leads can now be used, since the MR element is protected from damage during subsequent sputter etching to remove the plating base seed layer.

Claims

1. A magnetoresistive read transducer comprising:

a layer (22) of insulating or high resistivity material in contact with and extending over part of a magnetoresistive element (20), said material having a sufficiently high resistivity that it defines and is substantially coextensive with an active region of said magnetoresistive element;

a first conductor (24A) extending over and in electrical contact with the magnetoresistive element (20), and overlapping one edge (28) of the layer;

and a second conductor (24B) extending over and in electrical contact with the magnetoresistive element, and overlapping the opposite edge (30) of the layer, and spaced from the first conductor.

2. A magnetoresistive read transducer as claimed in claim 1, in which the layer (22) is composed of alumina.

3. A magnetoresistive read transducer as claimed



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Upon connection of the conductor leads 24 to a signal sensing means 32 (Fig. 5), the signal sensing means 32 determines the resistance changes in MR element 10 as a function of the magnetic fields which are intercepted by the MR element 10 over an effective track width defined by the distance between the edges 28 and 30 of the layer of insulating material 22.

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ture. Therefore, the major considerations for selecting a material for insulating layer 22 are its dielectric strength, resistivity (higher resistivity being better), and etch control. In a specific embodiment, a layer about 100nm thick of sputtered alumina was chosen since it has sufficient dielectric strength, can be selectively etched with excellent control, and is compatible with other components of the assembly.

As stated above, application of this invention removes the need for the conductive leads to have well-controlled geometries. This relaxation expands the techniques that can be used for lead fabrication. For example, lift-off using a bilayer method can be used since the tapered edges no longer cause concern with track definition. The taper simply extends on top of the insulating layer as shown in Fig. 6. Since the insulating layer acts also as a protective layer to the MR element, other lead fabrication techniques are now possible. One technique now possible is defining the leads by subtractive ion milling, since the insulating layer has sufficient etch resistance to protect the MR element. Chemical processes such as electrodepositing the leads can now be used, since the MR element is protected from damage during subsequent sputter etching to remove the plating base seed layer.

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and a second conductor (24B) extending over and in electrical contact with the magnetoresistive element, and overlapping the opposite edge (30) of the layer, and spaced from the first conductor.

2. A magnetoresistive read transducer as claimed in claim 1, in which the layer (22) is composed of alumina.

3. A magnetoresistive read transducer as claimed



in claim 2, in which the layer (22) of alumina is 100nm thick.

Reivendications

1. Transducteur de lecture magnéto-résistif comprenant :

une couche (22) formée d'un matériau isolant ou présentant une résistivité élevée, placée en contact avec et s'étendant sur une partie d'un élément magnéto-résistif (20), ledit matériau possédant une résistivité suffisamment élevée pour définir une région active dudit élément magnéto-résistif, et s'étendant sensiblement sur la même étendue que cette région;

un premier conducteur (24) qui s'étend sur et est en contact électrique avec l'élément magnéto-résistif (1), et chevauchant un bord (28) de la couche; et

un second conducteur (24B) qui s'étend sur et est en contact électrique avec l'élément magnéto-résistif, chevauche le bord opposé (30) de la couche et est espacé du premier conducteur.

2. Transducteur de lecture magnéto-résistif selon la revendication 1, dans lequel la couche (22) est formée d'alumine.
3. Transducteur de lecture magnéto-résistif selon la revendication 2, dans lequel la couche (22) en alumine possède une épaisseur de 100 nm.

Patentansprüche

1. Magnetoresistiver Lesewandler, der aufweist:

eine Schicht (22) aus einem isolierenden oder einem großen Widerstand besitzenden Material, die sich in Kontakt mit einem Teil eines magnetoresistiven Elements (20) befindet und über ihn erstreckt, wobei das Material einen hinreichend großen Widerstand aufweist, sodaß dieses einen aktiven Bereich des magnetoresistiven Elements definiert und im wesentlichen von gleicher Ausdehnung mit demselben ist,

einen ersten Leiter (24A), der sich über und in elektrischem Kontakt mit dem magnetoresistiven Element (20) erstreckt und einen Rand (28) der Schicht überdeckt,

einen zweiten Leiter (24B), der sich über und in elektrischem Kontakt mit dem magnetoresistiven Element erstreckt und den gegenüberliegenden Rand (30) der Schicht überdeckt und zu dem ersten Leiter beabstandet ist.

2. Magnetoresistiver Lesewandler nach Anspruch 1, bei welchem die Schicht (22) aus Aluminium besteht.

3. Magnetoresistiver Lesewandler nach Anspruch 2, bei welchem die Schicht (22) aus Aluminium 100 nm dick ist.