SYNTHETIC SPIN-VALVE DEVICE HAVING HIGH RESISTIVITY ANTI PARALLEL COUPLING LAYER

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to field of magnetoresistive sensors and may be utilized to improve spin-valve sensors.

2. Background Art

Spin valve sensors exploit changes in electrical resistance which occurs as a result of manipulating the relative orientation of the magnetization of ferromagnetic layers within a spin valve sensor. In conventional spin valve sensors, one ferromagnetic layer has its magnetization pinned while another, which has its magnetization set perpendicular to the pinned layer, is free to change its magnetic orientation in response to magnetized bits on an adjacent recording media. The magnetized bits on the recoding media, therefore, change the relative magnetization between the pinned layer and the free layer. An induced current through the spin valve is used to detect changes in the resistance of the spin valve that results from changes in the relative magnetization of the pinned and free layers.

The conventional spin valve utilizes an antiferromagnetic pinning layer adjacent the pinned layer to pin the direction of the magnetization of the pinned layer. The free layer, which may be made of several layers, is separated from the pinned layer by a thin nonmagnetic metallic layer.

Synthetic or improved spin valve sensors employ additional layers between the pinned layer and free layer/layers to create a laminate structure. Two additional layers are added: a second ferromagnetic layer, and a nonferromagnetic material layer which separates the pinned layer and the second ferromagnetic layer and creates antiparallel coupling between the pinned layer and the second ferromagnetic layer. The first ferromagnetic pinned layer, therefore, causes the second ferromagnetic layer to be pinned antiparallel to the first pinned layer. Such a structure improves the longitudinal biasing of the free layer and therefore the spin valve's dynamic range, thereby allowing improved recording density.

As discussed above, the magnetic moment on the magnetic media changes the resistance across the spin valve which can be detected by passing a current through the spin valve. The giant magnetoresistance, one measure of the performance of a spin valve, is given by:

$$GMR=(R\downarrow\uparrow-R\uparrow\uparrow)/R\uparrow\uparrow$$

where,

GMR is the giant magnetoresistance ratio

$R\downarrow\uparrow$ is the resistance across the sensor when the magnetization of the layers are not aligned

$R\uparrow\uparrow$ is the resistance across the sensor when the magnetization of the layers are aligned.

Spin valve layout and materials selection for the spin valve is critical to optimizing the GMR effect and sensor perfomance. It is an object of the present invention to provide an improved spin valve.

SUMMARY OF THE INVENTION

The present invention provides an improved synthetic spin valve sensor having a high resistivity antiparallel coupling layer between the pinned layers. The high resistivity antiparallel coupling layer typically is formed of rhenium.

The spin valve sensor of the present invention may be formed having a layered structure as follows: pinning layer/first pinned layer/high resistivity antiparallel coupling layer/second pinned layer/metallic nonferromagnetic spacer layer/free layer. Capping and seed layers typically are also included.

The antiparallel coupling layer of the present invention provides several advantages. The high resistivity of the antiparallel coupling layer of the present invention reduces shunt current through that layer which improves the GMR effect of the spin valve while maintaining sufficient antiparallel coupling between the pinned layers. The rhenium antiparallel coupling layer of the present invention also provides improved thermal stability.

A optional feature of the presently preferred embodiment of the improved spin valve is that it may be utilized to provide an improved data storage and retrieval apparatus. The data storage and retrieval apparatus may employ the improved spin valve sensor in a read head of the head assembly. The read head is used to detect the magnetic state of magnetized portions of a magnetic recording media as the media is moved by a motor with respect to the head assembly.

BRIEF SUMMARY OF THE DRAWINGS

FIG. **1** illustrates a disk type magnetic data storage and retrieval apparatus.

FIG. **2** is a simplified functional illustration of a head assembly shown in exploded perspective view.

FIG. **3** is a sectional view of a bottom synthetic spin valve sensor in accordance with the present invention.

FIG. **4** is a sectional view of a top synthetic spin valve sensor in accordance with the present invention.

FIG. **5** is a sectional view of a dual synthetic spin valve sensor in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

FIG. **1** shows the improved spin valve sensor of the present invention embodied in a disk type magnetic data storage and retrieval apparatus **200**. The improved spin valve of the present invention is located within a merged head assembly **220** which rides above a magnetic storage media **210**, depicted in FIG. **1** as a rotatable hard disk type storage media. The hard disk is coupled to a motor **240** to provide rotation of the disk relative to the head assembly **220**. An actuating means **230** may be used to position the head assembly **220** above the surface of the media **210** to read and write data in the form of magnetic bits from and to the media **210**. The data storage and retrieval apparatus **200**, typically has several hard disks **210** and several corresponding head assemblies **220**.

FIG. **2** shows a simplified functional illustration of the head assembly **220**. Merged head assemblies **220** are formed having a write head **7**, used to write or set the magnetization of bits **301**, **302** on the media **210**, while a read head **5**, reads the magnetization of those bits **301**, **302** from the media **210**. The depiction in FIG. **2** is a functional representation of a merged head, the merged head of the present invention may be formed by techniques well know in the art, such as by masking, depositing, and etching successive layers to form the well known structures of the merged head **220**.

FIG. **3** shows a possible structure of the spin valve read sensor **5** of the present invention. The structure of the spin