ZIG-ZAG SHAPE BIASED ANISOTROPIC MAGNETORESISTIVE SENSOR

REFERENCE TO RELATED APPLICATION

This patent application claims priority under 35 U.S.C. § 119(e) to provisional patent application Ser. No. 60/621,863 entitled "Zig-Zag Shaped Biased Anisotropic Magnetoresistive Sensor," which was filed on Oct. 25, 2004, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

Embodiments are generally related to sensing devices and methodologies. Embodiments are also related to magnetic sensors. Embodiments are additionally related to magnetoresistive sensors and components thereof.

BACKGROUND OF THE INVENTION

Magnetoresistive components are utilized in a variety of magnetic sensing applications. Among the applications that magnetic sensing devices find usefulness in are operations, such as, for example, navigation, position sensing, current sensing, vehicle detection, and rotational displacement. Many types of magnetic sensors are in use, but essentially all provide at least one output signal that represents the magnetic field sensed by the device. The Earth, magnets, and electrical currents can all generate magnetic fields. The sensor may be able to detect the presence, the strength, and/or the direction of the magnetic field. The strength of the magnetic field may be represented by a magnitude and a polarity (positive or negative). The direction of the magnetic field may be described by its angular position with respect to the sensor. One of the benefits of using magnetic sensors is that the output of the sensor is generated without the use of contacts. This is a benefit because over time contacts can degrade and cause system failures.

One type of magnetoresistive component that is often used in magnetic sensors is the anisotropic magnetoresistive (AMR) element. In high aspect (i.e., length to width) AMR sensor devices, for example, magnetic biasing is typically accomplished utilizing either equipotential straps located on top of the AMR sensing device that are oriented at angle, thereby biasing the current, or by utilizing an adjacent magnetic film or current to create a magnetic field that exerts a force on the magnetization. One of the problems with such devices is that the film structures associated with these devices are relatively complicated. It is therefore believed that an enhanced film structure as disclosed herein can be implemented to simplify the magnetic sensor fabrication while providing an improved and enhanced off-axis rejection.

BRIEF SUMMARY OF THE INVENTION

The following summary of the invention is provided to facilitate an understanding of some of the innovative features unique to the present invention and is not intended to be a full description. a full appreciation of the various aspects of the invention can be gained by taking the entire specification, claims, drawings, and abstract as a whole.

It is, therefore, one aspect of the present invention to provide for an improved magnetoresistive sensing apparatus.

It is another aspect of the present invention to provide for a magnetoresistive sensing apparatus that detects magnetic fields along a particular direction while retaining information concerning the polarity of saturating magnetic fields in a given direction, while being able to readily read-out such data.

It is a further aspect of the present invention to provide for a magnetoresistive sensing apparatus in which the magnetization in thin magnetic films thereof is biased based on an odd transfer function.

It is an additional aspect of the present invention to provide for a magnetoresistive sensing apparatus having a zig-zag shaped structure, which controls the magnetization angle thereof.

The aforementioned aspects of the invention and other objectives and advantages can now be achieved as described herein. a magnetoresistive sensing apparatus is disclosed, comprising a magnetic film having a zig-zag shaped structure, a central axis, and a magnetization associated with the magnetic film, wherein the zig-zag shaped structure biases the magnetization direction alternately at positive and negative angles thereof, thereby permitting the magnetoresistive sensing apparatus to be sensitive to a magnetic field parallel to the axis of the magnetoresistive sensing apparatus and insensitive to magnetic fields perpendicular to the axis. The zig-zag shaped structure creates a positive bias angle of the magnetization direction relative to a current direction of the magnetic film. The magnetoresistive sensing apparatus can generally be implemented in the context of an anisotropic magnetoresistive sensor. The magnetic film comprises a thin magnetic film, such as, for example, NiFe.

In general, the magnetoresistive sensing apparatus described herein can be utilized to sense magnetic fields along a particular direction and to retain the information about the polarity of saturating fields in a given direction while being able to readily and efficiently read out such information. The magnetoresistive sensing apparatus can bias the magnetization in thin films, wherein such films possess an odd transfer function (i.e., resistance versus magnetic field curve). In addition, by utilizing the zig-zag shape or structure to control the magnetization angle, the resulting sensor or device can be scaled to increasingly smaller dimensions.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying figures, in which like reference numerals refer to identical or functionally-similar elements throughout the separate views and which are incorporated in and form a part of the specification, further illustrate the present invention and, together with the detailed description of the invention, serve to explain the principles of the present invention.

FIG. **1** illustrates a diagram depicting a zig-zag shaped magnetoresistive sensing apparatus, which can be implemented in accordance with a preferred embodiment;

FIG. **2** illustrates a scanning electron micrograph with polarization analysis, in accordance with one embodiment; and

FIG. **3** illustrates graphs depicting resistance change versus the magnetic field along or perpendicular to the axis of the sensor or magnetoresistive sensing apparatus depicted in FIG. **1**, in accordance with another embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The particular values and configurations discussed in these non-limiting examples can be varied and are cited merely to illustrate at least one embodiment of the present invention and are not intended to limit the scope of the invention.