of a metallic nonferromagnetic material such as Cu, Ag, or Au. The free layer **85**, therefore, is free to rotate in the presence of the magnetic field produced by the magnetic media. The free layer **85** may be formed of a first free layer **80** and a second free layer **90**. The first and second free layers **80** & **90** may be formed of CoFe and NiFe respectively. The first free layer **80** may be formed of Co or its alloys to prevent interdiffusion between the NiFe of the second free layer **90** and the Cu of the spacer layer **70**. It also enhances the GMR effect. Typically, a hard bias layer (not shown) would be located adjacent the second free layer **90** to set the magnetic moment of the free layer **85**.

Unlike the pinned layers **40** & **60**, the magnetization of the free layer **85** is free to rotate in the presence of the externally applied field of the recording media thereby altering the resistance of the spin valve. Typically, a field of about 40–100 Oersteds, produced by the recording media, will cause the magnetization of the free layer to rotate thereby providing a detectible change in resistance of the spin valve.

A tantalum cap **100** typically is applied over the free layer **90** to prevent oxidation. The tantalum capping layer **100** may be deposited in its high resistivity β phase.

Although the spin valve **5** of FIG. **3** is represented as what may be called a bottom spin valve, it is also possible to fabricate any other type of spin valve.

FIG. **4** shows one of several possible alternate structures for the spin valve read sensor **5** of the present invention. The alternate structure of the spin valve **5** of FIG. **4** may comprise: a substrate **10**, a seed layer **20**, a free layer **85** that may comprise a first free layer portion **80** and a second free layer portion **90**, a spacer layer **70**, a second pinned layer **60**, a high resistivity antiparallel coupling layer **50**, a first pinned layer **40**, a pinning layer **30**, and a capping layer **100**.

The seed layer **20** typically is formed of tantalum. Tantalum typically is deposited to provide a suitable lattice structure to better control the structure and deposition of subsequent layers. It is preferred to deposit the tantalum layer so that it forms with high resistivity in its β phase. It is also possible to use zirconium, deposited in its 1, 1, 1 or FCC orientation, or any other material providing high resistivity, good thermal stability, and zero magnetic moment, as seed layer **20**.

In the embodiment of FIG. **4**, which can be referred to as a top synthetic spin-valve, it is preferred to form the pinning layer **30** of an antiferromagnetic material such as FeMn, IrMn, NiMn, PtMn, PtPdMn, or any other Mn based antiferromagnetic material. It is also possible to use other known antiferromagnetic materials such as NiO, NiCoO, or the like, or any known antiferromagnetic material. The other layers are formed as discussed with respect to FIG. **3** to provide the advantages discuss above.

FIG. **5** illustrates yet another possible structure for the spin valve read sensor **5** of the present invention. The alternate structure of the spin valve **5** of FIG. **5** may comprise: a substrate **10**; a seed layer **20**; a first pinned layer **40**; a high resistivity antiparallel coupling layer **50**; a second pinned layer **60**; a spacer layer **70**; a free layer **85** that may comprise a first free layer portion **80**, a second free layer portion **90**, and a third free layer portion **91**; a spacer layer **92**; a fourth pinned layer **93**; a high resistivity antiparallel coupling layer **94**; a fifth pinned layer **95**; a second pinning layer **96**; and a capping layer **100**.

With the embodiment of FIG. **5**, it is presently preferred to form the pinning layer **30** of an antiferromagnetic material such as NiO, NiCoO, or the like while forming the second pinning layer **96** of an antiferromagnetic material such as IrMn, PtMn, PtPdMn, NiMn, or any other Mn based antiferromagnetic material. Either antiferromagnetic pinning layer **30**, **96**, however, may be formed as discussed with the pinning layers of FIGS. **3** & **4**.

The third free layer portion **91** may be formed of Co, Fe, Ni or their alloys. Typically, the third free layer **91** is formed of CoFe. The third free layer is also free to rotate along with free layers **80** & **90**.

The spacer layers **70** & **92** are formed of a metallic nonferromagnetic material such as Cu, Ag, or Au. The free layer **85**, therefore, is free to rotate in the presence of the magnetic field produced by the magnetic media. The free layer **85** may be formed of a first free layer **80**, a second free layer **90**, and a third free layer **91**. The second free layer may be formed of NiFe with an adjacent hard bias layer (not shown). The first and third free layers **80** & **91** may be form of Co or its alloys, such as CoFe, to prevent interdiffusion between the NiFe and the Cu of the spacer layers **70** & **92** and to enhance the GMR effect.

The fourth pinned layer **95** is located adjacent the second pinning layer **96** so that the magnetic moment of the second pinning layer **96** is pinned so that it can not be rotated by the magnetized bits on the recording media. The domain state of the second pinning layer **96** may be set by annealing as discussed above. An example of the orientation of the fourth pinned layer **95** is depicted by arrow **104**.

The high resistivity antiparallel coupling layer **94** of the present invention couples the third pinned layer **93** in an antiparallel relationship to the fourth pinned layer **95**. The respective magnetic moment of the third pinned layer **93** is depicted by arrow **102**. The high resistivity antiparallel coupling layer **94** of the present invention is preferably formed of Re to provide the advantages discussed above. Additionally, the other layers of FIG. **5** may be formed as discussed above.

As discussed above, using a high resistivity material such as Re significantly reduces shunt current through the antiparallel coupling layer. So, in addition to the other advantages discussed above, because the embodiment of FIG. **5** has two antiparallel coupling layers **50** and **94**, the present invention provides an even greater reduction in the amount of shunt current through the spin valve sensor **5** of FIG. **5**.

While the preferred embodiments of the present invention have been described in detail above, many changes to these embodiments may be made without departing from the true scope and teachings of the present invention. The present invention, therefore, is limited only as claimed below.

What we claim is:

1. A spin valve sensor comprising:

a) a first layer capable of having a magnetic moment;

b) a pinning layer adjacent the first layer, the pinning layer having sufficient exchange field to pin the magnetic moment of the first layer;

c) a second layer capable of having a magnetic moment;

d) a high resistivity antiparallel coupling layer between the first and second layers for causing the magnetic moment of the second layer to align antiparallel to the first layer, the high resistivity antiparallel coupling layer consisting essentially of Re;

e) a free layer capable of changing magnetic orientation in response to an externally applied magnetic field;

f) a spacer layer between the free layer and the second layer; and

g) at least one of the first and second layers comprising at least one of Co, Fe, or Ni.