[0017] **FIG. 7** illustrates DR/R of a dual spin valve (DSV) with tantalum nitride as the cap layer as the applied field (oriented parallel to the pinning field direction) is varied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] In accordance with the invention, there is provided an electromagnetic component, which may be used to read information from magnetic information storage media. One embodiment of the invention may be seen in **FIG. 1**. Generally the components of the invention are referred to as a spin valve. A spin valve is an electromagnetic component used in computer disk drives. The invention provides spin valves having a cap layer that provides enhanced physical protection and increased electron scattering.

[0019] THE SPIN VALVE

[0020] As can be seen, **FIG. 1**, one exemplary embodiment of the spin valve or stack **2** of the invention comprises multiple layers of ferromagnetic and antiferromagnetic materials. **FIG. 1** depicts an exemplary dual spin valve **2** having a cap layer **58**.

[0021] Turning first to the lower portion **4** of the stack **2**, the lower layer **10** of the stack **2** functions to seed the deposition of the other layers that are subsequently deposited on the stack **2**. To this end, the seed layer **10** functions as a substrate and provides structural or textural orientation to the layers deposited subsequently. Generally the seed layer **10** may comprise any metal or metal alloy. Exemplary metals include nickel (Ni), chromium (Cr), tantalum (Ta), titanium (Ti), manganese (Mn), copper (Cu), tungsten (W), platinum (Pt), gold (Au), silver (Ag) or alloys of these metals. The seed layer **10** may be a mono- or bi-layer structure.

[0022] Generally, the thickness of the seed layer **10** may range from about 30 to 100 angstroms and preferably is about 50 angstroms in single or multiple layers. The composition of the seed layer **10** is preferably an alloy of nickel, iron and chrome, in a ratio of about 48:12:40, respectively in the first layer. With the second layer being nickel and iron at a respective ration of 85:15. Another preferred metal useful as a seed layer **10** is tantalum.

[0023] Antiferromagnetic layer **14**, or AFM layer functions to set the magnetic orientation of the lower portion **4** of the stack **2**. Generally, antiferromagnetic layer **14** is a metal oxide or metal alloy of platinum, manganese, nickel, chromium, iridium (Ir), rhodium (Rh), paladium (Pd), copper, ruthenium (Ru), and iron among other metals. Preferably, antiferromagnetic layer **14** comprises an alloy of platinum and manganese with generally a ratio of about 50 to 50, which is sputter deposited to a thickness of about 50 to 300 angstroms, preferably about 150 angstroms.

[0024] Pinned layer **18** functions to provide a fixed magnetic orientation to the lower portion **4** of the stack **2** and acts along with reference layer **26** to provide the fixed orientation of the entire spin valve stack. The magnetic orientation of the pinned layer **18** is fixed, (or pinned), by the antiferromagnetic layer **14**. Generally, the pinned layer **18** may comprise any number of highly magnetic metals or metal alloys such as cobalt, iron, nickel, chromium, platinum, or tantalum among others. Preferably, pinned layer **18** comprises an alloy of cobalt and iron at a preferred ratio of about 90 to 10. The pinned layer **18** may be sputter deposited through processes known in the art to a thickness of from about 10 to 40 angstroms, preferably about 15 to 30 angstroms.

[0025] Artificial exchange layer **22** functions as an intermediate layer between pinned layer **18** and reference layer **26**. Generally, artificial exchange layer **22** provides a medium for antiferromagnetic coupling between pinned layer **18** and reference layer **26**. The exchange layer **22** may comprise any material that has properties of nonmagnetic metals such as copper, chromium, silver, gold, ruthenium, rhodium or alloys thereof. Preferably, the exchange layer **22** comprises ruthenium which has been sputter deposited to a thickness of about 5 to 15 angstroms, preferably about 9 angstroms.

[0026] Reference layer **26** has a composition and thickness substantially similar to pinned layer **18** and functions to provide the fixed orientation of the spin valve stack **2**. In order to function as a spin valve, the reference layer **26** has a magnetic orientation that is opposite to the magnetic orientation of the pinned layer **18** (as a result of the antiferromagnetic coupling). This allows for the orientation of layer **26** to be fixed.

[0027] Alternatively, exchange layer **22** and reference layer **26** may be eliminated from the stack. In this embodiment, pinned layer **18** still functions to fix the magnetic orientation of the stack **2**, and accomplishes it with a lower net magnetism, allowing for higher sensitivity of the stack **2**.

[0028] The intermediate portion **6** of the stack **2** functions to separate the lower **4** and upper **8** portions of the stack **2** and to function as the free layer of the spin valve **2**. Generally, the intermediate portion **6** of the stack **2** comprises one or more spacer layers **30**, **38** and one or more free layers **34**.

[0029] The spacer layers, **30** and **38** function to isolate or insulate the free layer **34** from the pinned **18** and reference layers **26** in the respective upper **8** and lower **4** portions of the stack **2**. To this end, the spacer layers, **30** and **38** may comprise any non-magnetic electrically conductive material that magnetically insulates the free layer **34**. Spacer layers **30** and **38** comprise any nonmagnetic materials such as copper, silver, gold and alloys thereof. One preferred material for the spacer layers **30** and **38** is copper or alloys of copper that may be sputter deposited under low power to a thickness of about 15 to 35 angstroms, preferably about 20 angstroms.

[0030] The free layer **34** may be comprised of a single—or multiple layers. Generally, the free layer **34** functions to monitor an externally applied magnetic field. Accordingly, when the stack **2** is biased, the free layer **34** will follow the orientation of the resulting magnetic field. The free layer **34** may comprise any material that is a soft magnetic material such as nickel, cobalt, iron, and alloys thereof. Preferably, the free layer **34** comprises a mono- or tri-layer, which comprises cobalt, iron, nickel or combinations thereof. Most preferably, the free layer **34** is a tri-layer that begins with a cobalt iron layer in a ratio of about **90**:**10**, a second layer of nickel and iron in a ratio of about 85:15, and a final cobalt iron layer in a ratio of about 90:10. The free layer **34** may be deposited through sputtering to a thickness of about 10 to 150 angstroms, preferably about 20 to 30 angstroms.