[0046] On the other hand, a TMR layer comprises, for example, from the lower side, a free layer consisting of Ta of 5 nm, NiFe of 3 nm and a CoFe layer of 2 nm, a barrier layer consisting of Al2O3 of 2 nm, a pinned layer consisting of CoFe of 2 nm, Ru of 1 nm and CoFe of 1 nm, a anti-ferromagnetic layer consisting of MnIr of 10 nm, Ta of 3 nm, and NiFe of 5 nm.

[0047] After forming the magnetoresistive sensor layer **105**, a lift-off material is formed in the position as an active region (on the layer served both as the lower shield and electrode). Then, the magnetoresistive sensor layer is etched, for example, by the ion milling method. After etching, magnetic domain control layers **106** are formed so as to remove the lift-off mask. Thereafter, a pattern in the depth direction of the magnetoresistive sensor layer **105** is formed in the magnetic domain control layers **106**, and then, the portion therearound is removed by the ion milling. A mixed layer of Al2O3 and SiO2 having a thickness of 150 nm is formed thereon as a protective insulating layer **107** to define an upper shield layer **112**.

[0048] A write element having a magnetic core laminated through a recording gap is formed on the magnetoresistive sensor to define a magnetic head of the magnetic disk apparatus.

[0049] By means of a method represented by the above-mentioned manufacture method, the magnetoresistive sensor of the present invention and the magnetic head using the same are manufactured. In this, the magnetic domain control layer **106** has a required characteristic different from the case of flowing an electric current in the plane. In the magnetic domain control layer, there have been studied the magnetic domain control layer itself is: (1) a layer made by laminating, from the lower portion, an insulating layer Al2O3-SiO2 layer of 220 nm, a Cr underlayer of 5 nm, a magnetic layer CoCrPt of 25 nm, and an insulating protective Al2O3-SiO2 layer of 220 nm on the top, (2) a layer made by laminating, as the magnetic layer, a CoO underlayer of 5 nm, and a γ-Fe2O3 layer of 50 nm, (3) a layer made by laminating, as the magnetic layer, a γ-Fe2O3 layer of 50 nm, and (4) a layer by alternately laminating CoCrPt of 1.5 nm and SiO2 of 1.1 nm (60 nm thick).

[0050] In the method (1), there is shown a conventional magnetic domain control layer as shown in the schematic structure of **FIG. 5**, as a comparative example. When the conventional magnetic domain control layer is applied as-is, the gap between the shields Gs not less than 70 nm makes it possible to manufacture magnetic domain control layers **501**, **502** and **503**. However, the following points in formation of the junction of the ends of the magnetoresistive sensor layer are important in order to maintain insulation of the CoCrPt (**502**) from the lower portion Al2O3 (**501**).

[0051] One of the points is that, in order to maintain insulation, the ends of the magnetoresistive sensor layer **105** must be completely coated by the Al2O3 layer **501**, the hard metal magnetic CoCrPt (**502**) must be grown thereon, and the Al2O3 layer **503** grown thereon must completely coat the CoCrPt layer. For this reason, the sputtering apparatus forming the layer needs to have a characteristic such that the Al2O3 is inserted into the lift-off pattern in the plane, and CoCrPt is not inserted deeply therein, and to ensure such manufacture conditions. Further, for manufacture, the lift-off pattern must be formed, and when the size of the sensor is reduced (not more than 1 μm), the formation thereof is difficult. The insulating layer having a thickness less than 20 nm cannot have sufficient insulation properties, and when the layer is thick in order to maintain the sufficient insulation properties, the gap between the end of the magnetoresistive sensor layer **105** and the CoCrPt layer as the magnetic domain control layer is larger, so that the magnetic domain control force is weak, thereby making magnetic domain control impossible. For this reason, when the gap between the shields is not more than 70 nm in order to make the resolution of the read head high, the method (1) is difficult to use.

[0052] The method (2) is one embodiment of the present invention shown in **FIG. 4**. First, a lower shield **302** is formed on an appropriately treated substrate **301**, and the region in contact with opposite ends of the magnetoresistive sensor layer **105** thereon is formed with a CoO underlayers **304**. CoO (002) is grown in the CoO underlayer, and γ-Fe2O3 (65 nm) is formed thereon, so as to manufacture a magnetic domain control layer **303**. γ-Fe2O3 has a (004) orientation plane by the effect of the underlayer. This is the same for Co-γ-Fe2O3 as other ferrite.

[0053] This layer has a specific resistance not less than several 10 Ωcm in the layer state. In this case, the layer requires no lift-off pattern, and can be manufactured by the usual resist pattern. The magnetoresistive sensor layer may be in contact with the magnetic domain control layer, or the magnetic domain control layer may be lifted on the magnetoresistive sensor layer. According to this method, the magnetic domain control layer has electric resistivity much higher than the magnetoresistive sensor layer. A signal sensing current flows only through the magnetoresistive sensor layer, so as to eliminate a loss of the signal intensity due to shunting to the magnetic domain control layer.

[0054] Even when the gap between the shields is smaller, the insulating protective layer of conventional type is unnecessary. According to this, it is possible to reduce the total thickness of the magnetic domain control layer causing an equivalent susceptibility. The susceptibility is an amount to determine the thickness of the magnetic domain control layer by multiplying the magnetization of the free layer of the magnetoresistive sensor layer by the thickness thereof. In the case of the magnetic domain control layer, multiplication of the residual magnetization by the thickness is equivalent to this. γ-Fe2O3 or Co-γ-Fe2O3 in this study has a high specific resistance of 10^5 to 10^6 Ωcm, a coercivity of about 1.3 to 5.0 kOe, a residual magnetization of 1.2 to 3.5 kG, and a saturated magnetization of 3.5 to 4.2 kG. These values are smaller than those of CoCrPt (having a coercivity of about 1.0 to 3.0 kOe, a residual magnetization of 4 to 9 kG, and a saturated magnetization of 6.5 to 12.0 kG). In consideration of the protective insulating layer, it is effective for the magnetic domain control when the gap between the shields is small. As the layer formation process, the conventional four layers (Al2O3/Cr/CoCrPt/Al2O3) can be reduced to two layers, so as to make the operation efficient.

[0055] In the method (3) as another example of the present invention, **FIG. 3** shows a basic construction. This is the same as the method (2) except that the oxide underlayer **304** of the magnetic domain control layer is absent. In view of the manufacture method, the point of directly forming γ-Fe2O3 is different. In this case, the substrate temperature