

MAGNETIC MATERIAL TARGET AND MAGNETIC MATERIAL TARGET ASSEMBLY

FIELD OF THE INVENTION

[0001]

The present invention relates to a magnetic material target and magnetic material target assembly.

BACKGROUND OF THE INVENTION

[0002]

The layers constituting hard disk drives (HDDs) that employ perpendicular magnetic recording are made of materials based on ferromagnetic metals such as Co, Fe, and Ni, and the recording layers are often made of composite materials consisting of ferromagnetic alloys such as Co-Cr, Co-Pt, and Co-Cr-Pt, which are mainly composed of Co, and non-magnetic inorganic materials. Thin films for magnetic recording media such as hard disk drives are often produced by sputtering magnetic material targets containing the above materials, due to their high productivity.

[0003]

The magnetic material target is generally produced by first crushing and mixing the powder of the raw materials, and hot pressing the mixture to obtain a sintered body. After this, HIP (Hot Isostatic Pressing) processing may be performed to increase the density of the sintered body. The sintered body obtained in this way is processed on a lathe to produce a target of a specified shape (Patent Literatures 1 to 3).

CITATION LIST

Patent Literatures

[0004]

[Patent Literature 1] Japanese Patent No. 6445126

[Patent Literature 2] Japanese Patent No. 6332869

[Patent Literature 3] Japanese Patent No. 6958819

SUMMARY OF THE INVENTION

[0005]

As described above, a composite material consisting of a ferromagnetic alloy mainly composed of Co and a non-magnetic inorganic material is useful as a recording layer of a HDD, and is sputter-deposited by HDD media manufacturers to form a thin film with a granular structure in which magnetic particles are separated by oxide grain boundaries. In recent years, research has been conducted on various additive oxides for perpendicular magnetic recording media using Co as the main component of magnetic particles, and the development of a new magnetic material target containing an oxide of a new element is eagerly awaited.

[0006]

Therefore, an object of an embodiment of the present invention is to provide a novel magnetic material target and magnetic material target assembly having magnetic properties.

[0007]

The above problems are solved by the present invention, which is specified as follows.

- (1) A magnetic material target comprising:
 - one or more elements selected from Pt, B, Ti, and Si,
 - one or more elements selected from Gd, Ge, Sn, Te, and Hf, and
 - an oxide, with the balance being Co and selectively contained impurities,

wherein a total concentration of Co and Pt is 50 at% or more,
a total concentration of B, Ti, and Si is 10 at% or more,
a concentration of O is 20 at% or more, and
a total concentration of Gd, Ge, Sn, Te, and Hf is 1 at% or more.

- (2) The magnetic material target according to (1),
wherein the total concentration of Gd, Ge, Sn, Te, and Hf is 1 to 5 at%.
- (3) The magnetic material target according to (1),
wherein the total concentration of Gd, Ge, Sn, Te, and Hf is 1 to 3 at%.
- (4) The magnetic material target according to any one of (1) to (3),
wherein the oxide further contains one or more oxides of elements selected
from Al, Si, Ba, Be, Ca, Ce, Cr, Co, Dy, Er, Eu, Ga, Ho, Li, Mg, Mn, Nb, Nd, Pr, Sc,
Sm, Sr, Ta, Tb, Ti, V, Y, Zn, and Zr.
- (5) A magnetic material target assembly comprising:
the magnetic material target according to any one of (1) to (4) and
a backing plate bonded to the magnetic material target.

[0008]

According to the embodiments of the present invention, it is possible to
provide a novel magnetic material target and magnetic material target assembly
having magnetic properties.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 shows a graph showing the results of a test of the gas pressure
dependence of saturation magnetization (Ms) for Examples 1 to 5.

DETAILED DESCRIPTION OF THE INVENTION

[0010]

Next, the embodiments for carrying out the present invention will be described in detail. It should be understood that the present invention is not limited to the following embodiments, and that appropriate changes and improvements in the design may be made based on the ordinary knowledge of those skilled in the art without departing from the spirit of the present invention.

[0011]

<Magnetic Material Target>

The shape of the magnetic material target according to the embodiment of the present invention is not particularly limited, and may be a flat plate (including a disk or rectangular plate), a cylindrical shape, or any other shape.

[0012]

The magnetic material target according to the embodiment of the present invention contains one or more elements selected from Pt, B, Ti, and Si, one or more elements selected from Gd, Ge, Sn, Te, and Hf, an oxide, and the balance is Co and selectively contained impurities. By using the magnetic material target according to the embodiment of the present invention as a sputtering target, it is possible to produce a thin film for a magnetic recording medium such as a hard disk drive (HDD).

[0013]

The magnetic material target according to the embodiment of the present invention has a total concentration of Co and Pt of 50 at% or more. When the total concentration of Co and Pt in the magnetic material target is 50 at% or more, the magnetic properties are improved in that a certain level of magnetization can be ensured. There is no particular upper limit on the total concentration of Co and Pt in the magnetic material target, but from the viewpoint of ensuring grain boundary material, it is preferably 90 at% or less. Moreover, the total concentration of Co and

Pt in the magnetic material target is more preferably 50 to 85 at%, and even more preferably 50 to 80 at%.

[0014]

In the magnetic material target according to the embodiment of the present invention, the total concentration of B, Ti, and Si is 10 at% or more, and the concentration of O is 20 at% or more. With this configuration, B, Ti, Si, and O tend to form oxide grain boundaries of a granular structure in which magnetic particles are separated by oxide grain boundaries, so that a preferable magnetic thin film can be obtained. In the magnetic material target according to the embodiment of the present invention, the total concentration of B, Ti, and Si is preferably 10 to 15 at%, and more preferably 10 to 13 at%. In the magnetic material target according to the embodiment of the present invention, the concentration of O is preferably 20 to 35 at%, and more preferably 25 to 30 at%.

[0015]

The magnetic material target according to the embodiment of the present invention contains one or more elements selected from Gd, Ge, Sn, Te, and Hf. These elements may be contained as a single element, an alloy, or an oxide. An example of an oxide of Gd is Gd_2O_3 . An example of an oxide of Ge is GeO_2 . An example of an oxide of Sn is SnO_2 . An example of an oxide of Te is TeO_2 . An example of an oxide of Hf is HfO_2 .

Here, how to determine whether Gd is contained in the form of an oxide in the magnetic material target according to the embodiment of the present invention will be described below.

First, the magnetic material target is cut and the cross section is mirror-polished to obtain a sample for microstructure observation. More specifically, the cross section of the magnetic material target is polished in order using abrasive cloths and papers with grits ranging from P80 to P2000 by the mirror polishing, and

finally, a buff polishing is performed using aluminum oxide abrasive grains with a grain size of 0.3 μm to obtain a sample for microstructure observation having a polished surface on the cross section. At this time, aluminum oxide and granular polishing debris adhering to the polished surface are removed by washing. Next, element mapping is performed on the sputtered surface of the mirror-polished sample by performing WDX mapping analysis (Wave Length-Dispersive X-ray Mapping Spectroscopy) in a field of view of 50 μm ×50 μm using FE-EPMA (Field Emission-Electron Probe Micro Analysis). WDX mapping analysis in a field of view of 50 μm ×50 μm using FE-EPMA can be performed by performing stage scanning under conditions of an acceleration voltage of 15.0 kV and an irradiation current of 2.0×10^{-8} A. In this case, if the areas where the detection intensity of Gd and O is high coincide with each other, it is considered that the Gd is mostly present in the sintered body as an oxide. Therefore, it is determined that the Gd whose detection intensity is high coincides with O is contained in the form of Gd oxide.

In addition, in the magnetic material target according to the embodiment of the present invention, it can be determined that Ge, Sn, Te, Hf, Si, and Ti are contained in the form of oxide in the same manner as the above-mentioned method for determining the oxide of Gd.

In addition to the oxides of Gd, Ge, Sn, and Te, the oxides may further contain one or more oxides of elements selected from Al, Si, Ba, Be, Ca, Ce, Cr, Co, Dy, Er, Eu, Ga, Ho, Li, Mg, Mn, Nb, Nd, Pr, Sc, Sm, Sr, Ta, Tb, Ti, V, Y, Zn, and Zr in order to further improve the magnetic properties.

[0016]

The magnetic material target according to the embodiment of the present invention has a total concentration of Gd, Ge, Sn, Te, and Hf of 1 at% or more. Gd, Ge, Sn, Te, and Hf contribute to the formation of magnetic grains and oxide grain boundaries with a granular structure, and are therefore considered to contribute to

the formation of a thin film having magnetic properties. The total concentration of Gd, Ge, Sn, Te, and Hf in the magnetic material target is preferably 1.2 at% or more. The total concentration of Gd, Ge, Sn, Te, and Hf in the magnetic material target may be 1 to 5 at%, 1 to 3 at%, or 1 to 2 at%.

[0017]

The remainder of the magnetic material target according to the embodiment of the present invention may or may not contain impurities. Examples of the impurities include metal elements such as Fe, Ni, Cu, Zr, Al, W, V, Zn, and Ta, and elements such as C or N from gas components such as carbon dioxide and nitrogen in the atmosphere, or compounds thereof. The content of the impurities contained in the remainder of the magnetic material target according to the embodiment of the present invention may be 0.5 mol% or less, or 0.15 mol% or less. Furthermore, the impurities can be analyzed by taking an analysis sample from the magnetic material target and using infrared absorption spectrometry, ICP optical emission spectrometry, GDMS (glow discharge mass spectrometry), or the like. The amount and shape of the analysis sample vary depending on the analysis method used, and the optimal amount and shape for each method can be selected.

[0018]

<Magnetic material target assembly>

The magnetic material target according to the embodiment of the present invention may be joined to a backing plate as necessary to form a magnetic material target assembly. The magnetic material target assembly can be mounted on a sputtering device and used. As the brazing material, indium or indium tin can be used. The magnetic material target according to the embodiment of the present invention may be directly mounted in a sputtering device and used without using a backing plate. The material of the backing plate is not particularly limited, and examples thereof include Cu, Ti, Mo, and alloys containing at least one of these (for example, Cu-Ni-

Si alloys (for example, C18000, etc.), CuZn alloys, and CuCr alloys). The material of the backing plate preferably has high thermal conductivity, and from this viewpoint, Cu is suitable.

[0019]

<Method of manufacturing a magnetic material target>

The method of manufacturing a magnetic material target according to the embodiment of the present invention will be described in detail below.

The magnetic material target according to the embodiment of the present invention can be manufactured by a powder sintering method. First, powders of each metal element are prepared. In addition, alloy powders of these metals (for example, Co-Pt powder) may be used instead of the powders of each metal element. In particular, it is preferable to use Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, Gd₂O₃ powder, GeO₂ powder, SnO₂ powder, TeO₂ powder, HfO₂ powder, etc. Regarding the 50% cumulative volume particle size D50 (average particle size D50) of each raw material powder, the following sizes can be used: Co powder: 1 to 10 μm, Pt powder: 1 to 10 μm, B₂O₃ powder: 0.1 to 5 μm, TiO₂ powder: 0.5 to 5 μm, SiO₂ powder: 1 to 50 μm, CoO powder: 1 to 50 μm, Gd₂O₃ powder: 1 to 50 μm, GeO₂ powder: 1 to 50 μm, SnO₂ powder: 1 to 50 μm, TeO₂ powder: 1 to 50 μm, HfO₂ powder: 1 to 50 μm. The purity of these raw material powders is usually 2N (99% by mass) or more, preferably 3N (99.9% by mass) or more, and more preferably 4N (99.99% by mass) or more. If the purity is lower than 2N, the sintered body contains a large amount of impurities, which may cause problems such as the desired physical properties not being obtained (for example, generation of particles due to arcing). These raw material powders can be appropriately prepared based on the composition and purity of the desired sintered body.

[0020]

Then, these metal powders are weighed out to obtain the desired composition, and mixed using a mixing device while also being crushed. Non-magnetic particles may also be mixed with the metal powder at this stage. A ball mill, mortar, etc. may be used as the mixing device, but it is preferable to use a powerful mixing method such as a ball mill. Also, considering the problem of oxidation during mixing, it is preferable to mix in an inert gas atmosphere or in a vacuum.

[0021]

Here, the mixing is performed by carrying out primary mixing, followed by sieving, and then secondary mixing. It is preferable to mix for 5 to 30 hours in the primary mixing, and it is preferable to mix for 5 to 30 hours in the secondary mixing.

[0022]

The mixed powder obtained in this way is molded and sintered using a hot press device to create a sintered body. The molding and sintering are not limited to hot pressing, and plasma discharge sintering and hot isostatic sintering can also be used. The sintering conditions can be 650 to 1400°C and 0.5 to 12 hours.

[0023]

Then, the sintered body removed from the hot press is subjected to HIP (Hot Isostatic Pressing). HIP processing is an effective means for improving the density of the sintered body. The holding temperature during HIP processing is 650-1100°C, the holding time is 0.5-12 hours, and the pressure is 100 MPa or more. The sintered body thus obtained is then processed into the desired shape using a lathe to produce a magnetic material target.

[0024]

<Film formation method using a magnetic material target>

The magnetic material target according to the embodiment of the present invention can be used to form a thin film that mainly constitutes a magnetic

recording medium. Specifically, a sputtering device is used to sputter the surface of the magnetic material target with accelerated argon ions, particles (sputtered particles) are released from the magnetic material target, and the sputtered particles are deposited on the surface of a substrate that has been placed in front of it, forming a thin film on the surface of the substrate. The sputtering conditions can be set appropriately depending on the desired film thickness and composition.

EXAMPLES

[0025]

The following examples of the present invention are provided to better understand the present invention and its advantages and are not intended to limit the invention.

[0026]

<Example 1>

The magnetic material target of Example 1 was manufactured by the following manufacturing method.

As raw material powders, 3N (99.9 mass%) Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, and Gd₂O₃ powder were prepared and weighed to have a composition of Co-Pt-B-Ti-Si-Gd-O (Pt 10-20 at%, B 5-10 at%, Ti 1-5 at%, Si 1-5 at%, Gd 0.5-7 at%, O 25-30 at%, Co (balance)). The raw material powders were prepared so that the total composition was 100 at%.

The 50% cumulative volume grain size D50 (average grain size D50) of the raw material powders was as follows:

Co powder: 4 μm, Pt powder: 3 μm, B₂O₃ powder: 0.1-5 μm, TiO₂ powder: 0.5-5 μm, SiO₂ powder: 1-50 μm, CoO powder: 1-50 μm, Gd₂O₃ powder: 1-50 μm

Then, the weighed Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, and Gd₂O₃ powder were put into a ball mill pot together with

grinding media, and primary mixing was carried out for 10 hours, followed by secondary mixing for 10 hours, in that order.

[0027]

The mixed powder removed from the ball mill pot was then filled into a carbon mold and hot pressed. The hot pressing conditions were a vacuum atmosphere, a heating rate of 300°C/hour, a holding temperature (sintering temperature) of 850°C, and a holding time (sintering time) of 2 hours. A pressure of 30 MPa was applied from the start of heating to the end of holding. After the holding, the sintered body was naturally cooled in the chamber. After that, the sintered body was taken out of the hot press mold and subjected to HIP processing. The HIP processing conditions were a heating rate of 300°C/hour, a holding temperature of 850°C, and a holding time of 2 hours. The gas pressure of Ar gas was gradually increased from the start of the heating, and the pressure was 150 MPa during the holding. After the holding, the sintered body was naturally cooled in the furnace. In this way, the magnetic material target according to Example 1 was produced.

[0028]

<Example 2>

The magnetic material target of Example 2 was manufactured by the following manufacturing method.

As raw material powders, 3N (99.9 mass%) Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, and GeO₂ powder were prepared and weighed to have a composition of Co-Pt-B-Ti-Si-Ge-O (Pt 10-20 at%, B 5-10 at%, Ti 1-5 at%, Si 1-5 at%, Ge 0.5-7 at%, O 25-30 at%, Co (balance)). The raw material powders were prepared so that the total composition was 100 at%.

The 50% cumulative volume grain size D50 (average grain size D50) of the raw material powders was as follows:

Co powder: 4 μm , Pt powder: 3 μm , B_2O_3 powder: 0.1-5 μm , TiO_2 powder: 0.5-5 μm , SiO_2 powder: 1-50 μm , CoO powder: 1-50 μm , GeO_2 powder: 1-50 μm

Then, the weighed Co powder, Pt powder, B_2O_3 powder, TiO_2 powder, SiO_2 powder, CoO powder, and GeO_2 powder were put into a ball mill pot together with grinding media, and primary mixing was carried out for 10 hours, followed by secondary mixing for 10 hours, in that order.

[0029]

The mixed powder removed from the ball mill pot was then filled into a carbon mold and hot pressed. The hot pressing conditions were a vacuum atmosphere, a heating rate of 300°C/hour, a holding temperature (sintering temperature) of 850°C, and a holding time (sintering time) of 2 hours. A pressure of 30 MPa was applied from the start of heating to the end of holding. After the holding, the sintered body was naturally cooled in the chamber. After that, the sintered body was taken out of the hot press mold and subjected to HIP processing. The HIP processing conditions were a heating rate of 300°C/hour, a holding temperature of 850°C, and a holding time of 2 hours. The gas pressure of Ar gas was gradually increased from the start of the heating, and the pressure was 150 MPa during the holding. After the holding, the sintered body was naturally cooled in the furnace. In this way, a magnetic material target according to Example 2 was produced.

[0030]

<Example 3>

The magnetic material target of Example 3 was manufactured by the following manufacturing method.

As raw material powders, 3N (99.9 mass%) Co powder, Pt powder, B_2O_3 powder, TiO_2 powder, SiO_2 powder, CoO powder, and SnO_2 powder were prepared and weighed to have a composition of Co-Pt-B-Ti-Si-Sn-O (Pt 10-20 at%, B 5-10

at%, Ti 1-5 at%, Si 1-5 at%, Sn 0.5-7 at%, O 25-30 at%, Co (balance)). The raw material powders were prepared so that the total of the composition was 100 at%.

The 50% cumulative volume grain size D50 (average grain size D50) of the raw material powders was as follows:

Co powder: 4 μm , Pt powder: 3 μm , B_2O_3 powder: 0.1-5 μm , TiO_2 powder: 0.5-5 μm , SiO_2 powder: 1-50 μm , CoO powder: 1-50 μm , SnO_2 powder: 1-50 μm

Then, the weighed Co powder, Pt powder, B_2O_3 powder, TiO_2 powder, SiO_2 powder, CoO powder, and SnO_2 powder were put into a ball mill pot together with grinding media, and primary mixing was carried out for 10 hours, followed by secondary mixing for 10 hours, in that order.

[0031]

The mixed powder removed from the ball mill pot was then filled into a carbon mold and hot pressed. The hot pressing conditions were a vacuum atmosphere, a heating rate of 300°C/hour, a holding temperature (sintering temperature) of 850°C, and a holding time (sintering time) of 2 hours. A pressure of 30 MPa was applied from the start of heating to the end of holding. After the holding, the sintered body was naturally cooled in the chamber. After that, the sintered body was taken out of the hot press mold and subjected to HIP processing. The HIP processing conditions were a heating rate of 300°C/hour, a holding temperature of 850°C, and a holding time of 2 hours. The gas pressure of Ar gas was gradually increased from the start of the heating, and the pressure was 150 MPa during the holding. After the holding, the sintered body was naturally cooled in the furnace. In this way, a magnetic material target according to Example 3 was produced.

[0032]

<Example 4>

The magnetic material target of Example 4 was manufactured by the following manufacturing method.

As raw material powders, 3N (99.9 mass%) Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, and TeO₂ powder were prepared and weighed to have a composition of Co-Pt-B-Ti-Si-Te-O (Pt 10-20 at%, B 5-10 at%, Ti 1-5 at%, Si 1-5 at%, Te 0.5-7 at%, O 25-30 at%, Co (balance)). The raw material powders were prepared so that the total composition was 100 at%.

The 50% cumulative volume grain size D50 (average grain size D50) of the raw material powders was as follows:

Co powder: 4 μm, Pt powder: 3 μm, B₂O₃ powder: 0.1-5 μm, TiO₂ powder: 0.5-5 μm, SiO₂ powder: 1-50 μm, CoO powder: 1-50 μm, TeO₂ powder: 1-50 μm

Then, the weighed Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, and TeO₂ powder were put into a ball mill pot together with grinding media, and primary mixing was carried out for 10 hours, followed by secondary mixing for 10 hours, in that order.

[0033]

The mixed powder removed from the ball mill pot was then filled into a carbon mold and hot pressed. The hot pressing conditions were a vacuum atmosphere, a heating rate of 300°C/hour, a holding temperature (sintering temperature) of 700°C, and a holding time (sintering time) of 2 hours. A pressure of 30 MPa was applied from the start of heating to the end of holding. After the holding, the sintered body was naturally cooled in the chamber. After that, the sintered body was taken out of the hot press mold and subjected to HIP processing. The HIP processing conditions were a heating rate of 300°C/hour, a holding temperature of 750°C, and a holding time of 2 hours. The gas pressure of Ar gas was gradually increased from the start of the heating, and the pressure was 150 MPa during the holding. After the holding, the sintered body was naturally cooled in the furnace. In this way, a magnetic material target according to Example 4 was produced.

[0034]

<Example 5>

The magnetic material target of Example 5 was manufactured by the following manufacturing method.

As raw material powders, 3N (99.9 mass%) Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, and HfO₂ powder were prepared and weighed to have a composition of Co-Pt-B-Ti-Si-Hf-O (Pt 10-20 at%, B 5-10 at%, Ti 1-5 at%, Si 1-5 at%, Hf 0.5-7 at%, O 25-30 at%, Co (balance)). The raw material powders were prepared so that the total composition was 100 at%.

The 50% cumulative volume grain size D50 (average grain size D50) of the raw material powders was as follows:

Co powder: 4 μm, Pt powder: 3 μm, B₂O₃ powder: 0.1-5 μm, TiO₂ powder: 0.5-5 μm, SiO₂ powder: 1-50 μm, CoO powder: 1-50 μm, HfO₂ powder: 1-50 μm

Then, the weighed Co powder, Pt powder, B₂O₃ powder, TiO₂ powder, SiO₂ powder, CoO powder, and HfO₂ powder were put into a ball mill pot together with grinding media, and primary mixing was carried out for 10 hours, followed by secondary mixing for 10 hours, in that order.

[0035]

The mixed powder removed from the ball mill pot was then filled into a carbon mold and hot pressed. The hot pressing conditions were a vacuum atmosphere, a heating rate of 300°C/hour, a holding temperature (sintering temperature) of 850°C, and a holding time (sintering time) of 2 hours. A pressure of 30 MPa was applied from the start of heating to the end of holding. After the holding, the sintered body was allowed to cool naturally in the chamber. After that, the sintered body was removed from the hot press mold and subjected to HIP processing. The conditions of HIP processing were a heating rate of 300°C/hour, a holding temperature of 850°C, and a holding time of 2 hours. The Ar gas pressure was gradually increased from the start of the heating, and was pressurized at 150

MPa during the holding. After the holding, the sintered body was allowed to cool naturally in the furnace. In this way, the magnetic material target of Example 5 was produced.

[0036]

<Composition analysis>

Chips were collected from the magnetic material targets of Examples 1 to 5, and the compositions of Co, Pt, B, Ti, Si, Gd, Ge, Sn, Te, and Hf were analyzed by ICP optical emission spectroscopy (Model SPS5520, manufactured by Hitachi High-Tech Corporation). In addition, O was quantitatively analyzed using a non-dispersive infrared absorption method (CS-444, manufactured by LECO Corporation).

Table 1 shows the analyzed compositions of the magnetic material targets of Examples 1 to 5.

[0037]

<Oxides>

The oxides contained in the magnetic material targets of Examples 1 and 5 were analyzed as follows.

First, the magnetic material target was cut and its cross section was mirror-polished to obtain a sample for microstructural observation. More specifically, the cross section of the magnetic material target was polished in order with abrasive cloths and papers with grits ranging from P80 to P2000, and finally buffed with aluminum oxide abrasive grains with a particle size of 0.3 μm to obtain a sample for microstructural observation having a polished surface on the cross section. In addition, aluminum oxide and granular polishing debris adhering to the polished surface were thoroughly removed by washing. Next, element mapping was performed on the sputtered surface of the mirror-polished sample by performing WDX mapping analysis (Wave Length-Dispersive X-ray Mapping Spectroscopy) in a field of view of 50 μm x 50 μm using FE-EPMA (Field Emission-Electron Probe

Micro Analysis). WDX mapping analysis in a field of view of 50 μm x 50 μm using FE-EPMA could be performed by performing stage scanning under conditions of an acceleration voltage of 15.0 kV and an irradiation current of 2.0×10^{-8} A. At this time, if the areas where the detection intensities of Gd and O are high coincide with each other, it is considered that most of the Gd is present in the sintered body as an oxide. Therefore, Gd, where the part with high detection intensity coincided with O, was determined to be present in the form of Gd oxide.

Whether Hf was present in the form of Hf oxide was also determined in the same manner as the method for determining Gd oxide described above.

As a result, Gd oxide was confirmed in the magnetic material target of Example 1, and Hf oxide was confirmed in the magnetic material target of Example 5.

Furthermore, Ti oxide and Si oxide were confirmed in the magnetic material targets of Examples 1 to 5 using the same measurement method as above.

[0038]

[Table 1]

	Varieties	composition (at%)							
		Co+Pt	B+Ti+Si	O	Gd	Ge	Sn	Te	Hf
Example1	Co-Pt-B ₂ O ₃ -TiO ₂ -SiO ₂ -CoO-Gd ₂ O ₃	50~60	10~20	20~30	1~5				
Example2	Co-Pt-B ₂ O ₃ -TiO ₂ -SiO ₂ -CoO-GeO ₂	50~60	10~20	20~30		1~5			
Example3	Co-Pt-B ₂ O ₃ -TiO ₂ -SiO ₂ -CoO-SnO ₂	50~60	10~20	20~30			1~5		
Example4	Co-Pt-B ₂ O ₃ -TiO ₂ -SiO ₂ -CoO-TeO ₂	50~60	10~20	20~30				1~5	
Example5	Co-Pt-B ₂ O ₃ -TiO ₂ -SiO ₂ -CoO-HfO ₂	50~60	10~20	20~30					1~5

[0039]

<Gas pressure dependence of saturation magnetization (Ms)>

The gas pressure dependence of saturation magnetization (Ms) was measured for the magnetic material targets of Examples 1 to 5 by the following method.

First, a magnetron sputtering device (C-3010 manufactured by Canon Anelva Corporation) was used to deposit Cr-Ti (6 nm), Ni-W (5 nm), and Ru (20 nm) in that

order on a glass substrate. The sputtering targets described above were then sputtered at 300 W in an Ar 3.0 Pa atmosphere to deposit magnetic films with a thickness of 11 nm. After that, a protective film of Ru (3 nm) was deposited to prevent oxidation of the magnetic film, forming each layer. The saturation magnetization (M_s) of the magnetic films obtained by the above film deposition operation was measured using a vibrating sample magnetometer manufactured by Tamagawa Seisakusho. The measurement conditions were a maximum applied magnetic field of 22 kOe in all cases.

The test results are shown in Figure 1. It can be seen from Figure 1 that magnetic material targets having magnetic properties were obtained for all Examples 1 to 5.

[0040]

According to one embodiment of the present invention, a novel magnetic material target having magnetic properties can be obtained, which may contribute to the sophistication of thin film formation technology by sputtering used in the manufacture of magnetic recording hard disk media, etc. Therefore, one embodiment of the present invention may contribute to Goal 9 of the Sustainable Development Goals (SDGs) led by the United Nations, "Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation."

CLAIMS

1. A magnetic material target comprising:
one or more elements selected from Pt, B, Ti, and Si,
one or more elements selected from Gd, Ge, Sn, Te, and Hf, and
an oxide, with the balance being Co and selectively contained impurities,
wherein a total concentration of Co and Pt is 50 at% or more,
a total concentration of B, Ti, and Si is 10 at% or more,
a concentration of O is 20 at% or more, and
a total concentration of Gd, Ge, Sn, Te, and Hf is 1 at% or more.
2. The magnetic material target according to claim 1,
wherein the total concentration of Gd, Ge, Sn, Te, and Hf is 1 to 5 at%.
3. The magnetic material target according to claim 1,
wherein the total concentration of Gd, Ge, Sn, Te, and Hf is 1 to 3 at%.
4. The magnetic material target according to claim 1,
wherein the oxide further contains one or more oxides of elements selected
from Al, Si, Ba, Be, Ca, Ce, Cr, Co, Dy, Er, Eu, Ga, Ho, Li, Mg, Mn, Nb, Nd, Pr, Sc,
Sm, Sr, Ta, Tb, Ti, V, Y, Zn, and Zr.
5. A magnetic material target assembly comprising:
the magnetic material target according to any one of claims 1 to 4 and
a backing plate bonded to the magnetic material target.