

DESCRIPTION

SPUTTERING TARGET FOR FORMING MAGNETIC THIN FILM

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TECHNICAL FIELD

[0001] The present invention relates to a ferromagnetic sputtering target that is used for the deposition of a magnetic thin film of a magnetic recording medium, particularly for the deposition of a granular film of a magnetic recording medium in a hard disk adopting the perpendicular magnetic recording method, and to a nonmagnetic grain-dispersed ferromagnetic sputtering target containing Co or Fe as its primary component and which is capable of suppressing the generation of particles during sputtering.

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BACKGROUND ART

[0002] A Co or Fe (ferromagnetic metals) based material is being used for a recording layer in a hard disk adopting the perpendicular magnetic recording method. Among the above, composite materials formed of an alloy having a Co-Cr-based, Co-Pt-based, Co-Cr-Pt-based or Fe-Pt-based ferromagnetic metal as its primary component, and a nonmagnetic inorganic material, are often used. A magnetic thin film of a magnetic recording medium such as a hard disk is often produced by sputtering a target comprising the foregoing materials because of its high productivity.

[0003] As methods of producing a sputtering target for a magnetic recording medium, the melting method or powder metallurgy could be taken. While it is not necessarily appropriate to suggest which method is more preferable because it would depend on the required characteristics, a sputtering target formed from an alloy having a ferromagnetic metal as its primary component, and nonmagnetic inorganic grains, which is used for forming a recording layer in a hard disk adopting the perpendicular magnetic recording method, is generally produced via powder metallurgy. This is because of difficulty in producing such a target by the melting method since it is necessary to uniformly disperse inorganic grains such as boron oxide in a basis alloy.

[0004] Upon searching for publications disclosing that boron oxide is added in a

magnetic recording medium, there were the following patent documents. Patent Document 1 discloses "a magnetic recording medium having a magnetic data storage layer, the magnetic data storage layer comprising: a first alloy having a magnetic anisotropy constant of at least 0.5×10^7 ergs/cm³ (0.5/Jcm³); and an oxidized compound of oxygen and one or more elements, at least one of the one or more elements having a negative reduction potential". Patent Document 1 describes boron oxide as the oxidized compound, but does not in any way describe the problems encountered from the existence of boron oxide in the target, or the solutions to such problems.

[0005] Patent Document 2 discloses "a target used for forming a Co series magnetic layer of a magnetic recording medium by a sputtering method, wherein the target contains 5 mol% or more of Cr or Cr alloy, 5 mol% or more of CoO, and 3 mol% to 20 mol% of oxides having a melting point of 800°C or less in total, and the porosity thereof is 7% or less", and describes boron oxide and other oxides as oxides having a melting point of 800°C or less. Here, similar to Patent Document 1 described above, Patent Document 2 does not in any way describe the problems encountered from the existence of boron oxide in the sintered compact or the target formed from the sintered compact, or the solutions to such problems.

[0006] Patent Document 3 discloses "the sputtering target made of a sintered compact consisting of a ferromagnetic alloy, which contains ≤ 20 mol% Cr and the balance Co, and a non-metallic inorganic material, wherein the non-metallic inorganic material has a volume fraction of ≤ 40 vol.% and contains at least a cobalt oxide and an oxide of boron". Here, Patent Document 3 describes the inclusion of "oxide of boron" as with Patent Documents 1 and 2 described above, but does not in any way describe the problems encountered from the existence of boron oxide in the target, or the solutions to such problems.

[0007] Patent Document 4 discloses "a sputtering target for a magnetic recording film containing SiO₂, wherein the sputtering target contains B (boron) in an amount of 10 to 1000 wtppm". Here, B (boron) described above includes boron oxide, but similar to Patent Documents 1, 2 and 3 described above, Patent Document 4 does not in any way describe the problems encountered from the existence of boron oxide in the sintered compact or the target formed from the sintered compact, or the solutions to such problems.

[CITATION LIST]

[PATENT DOCUMENTS]

[0008] Patent Document 1: JP 2008-059733 A
Patent Document 2: JP 2012-033247 A
Patent Document 3: JP 2012-117147 A
Patent Document 4: JP 5009448 B

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SUMMARY OF INVENTION

[TECHNICAL PROBLEM]

[0009] Composite materials formed from a ferromagnetic alloy and a nonmagnetic material are often used in a sputtering target for a magnetic recording film, and oxides and the like are known as the nonmagnetic material. Particularly, boron oxide (B_2O_3) is often added due to its favorable characteristics. Nevertheless, a target to which boron oxide has been added entails a problem in that the boron oxide grains become large after sintering. Meanwhile, when the sintering temperature is lowered to suppress grain growth, high density cannot be achieved, and there is a problem in that numerous particles are generated. Moreover, because boron oxide has a low melting point, boron oxide becomes eluted during sputtering, and it is considered that such elution becomes the source of arcing, and consequently results in the generation of particles.

[0010] To deal with the foregoing problem, the present applicant previously provided a technology capable of maintaining a fine structure by adding one or more types of compounds (complex oxides) among $CrBO_3$, $Co_2B_2O_5$, and $Co_3B_2O_6$ as oxides of boron, and suppressing the generation of particles (Japanese Patent Application No. 2013-095486). Nevertheless, as a result of additional research, a problem was discovered in that, even when a complex oxide of boron is added, there were cases where boron oxide would also exist in the target, and cause the generation of particles.

[SOLUTION TO PROBLEM]

[0011] As a result of intense study to resolve the foregoing problems, in light of the fact that B_2O_3 having a low melting point becomes melted during sputtering and causes particle generation, the present inventors discovered that particle generation deriving from B_2O_3 can be considerably suppressed by: perceiving the amount of B_2O_3 existing in the target, and reducing this amount by leveraging the B_2O_3 characteristic of being eluted in the water so that boron in the target does not exist in the form of B_2O_3 . Based on the foregoing discovery, the following invention is

provided.

1) A sputtering target containing a Co-containing alloy and boron and/or an oxide of boron, wherein an amount of metal boron in boron oxide (B_2O_3) that dissolves into water is $7000 \mu\text{g}/\text{m}^2$ or less.

2) The sputtering target according to 1) above, wherein the sputtering target contains boron in an amount of 0.5 at% or more and 15 at% or less.

3) The sputtering target according to 1) or 2) above, wherein the sputtering target contains an oxide having one or more types of elements selected from Ti, Si, Co, Cr, and Mn as its constituents.

4) The sputtering target according to any one of 1) to 3) above, wherein the sputtering target contains one or more types of metal elements selected from Ti, V, Mn, Zr, Nb, Mo, Ta, W, Ru, and Pt, and a total content of the metal elements is 0.5 at% or more and 30 at% or less.

[ADVANTAGEOUS EFFECTS OF INVENTION]

Because the nonmagnetic grain-dispersed ferromagnetic sputtering target of the present invention, which is controlled in the manner described above, is capable of considerably suppressing the generation of particles caused by the elution of boron oxide (B_2O_3) during sputtering, the present invention yields superior effects of being able to reduce the percent defective of magnetic recording films, and thereby reduce costs, and can contribute significantly to improvement in the quality and production efficiency of magnetic thin films.

BRIEF DESCRIPTION OF DRAWINGS

[Fig. 1] This is a graph showing the correlation between the elution amount of boron and the generation of particles.

DESCRIPTION OF EMBODIMENTS

The sputtering target of the present invention has a structure in which oxide grains, at least containing boron, are dispersed as a nonmagnetic material in an alloy containing Co or Fe. As the Co-containing alloy, considered may be ferromagnetic alloys such as a Co-Cr alloy, a Co-Pt alloy, and a Co-Cr-Pt alloy. Moreover, in order to improve the magnetic properties, it would be effective to contain one or more types of metal elements selected from Ti, V, Mn, Zr, Nb, Mo, Ta,

W, Ru, and Pt in an amount of 0.5 at% or more and 10 at% or less.

[0015] The sputtering target of the present invention contains metal boron and/or an oxide of boron. Even when metal boron is added, there are cases where the metal boron becomes oxidized and forms B_2O_3 , and, even when a complex oxide containing boron and another metal is added, there are cases where B_2O_3 is formed.

The present invention is characterized in that the amount of metal boron in the boron oxide (B_2O_3) that dissolves into water is $7000 \mu\text{g}/\text{m}^2$ or less. Here, the amount of metal boron that dissolves into water is defined as a value ($\mu\text{g}/\text{m}^2$) obtained by measuring the elution amount ($\mu\text{g}/\text{g}$) of metal boron in the boron oxide that eluted into the water per 1.0 g of the pulverized powder of the target, and dividing the measured elution amount by the specific surface area (m^2/g) of the pulverized powder. Note that the elution amount is divided by the specific surface area for normalization because the elution amount of metal boron into the water increases as the specific surface area of the powder increases (as the grain size decreases).

[0016] The amount of metal boron in the boron oxide (B_2O_3) that dissolves into water can be measured as follows. Foremost, the surface of the sputtering target is subject to dry treatment, and chips (1 to 5 g) are collected. Desirably, the chips are collected from the target surface, on which oxide film is not adherent, and which has not come into contact with a solvent such as water or ethanol. Subsequently, these chips are pulverized until the specific surface area becomes 0.05 to $1.00 \text{ m}^2/\text{g}$. When the specific surface area is less than $0.05 \text{ m}^2/\text{g}$, there is a possibility that the oxide is not sufficiently exposed on the surface. When the specific surface area exceeds $1.00 \text{ m}^3/\text{g}$, it is difficult to collect the powder because of the adherence to the pulverizing device. As the pulverizing device, a closed-type pulverizing device capable of preventing the scattering of powder is desirably used. Moreover, the specific surface area can be measured using a specific surface area measuring device (Monosorb manufactured by Spectris Co., Ltd., Malvern Instruments).

Next, 1 g of this pulverized powder is immersed in 50 to 100 cc of room-temperature water. Because the solubility of B_2O_3 is $0.028 \text{ g}/\text{cc}$, B_2O_3 does not become saturated when the amount of water is 50 cc or more. Meanwhile, when the amount of water exceeds 100 cc, the B concentration becomes weak and difficult to be analyzed. Subsequently, an ICP (SPS3500DD manufactured by Hitachi High-Tech Science Corporation) is used to measure, using the eluted water

described above, the amount of metal boron in the boron oxide (B_2O_3) that dissolved into the water.

[0017] Boron is preferably contained in an amount of 0.5 at% or more and 15 at% or less relative to the composition of the sputtering target. Boron exists as a single metal, an alloy, or an oxide component. When the content of boron is less than 0.5 at% or higher than 15 at%, it is difficult to obtain the intended magnetic properties. The content of boron and foregoing additive metals (Ti, V, Mn and the like) can be measured by dissolving the chips collected from the sputtering target (sintered compact) in acid, and measuring the product using an ICP-AES device.

Moreover, publicly known oxides may also be included as nonmagnetic materials, and, for instance, considered may be oxides having one or more types of elements selected from Ti, Si, Co, Cr, and Mn as its constituents.

[0018] The sputtering target of the present invention can be produced via powder metallurgy. Foremost, a Co powder, an Fe powder, a Pt powder and the like are prepared as metal powders. Here, in addition to using single-element metal powders, alloy powders can also be used. The grain size of these metal powders is desirably within a range of 0.1 to 10 μm . This is because, when the grain size is 0.1 to 10 μm , more uniform mixing is possible, and the segregation and coarse crystallization in the sintered target can be prevented. When the metal powder is larger than 10 μm , there are cases where the oxide phase is not dispersed finely, and when the metal powder is smaller than 0.1 μm , there are cases where the influence from the oxidation of the metal powder may become a problem.

[0019] The oxide of boron is preferably used as the raw material powder in the form of a complex oxide obtained by synthesizing B_2O_3 and another oxide (Cr_2O_3 , TiO_2 , or the like). As the complex oxide, complex oxides such as $CrBO_3$, $Co_2B_2O_5$, $Co_3B_2O_6$, $Mn_3B_2O_6$, and $TiBO_3$ having a relatively high melting point may be used as the raw material powder. However, B_2O_3 may also be used as the raw material and, in such a case, it is necessary to form a complex oxide with another oxide during the sintering process by controlling the sintering temperature.

Note that, for instance, the $TiBO_3$ powder to be used may be obtained by subjecting a B_2O_3 powder and a Ti_2O_3 powder to mixing, synthesizing and pulverizing. Similarly, the $CrBO_3$ powder, the $Co_2B_2O_5$ powder, the $Co_3B_2O_6$ powder or the $Mn_3B_2O_6$ powder to be used may be respectively obtained by subjecting a B_2O_3 powder, and a Cr_2O_3 powder or a CoO powder or a MnO powder, to mixing, synthesizing and pulverizing.

[0020] The average grain size of this oxide powder is desirably within a range of 0.2 to 5 μm . When the grain size is 0.2 to 5 μm , there is an advantage in that the uniform mixing with the metal powder is facilitated. Meanwhile, when the average grain size of the oxide powder is larger than 5 μm , there are cases where a coarse oxide phase is generated after the sintering process. When the average grain size of the oxide powder is smaller than 0.2 μm , there are cases where the oxide powders become agglomerated.

[0021] Next, the foregoing raw material powders are weighed to achieve the intended composition, and mixed and pulverized using a known method such as a ball mill. In order to shorten the mixing time and improve the productivity, a high-energy ball mill is preferably used. Next, the thus obtained mixed powder is molded and sintered via the hot press method in a vacuum atmosphere or an inert gas atmosphere. Other than the hot press method, other various pressure sintering methods such as the plasma discharge sintering method may be used. In particular, the hot isostatic pressing method is effective for improving the density of the sintered compact. The sintering temperature is often within the range of 700°C to 1400°C depending on the composition. However, when using B_2O_3 as the raw material powder, the sintering temperature needs to be set to be within the range of 1000 to 1400°C.

[0022] Next, the obtained sintered compact is processed into an intended shape using a lathe, and the surface thereof is cut and ground to prepare the sputtering target of the present invention. Because the thus produced sputtering target can considerably reduce the amount of particles that are generated during sputtering, the present invention has superior effects of being able to improve the yield during deposition.

[EXAMPLES]

[0023] The present invention is now explained in detail with reference to the Examples and Comparative Examples. Note that these Examples are merely illustrative, and the present invention shall in no way be limited thereby. In other words, various modifications and other embodiments are covered by the present invention, and the present invention is limited only by the scope of its claims.

[0024] (Example 1)

A Co powder, a Cr powder, and a Pt powder were prepared as metal powders, and a $\text{Co}_3\text{TiB}_2\text{O}_8$ powder, a SiO_2 powder, and a CoO powder were prepared as nonmagnetic material powders. Used as the $\text{Co}_3\text{TiB}_2\text{O}_8$ powder was a powder

that was prepared in advance by subjecting a CoO powder, a TiO₂ powder and a B₂O₃ powder to mixing, synthesizing and pulverizing. These powders were weighed to be 2000 g based on the following composition ratio.

Composition (at%): Co - 1.17Cr - 11.72Pt - 3.13B - 1.56Ti - 3.13Si - 20.31O

[0025] Next, the weighed powders were placed in a ball mill pot having a capacity of 10 liters together with tungsten alloy balls as the pulverizing medium, and mixed by rotating the ball mill pot for 120 hours. The thus obtained mixed powder was filled in a copper mold, and hot pressed in a vacuum atmosphere at a temperature of 980°C, holding time of 2 hours, and pressure of 30 MPa to obtain a sintered compact. The obtained sintered compact was cut with a lathe to obtain a disk-shaped sputtering target having a diameter of 164 mm and a thickness of 4 mm.

[0026] The surface of this sputtering target was subject to a turning process and chips were collected, and the collected chips were pulverized so that their specific surface area is 0.05 m²/g or more. The specific surface area of this pulverized powder was 0.33 m²/g. Next, 1.0 g of this pulverized powder was immersed in 100 cc of room-temperature water for 1 hour. Subsequently, quantitative analysis of boron in the eluted water was performed based on ICP. As a result of the analysis, the elution amount of metal boron in the boron oxide (B₂O₃) that eluted into the water was 590 µg relative to 1.0 g of the pulverized powder. Accordingly, the elution amount of metal boron in the boron oxide (B₂O₃) in the pulverized powder of the sputtering target that eluted into the water was 1788 (= 590/0.33) µg/m².

[0027] Next, this sputtering target was mounted in DC magnetron sputtering equipment to perform sputtering. Sputtering deposition onto a 4-inch silicon substrate was performed for 20 seconds under the following sputtering conditions; namely, sputter power of 1.0 kW and Ar gas pressure of 3.2 Pa. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. Here, the average number of particles on the silicon substrate was 2 particles, and resulted in an extremely low level. The foregoing results are shown in Table 1.

[0028] [Table 1]

	Composition (at%)										B raw material	B elution amount ($\mu\text{g/g}$)	Specific surface area (m^2/g)	B elution amount ($\mu\text{g}/\text{m}^2$)	Number of particles
	Co	Cr	Pt	B	Mn	Ti	Si	O							
Example 1	Remainder	1.17	11.72	3.13		1.56	3.13	20.31			$\text{Co}_3\text{TiB}_2\text{O}_8$	590	0.33	1788	2
Example 2	Remainder	1.19	11.9	3.17		2.38		15.87			CrBO_3 , TiBO_3	40	0.61	66	3
Example 3	Remainder	3.2	12.4	3.2	2.4		1.6	18.4			$\text{Mn}_3\text{B}_2\text{O}_6$, CrBO_3	180	0.15	1200	5
Example 4	Remainder	6.25	7.81	2.34			0.78	18.75			B_2O_3	10	0.35	29	6
Comparative Example 1	Remainder		15.57	3.28		4.92	1.64	18.03			B	1300	0.07	18571	20
Comparative Example 2	Remainder		14.75	4.92		2.46	1.64	14.75			B	4700	0.15	31333	27
Comparative Example 3	Remainder	1.14	11.36	4.55		1.52	3.03	21.97			CrBO_3 , B	650	0.05	13000	17
Comparative Example 4	Remainder	6.25	7.81	2.34			0.78	18.75			B_2O_3	1000	0.12	8333	11

[0029] (Example 2)

A Co powder and a Pt powder were prepared as metal powders, and a CrBO_3 powder, a TiBO_3 powder, a TiO_2 powder, and a Co_3O_4 powder were prepared as nonmagnetic material powders. Used as the CrBO_3 powder was a powder that was prepared in advance by subjecting a Cr_2O_3 powder and a B_2O_3 powder to mixing, synthesizing and pulverizing; and used as the TiBO_3 powder was a powder that was prepared in advance by subjecting a Ti_2O_3 powder and a B_2O_3 powder to mixing, synthesizing and pulverizing. These powders were weighed to be 2000 g based on the following composition ratio. Subsequently, the weighed powders were mixed and thereafter hot pressed based on the same methods as Example 1, and the obtained sintered compact was cut to obtain a sputtering target.

Composition (at%): Co - 1.19Cr - 11.90Pt - 3.17B - 2.38Ti - 15.87O

[0030] Next, quantitative analysis of boron was performed using the pulverized powder collected from this sputtering target based on the same method as Example 1. As a result of the analysis, the elution amount of metal boron in the boron oxide (B_2O_3) that eluted into the water was 40 μg relative to 1.0 g of the pulverized powder. Because the specific surface area of this pulverized powder was 0.61 m^2/g , the elution amount of metal boron in the boron oxide (B_2O_3) in the pulverized powder of the sputtering target that eluted into the water was 66 (= 40/0.61) $\mu\text{g}/\text{m}^2$. Moreover, sputtering was performed using this sputtering target under the same conditions as Example 1. Consequently, the average number of particles was 3 particles, and resulted in an extremely low level.

[0031] (Example 3)

A Co powder, a Cr powder, and a Pt powder were prepared as metal powders, and a CrBO_3 powder, a $\text{Mn}_3\text{B}_2\text{O}_6$ powder, a CoO powder, and a SiO_2 powder were prepared as nonmagnetic material powders. Used as the $\text{Mn}_3\text{B}_2\text{O}_6$ powder was a powder that was prepared in advance by subjecting a MnO powder and a B_2O_3 powder to mixing, synthesizing and pulverizing. These powders were weighed to be 2000 g based on the following composition ratio. Subsequently, the weighed powders were mixed and thereafter hot pressed based on the same methods as Example 1, and the obtained sintered compact was cut to obtain a sputtering target.

Composition (at%): Co - 3.2Cr - 12.4Pt - 3.20B - 2.40Mn - 1.60Si - 18.40O

[0032] Next, quantitative analysis of boron was performed using the pulverized powder collected from this sputtering target based on the same method as Example 1. As a result of the analysis, the elution amount of metal boron in the boron oxide

(B₂O₃) that eluted into the water was 180 µg relative to 1.0 g of the pulverized powder. Because the specific surface area of this pulverized powder was 0.15 m²/g, the elution amount of metal boron in the boron oxide (B₂O₃) in the pulverized powder of the sputtering target that eluted into the water was 1200 (= 180/0.15) µg/m². Moreover, sputtering was performed using this sputtering target under the same conditions as Example 1. Consequently, the average number of particles was 5 particles, and resulted in an extremely low level.

[0033] (Example 4)

A Co powder and a Pt powder were prepared as metal powders, and a B₂O₃ powder, a Cr₂O₃ powder, a CoO powder, and a SiO₂ powder were prepared as nonmagnetic material powders. These powders were weighed to be 2000 g based on the following composition ratio. Subsequently, the weighed powders were mixed based on the same methods as Example 1 and thereafter hot pressed at 1300°C, and the obtained sintered compact was cut to obtain a sputtering target.

Composition (at%): Co - 6.25Cr - 7.81Pt - 2.34B - 0.78Si - 18.75O

[0034] Next, quantitative analysis of boron was performed using the pulverized powder collected from this sputtering target based on the same method as Example 1. As a result of the analysis, the elution amount of metal boron in the boron oxide (B₂O₃) that eluted into the water was 10 µg relative to 1.0 g of the pulverized powder. The used raw material was B₂O₃, but because the sintering temperature was high, it is considered that B₂O₃ formed a complex oxide with an oxide such as Cr₂O₃ during sintering, which resulted in the low elution amount into the water. Because the specific surface area of this pulverized powder was 0.35 m²/g, the elution amount of metal boron in the boron oxide (B₂O₃) in the pulverized powder of the sputtering target that eluted into the water was 29 (= 10/0.35) µg/m². Moreover, sputtering was performed using this sputtering target under the same conditions as Example 1. Consequently, the average number of particles was 6 particles, and resulted in an extremely low level.

[0035] (Comparative Example 1)

A Co powder, a Pt powder, and a B powder were prepared as metal powders, and a TiO₂ powder, a SiO₂ powder, and a CoO powder were prepared as nonmagnetic material powders. These powders were weighed to be 2000 g based on the following composition ratio. Subsequently, the weighed powders were mixed and thereafter hot pressed based on the same methods as Example 1, and the obtained sintered compact was cut to obtain a sputtering target.

Composition (at%): Co - 15.57Pt - 3.28B - 4.92Ti - 1.64Si - 18.03O

[0036] Next, quantitative analysis of boron was performed using the pulverized powder collected from this sputtering target based on the same method as Example 1. As a result of the analysis, the elution amount of metal boron in the boron oxide (B_2O_3) that eluted into the water was 1300 μg relative to 1.0 g of the pulverized powder. Because the specific surface area of this pulverized powder was $0.07 m^2/g$, the elution amount of metal boron in the boron oxide (B_2O_3) in the pulverized powder of the sputtering target that eluted into the water was 18571 (= $1300/0.07$) $\mu g/m^2$. Moreover, sputtering was performed using this sputtering target under the same conditions as Example 1. Consequently, the average number of particles was 20 particles, and resulted in numerous particles.

[0037] (Comparative Example 2)

A Co powder, a Pt powder, and a B powder were prepared as metal powders, and a TiO_2 powder, a SiO_2 powder, and a Co_3O_4 powder were prepared as nonmagnetic material powders. These powders were weighed to be 2000 g based on the following composition ratio. Subsequently, the weighed powders were mixed and thereafter hot pressed based on the same methods as Example 1, and the obtained sintered compact was cut to obtain a sputtering target.

Composition (at%): Co - 14.75Pt - 4.92B - 2.46Ti - 1.64Si - 14.75O

[0038] Next, quantitative analysis of boron was performed using the pulverized powder collected from this sputtering target based on the same method as Example 1. As a result of the analysis, the elution amount of metal boron in the boron oxide (B_2O_3) that eluted into the water was 4700 μg relative to 1.0 g of the pulverized powder. Because the specific surface area of this pulverized powder was $0.15 m^2/g$, the elution amount of metal boron in the boron oxide (B_2O_3) in the pulverized powder of the sputtering target that eluted into the water was 31333 (= $4700/0.15$) $\mu g/m^2$. Moreover, sputtering was performed using this sputtering target under the same conditions as Example 1. Consequently, the average number of particles was 27 particles, and resulted in numerous particles.

[0039] (Comparative Example 3)

A Co powder, a Pt powder, and a B powder were prepared as metal powders, and a $CrBO_3$ powder, TiO_2 powder, a SiO_2 powder, and a CoO powder were prepared as nonmagnetic material powders. These powders were weighed to be 2000 g based on the following composition ratio. Subsequently, the weighed powders were mixed and thereafter hot pressed based on the same methods as

Example 1, and the obtained sintered compact was cut to obtain a sputtering target.

Composition (at%): Co - 1.14Cr - 11.36Pt - 4.55B - 1.52Ti - 3.03Si - 21.97O

[0040] Next, quantitative analysis of boron was performed using the pulverized powder collected from this sputtering target based on the same method as Example 1. As a result of the analysis, the elution amount of metal boron in the boron oxide (B_2O_3) that eluted into the water was 650 μg relative to 1.0 g of the pulverized powder. Because the specific surface area of this pulverized powder was 0.05 m^2/g , the elution amount of metal boron in the boron oxide (B_2O_3) in the pulverized powder of the sputtering target that eluted into the water was 13000 (= 650/0.05) $\mu g/m^2$. Moreover, sputtering was performed using this sputtering target under the same conditions as Example 1. Consequently, the average number of particles was 17 particles, and resulted in numerous particles.

[0041] (Comparative Example 4)

A Co powder, a Pt powder, and a B powder were prepared as metal powders, and a B_2O_3 powder, a SiO_2 powder, a Cr_2O_3 powder, and a CoO powder were prepared as nonmagnetic material powders. These powders were weighed to be 2000 g based on the following composition ratio. Subsequently, the weighed powders were mixed and thereafter hot pressed based on the same methods as Example 1, and the obtained sintered compact was cut to obtain a sputtering target.

Composition (at%): Co - 6.25Cr - 7.81Pt - 2.34B - 0.78Si - 18.75O

[0042] Next, quantitative analysis of boron was performed using the pulverized powder collected from this sputtering target based on the same method as Example 1. As a result of the analysis, the elution amount of metal boron in the boron oxide (B_2O_3) that eluted into the water was 1000 μg relative to 1.0 g of the pulverized powder. Because the specific surface area of this pulverized powder was 0.12 m^2/g , the elution amount of metal boron in the boron oxide (B_2O_3) in the pulverized powder of the sputtering target that eluted into the water was 8333 (= 1000/0.12) $\mu g/m^2$. Moreover, sputtering was performed using this sputtering target under the same conditions as Example 1. Consequently, the average number of particles was 11 particles, and resulted in numerous particles.

[0043] The relation of the elution amount of boron and the number of particles regarding the sputtering targets in the foregoing Examples and Comparative Examples is shown in Fig. 1. As shown in Fig. 1, there is a correlation between the elution amount of boron and the number of particles, and it has been demonstrated that a target with minimal generation of particles can be obtained by

properly controlling the existence form and amount of boron (oxide) in the target.

INDUSTRIAL APPLICABILITY

5 [0044] The present invention can considerably suppress the generation of particles
caused by the elution of B_2O_3 during sputtering by controlling the existence form of
boron existing in the sputtering target, and thus yields superior effects of being able
to reduce the percent defective of magnetic recording films, and thereby reduce
costs. The present invention is suitable as a ferromagnetic sputtering target for
10 use in the deposition of magnetic thin films of magnetic recording mediums,
particularly for use in the deposition of hard disk drive recording layers.

CLAIMS

[Claim 1] A sputtering target containing a Co-containing alloy and boron and/or an oxide of boron, wherein:

the oxide of boron is one or more types selected from $\text{Co}_3\text{TiB}_2\text{O}_8$, TiBO_3 , $\text{Mn}_3\text{B}_2\text{O}_6$, and CrBO_3 ; and

the sputtering target additionally contains boron oxide (B_2O_3) in an amount of $7000 \mu\text{g}/\text{m}^2$ or less in terms of the amount of metal boron in boron oxide that dissolves into water.

[Claim 2] The sputtering target according to claim 1, wherein the sputtering target contains boron and/or an oxide of boron in an amount of 0.5 at% or more and 15 at% or less.

[Claim 3] The sputtering target according to claim 1 or claim 2, wherein the sputtering target contains one or more types of metal elements selected from Ti, V, Mn, Zr, Nb, Mo, Ta, W, Ru, and Pt, and a total content of the metal elements is 0.5 at% or more and 30 at% or less.