

## DESCRIPTION

Fe-Pt-BASED SINTERED COMPACT SPUTTERING TARGET  
AND MANUFACTURING METHOD THEREFOR

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## TECHNICAL FIELD

[0001] The present invention relates to an Fe-Pt-based sintered compact sputtering target that is used for the production of a magnetic thin film in a thermally assisted magnetic recording media, and to a method of producing the same.

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[0002] In the field of magnetic recording as represented with hard disk drives, a material that is based on a ferromagnetic metal such as Co, Fe, or Ni is being used as the material for forming a magnetic thin film in a magnetic recording medium. For example, a Co-Cr-based or a Co-Cr-Pt-based ferromagnetic alloy having Co as its main component has been used for the magnetic thin film of a hard disk that adopts the longitudinal magnetic recording system. Moreover, a composite material made from a Co-Cr-Pt-based ferromagnetic alloy having Co as its main component and nonmagnetic inorganic grains is often used for the magnetic thin film of a hard disk that adopts the perpendicular magnetic recording system which has been put into practical use in recent years. In addition, these magnetic thin films are often produced by sputtering a target made from the foregoing materials using a DC magnetron sputtering equipment in light of its high productivity.

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[0003] The recording density of hard disks is rapidly increasing year by year, and the current surface density of 600 Gbit/in<sup>2</sup> is expected to reach 1 Tbit/in<sup>2</sup> in the future. When the recording density reaches 1 Tbit/in<sup>2</sup>, the size of the recording bit will fall below 10 nm. In such a case, it is anticipated that the superparamagnetization caused by thermal fluctuation will become a problem, and it is further anticipated that the currently used materials of a magnetic recording medium; for instance, a material with higher magnetic crystalline anisotropy obtained by adding Pt to a Co-Cr-based alloy, will no longer be sufficient. This is because magnetic grains to stably behave as a ferromagnetic at a size of 10 nm or less need to possess even higher magnetic crystalline anisotropy.

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[0004] Based on the reasons described above, an FePt phase having an L1<sub>0</sub> structure is attracting attention as a material for use in an ultrahigh density recording medium. Since an FePt phase yields superior corrosion resistance and oxidation resistance in addition to having high magnetic crystalline anisotropy, it is expected to become a material that can be suitably applied for a magnetic recording medium. Furthermore, in connection with using the FePt phase as a material for use in an ultrahigh density recording medium, demanded is the development of technology for dispersing the ordered FePt magnetic grains, in a magnetically isolated state, while densely aligning the orientation thereof as much as possible.

[0005] In light of the foregoing circumstances, a magnetic thin film having a granular structure in which the FePt magnetic grains having an L1<sub>0</sub> structure are separated from each other through the interposition of nonmagnetic materials such as oxides and carbon is being proposed for use in a magnetic recording medium of next-generation hard disks adopting the thermally assisted magnetic recording system. This magnetic thin film having a granular structure has a structure in which the magnetic grains are magnetically insulated through the interposition of nonmagnetic substances. Generally speaking, a granular structure magnetic thin film having an Fe-Pt phase is deposited using an Fe-Pt-based sintered compact sputtering target.

[0006] With regard to a sputtering target of Fe-Pt-based magnetic material sintered compact, the present inventors have previously disclosed a technology relating to a ferromagnetic material sputtering target which is configured from a magnetic phase such as an Fe-Pt alloy, and a nonmagnetic phase that separates the magnetic phase, and in which a metal oxide is used as one of the nonmagnetic phase materials (Patent Document 1).

In addition, Patent Document 2 discloses a sputtering target for use in forming a magnetic recording medium film, which is configured from a sintered compact having a structure in which a C layer is dispersed in an FePt alloy phase; and Patent Document 3 discloses a sputtering target for use in forming a magnetic recording medium film, which is configured from a SiO<sub>2</sub> phase, an FePt alloy phase and an interdiffusion phase. Moreover, Patent Document 4 discloses an Fe-Pt-based ferromagnetic material sputtering target configured from Pt, SiO<sub>2</sub>, Sn, and the remainder being Fe; and Patent Document 5 discloses a sputtering target for a magnetic recording film, in which the peak

intensity ratio of the quartz (011) plane relative to the background intensity in the X-ray diffraction is 1.40 or more.

[0007] A hexagonal BN (compound of boron and nitrogen) as the foregoing nonmagnetic material exhibits superior performance as a lubricant, but when it is used as the raw material of powder metallurgy, it is difficult to produce a high density sintered compact due to inferior sinterability. When the density of a sintered compact is low as described above, there are problems in that defects such as cracks or chippings occur when the sintered compact is processed into a target, which deteriorate the production yield. Moreover, when the density is low, numerous holes are generated in the target, and there are problems in that these holes cause abnormal discharge, generate particles (foreign particles that adhere to the substrate) during sputtering, and deteriorate the production yield.

[0008] Patent Document 1: International Publication No. WO2012/029498

Patent Document 2: JP 2012-102387 A

Patent Document 3: JP 2011-208167 A

Patent Document 4: International Publication No. WO2012/086578

Patent Document 5: Japanese Patent No. 5009447

## SUMMARY OF INVENTION

### [Technical Problem]

[0009] An object of the present invention is to provide an Fe-Pt-based sintered compact in which a hexagonal BN is used as the nonmagnetic material and which enables the production of a magnetic thin film in a thermally assisted magnetic recording media, and additionally provide a sputtering target capable of reducing the amount of particles that is generated during sputtering.

### [Solution to Problem]

[0010] In order to achieve the foregoing object, as a result of intense study, the present inventors discovered that, since a hexagonal BN as a nonmagnetic material possesses a two-dimensional crystal structure, when the crystal orientation of the hexagonal BN is random in the sintered compact, this will affect the electrical conduction, and cause the sputtering to be unstable such as by generating an abnormal discharge.

[0011] Based on the foregoing discovery, the present invention provides:

1) An Fe-Pt-based sintered compact sputtering target containing BN, wherein a ratio of an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a cross section that is perpendicular to a sputtering surface relative to an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a plane that is horizontal to a sputtering surface is 2 or more.

2) The sintered compact sputtering target according to 1) above, wherein an average thickness of the hexagonal BN phase in a cross section that is perpendicular to the sputtering surface is 30  $\mu\text{m}$  or less.

3) The sintered compact sputtering target according to 1) or 2) above, wherein a Pt content is 5 mol% or more and 60 mol% or less.

4) The sintered compact sputtering target according to any one of 1) to 3) above, wherein a BN content is 1 mol% or more and 60 mol% or less.

5) The sintered compact sputtering target according to any one of 1) to 4) above, wherein the sintered compact sputtering target contains, as an additive element, one or more elements selected from a group consisting of C, Ru, Ag, Au, and Cu in an amount of 0.5 mol% or more and 40.0 mol% or less.

6) The sintered compact sputtering target according to any one of 1) to 5) above, wherein the sintered compact sputtering target contains, as an additive material, one or more inorganic materials selected from a group consisting of oxide, nitride, carbide, and carbonitride.

7) A method of producing the sputtering target according to any one of 1) to 6) above, wherein flaky or tabular raw material powders are mixed and molded, and an obtained compact is subject to uniaxial pressure sintering.

#### [Advantageous Effects of Invention]

[0012] The Fe-Pt-based sintered compact of the present invention in which BN is used as the nonmagnetic material yields a superior effect of being able to suppress the abnormal discharge and amount of particles that are generated during sputtering by improving the orientation of the hexagonal BN.

#### BRIEF DESCRIPTION OF DRAWINGS

[0013] [Fig. 1] This is a microphotograph of the target of Example 1 (plane that is horizontal to the sputtering surface and cross section that is perpendicular to

the sputtering surface).

[Fig. 2] This is a microphotograph of the target of Example 2 (plane that is horizontal to the sputtering surface and cross section that is perpendicular to the sputtering surface).

[Fig. 3] This is a microphotograph of the target of Example 3 (plane that is horizontal to the sputtering surface and cross section that is perpendicular to the sputtering surface).

[Fig. 4] This is a microphotograph of the target of Comparative Example 1 (plane that is horizontal to the sputtering surface and cross section that is perpendicular to the sputtering surface).

[Fig. 5] This is an X-ray diffraction profile of the target of Example 1 (plane that is horizontal to the sputtering surface) (uppermost level).

[Fig. 6] This is an X-ray diffraction profile of the target of Example 1 (cross section that is perpendicular to the sputtering surface) (uppermost level).

[Fig. 7] This is an X-ray diffraction profile of the target of Example 2 (plane that is horizontal to the sputtering surface) (uppermost level).

[Fig. 8] This is an X-ray diffraction profile of the target of Example 2 (cross section that is perpendicular to the sputtering surface) (uppermost level).

[Fig. 9] This is an X-ray diffraction profile of the target of Example 3 (plane that is horizontal to the sputtering surface) (uppermost level).

[Fig. 10] This is an X-ray diffraction profile of the target of Example 3 (cross section that is perpendicular to the sputtering surface) (uppermost level).

[Fig. 11] This is an X-ray diffraction profile of the target of Comparative Example 1 (plane that is horizontal to the sputtering surface) (uppermost level).

[Fig. 12] This is an X-ray diffraction profile of the target of Comparative Example 1 (cross section that is perpendicular to the sputtering surface) (uppermost level).

## DESCRIPTION OF EMBODIMENTS

[0014] Since a hexagonal BN as a nonmagnetic material possesses a two-dimensional crystal structure, when the crystal orientation of the hexagonal BN is random in the target, there are cases where this will affect the electrical conduction, and cause the sputtering to be unstable. Accordingly, stable sputtering is enabled by aligning the orientation of the hexagonal BN crystals in

a single direction.

[0015] In other words, the Fe-Pt-based sintered compact sputtering target of the present invention contains a hexagonal BN as a nonmagnetic material, and the ratio of an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a cross section that is perpendicular to a sputtering surface relative to an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a plane that is horizontal to a sputtering surface is 2 or more.

[0016] Moreover, with the Fe-Pt-based sintered compact sputtering target of the present invention, the hexagonal BN phase is preferably flaky or tabular, and more preferably the average thickness of the hexagonal BN phase in a cross section that is perpendicular to the sputtering surface is 30  $\mu\text{m}$  or less. It is thereby possible to reduce the influence of the electrical conduction caused by the hexagonal BN, and enable the implementation of stable sputtering.

[0017] In the present invention, the Pt content is preferably 5 mol% or more and 60 mol% or less. By causing the Pt content to be 5 mol% or more and 60 mol% or less, it is possible to obtain favorable magnetic properties. Moreover, the hexagonal BN content is preferably 1 mol% or more and 60 mol% or less. By causing the content of BN as a nonmagnetic material to be 1 mol% or more and 60 mol% or less, it is possible to improve the magnetic insulation.

Note that, with the Fe-Pt-based sintered compact sputtering target of the present invention, excluding Pt, hexagonal BN, and the after-mentioned additive elements and additive materials, the remainder is Fe.

[0018] Moreover, in the present invention, it is preferable to add, as an additive element, one or more elements selected from a group consisting of C, Ru, Ag, Au, and Cu in a total amount of 0.5 mol% or more and 40.0 mol% or less. Moreover, it is preferable to add, as an additive material, one or more inorganic materials selected from a group consisting of oxide, nitride, carbide, and carbonitride. These additive elements and additive materials are effective components for improving the magnetic properties of the sputtered film.

[0019] The Fe-Pt-based magnetic material sintered compact of the present invention can be produced, for example, according to the following method.

Foremost, respective raw material powders (Fe powder, Pt powder, BN powder) are prepared. An alloy powder (Fe-Pt powder) may also be used as the raw material powder. While this will also depend on the composition, an alloy powder containing Pt is effective for reducing the amount of oxygen in the

raw material powder. In addition, the respective raw material powders of the additive components listed above may also be prepared as needed.

[0020] Subsequently, the metal powders (Fe powder, Pt powder) or the alloy powder (Fe-Pt alloy powder) is pulverized using a ball mill or a medium agitation mill. Normally, the foregoing metal raw material powders used are of a spherical shape, a massive form or another indefinite shape, but since the hexagonal BN is tabular or flaky, when BN is mixed with such powders and sintering is performed thereto, it becomes difficult to align the orientation of the hexagonal BN in the sintered compact. Thus, by causing the metal raw material powders to be tabular or flaky by pulverization, it is possible to achieve a structure in which the metal raw materials and the hexagonal BN are mutually accumulated, and align the orientation of the hexagonal BN.

[0021] The metal powders or the alloy powder obtained by the pulverization process described above is mixed with the hexagonal BN powder using a mortar, a medium agitation mill, a sieve or the like. The additive components or the additive materials may be poured in together with the metal raw material powders, poured in together with the hexagonal BN powder, or poured in at the stage of mixing the metal raw material powders and the hexagonal BN powder.

The thus obtained mixed powder is thereafter molded and sintered via hot press. In addition to hot press, used may be the plasma discharge sintering method or the hot isostatic pressure sintering method. While the holding temperature during sintering will depend on the composition of the sputtering target, in many cases, the holding temperature is within a range of 800°C to 1400°C.

[0022] The sintered compact is removed from the mold after the hot press and subsequently subject to hot isostatic pressing. Hot isostatic pressing is effective for increasing the density of the sintered compact. While the holding temperature during the hot isostatic pressing will depend on the composition of the sintered compact, in many cases, the holding temperature is within a range of 800°C to 1200°C. Moreover, the pressure is set to be 100 MPa or more. In addition, the thus obtained sintered compact is processed with a lathe into an intended shape to prepare a sputtering target.

Based on the foregoing process, it is possible to produce an Fe-Pt-based sintered compact sputtering target containing BN, wherein a ratio of an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a cross section that

is perpendicular to a sputtering surface relative to an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a plane that is horizontal to a sputtering surface is 2 or more.

The evaluation of the crystal orientation was performed using an X-ray diffraction device, and as to a plane that is horizontal to the sputtering surface and a cross section that is perpendicular to the sputtering surface of a sintered compact for a sputtering target, the X-ray diffraction intensities thereof were measured based on the following measurement conditions. Device: UltimaIV Protectus manufactured by Rigaku Corporation; tube: Cu; tube voltage: 40 kV; tube current: 30 mA; scanning range ( $2\theta$ ):  $10^\circ$  to  $90^\circ$ ; measurement step ( $2\theta$ ):  $0.01^\circ$ ; scanning speed ( $2\theta$ ):  $1^\circ$  per minute; scan mode:  $2\theta/\theta$ . Note that the diffraction peak of the hexagonal BN (002) plane appears near ( $2\theta$ ):  $26.75^\circ$ .

#### [Examples]

[0023] The present invention is now explained based on the following Examples and Comparative Examples. Note that these Examples are merely illustrative, and the present invention is not limited in any way by these Examples. In other words, the present invention is limited only based on its scope of claims, and the present invention covers various modifications other than the Examples included herein.

#### [0024] (Example 1)

As raw material powders, an Fe-Pt alloy powder and a hexagonal BN powder (flaky) were prepared, and these powders were weighed to achieve 70(50Fe-50Pt)-30BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was  $10\ \mu\text{m}$ . The powder removed from the medium agitation mill and the BN powder were mixed using a V-type mixer and subject to further mixing with a  $150\ \mu\text{m}$  sieve, and this mixed powder was filled in a carbon mold and hot pressed.

The hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of  $300^\circ\text{C}/\text{hour}$ , holding temperature of  $1200^\circ\text{C}$ , holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding,

the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. The hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. The results are shown in Fig. 1. Based on Fig. 1, it can be seen that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, based on Fig. 1, the average thickness of the hexagonal BN phase was 3  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 657, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 54, and the intensity ratio thereof was 12.2.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering. The sputtering conditions were as follows; namely, input power of 1 kW and Ar gas pressure of 1.7 Pa, and, after pre-sputtering of 2 kWhr, film deposition was performed onto a Si substrate having a 4-inch diameter for 20 seconds. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 250 and favorable results were obtained.

#### [0025] (Example 2)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), and a SiO<sub>2</sub> powder were prepared, and these powders were weighed to achieve 70(50Fe-50Pt)-5SiO<sub>2</sub>-25BN (mol%).

Next, the Fe-Pt alloy powder and the SiO<sub>2</sub> powder were placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a

grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill and the BN powder were mixed using a V-type mixer and subject to further mixing with a 100  $\mu\text{m}$  sieve, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was observed using an SEM in the furnace. The results are shown in Fig. 2. Based on Fig. 2, it can be seen that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, based on Fig. 2, the average thickness of the hexagonal BN phase was 9  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 566, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 45, and the intensity ratio thereof was 12.6.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 30 and favorable results were obtained.

[0026] (Example 3)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), a Ag powder, and a C (flaked graphite) powder were prepared, and these powders were weighed to achieve 58(35Fe-10Pt)-20Ag-20BN-2C (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill, the BN powder, the C powder and the Ag powder were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. The results are shown in Fig. 3. Based on Fig. 3, it can be seen that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, based on Fig. 3, the average thickness of the hexagonal BN phase was 2.2  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 327, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 45, and the intensity ratio thereof was 7.3.

Subsequently, the obtained sintered compact was cut with a lathe into a

shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 25 and favorable results were obtained.

[0027] (Example 4)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), and a Ag powder were prepared, and these powders were weighed to achieve 55(45Fe-45Pt-10Ag)-45BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill, the BN powder and the Ag powder were mixed using a V-type mixer and subject to further mixing with a 150  $\mu\text{m}$  sieve, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 6  $\mu\text{m}$ . Subsequently, the X-ray diffraction

method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 713, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 52, and the intensity ratio thereof was 13.7.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 83 and favorable results were obtained.

[0028] (Example 5)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), a Ag powder, and a SiO<sub>2</sub> powder were prepared, and these powders were weighed to achieve 80(50Fe-40Pt-10Ag)-5SiO<sub>2</sub>-15BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10 μm. The powder removed from the medium agitation mill, the BN powder, the Ag powder and the SiO<sub>2</sub> powder were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of

holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 2.4  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 158, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 46, and the intensity ratio thereof was 3.4.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 25 and favorable results were obtained.

[0029] (Example 6)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), and a Cu powder were prepared, and these powders were weighed to achieve 80(50Fe-45Pt-5Cu)-20BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill, the BN powder and the Cu powder were mixed using a V-type mixer and subject to further mixing with a 150  $\mu\text{m}$  sieve, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 3 µm. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 498, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 43, and the intensity ratio thereof was 11.6.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 126 and favorable results were obtained.

#### [0030] (Example 7)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), and a Au powder were prepared, and these powders were weighed to achieve 80(50Fe-45Pt-5Au)-20BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10 µm. The powder removed from the medium agitation mill, the BN powder and the Au powder were mixed using a V-type mixer and subject to further mixing with a 150 µm sieve, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 2.5  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 523, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 46, and the intensity ratio thereof was 11.4.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 174 and favorable results were obtained.

[0031] (Example 8)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), a Ru powder, a  $\text{SiO}_2$  powder, and a  $\text{TiO}_2$  powder were prepared, and these powders were weighed to achieve 74(48Fe-48Pt-4Ru)-3 $\text{SiO}_2$ -3 $\text{TiO}_2$ -20BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having

a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill, the BN powder, the Ru powder, the SiO<sub>2</sub> powder, and the TiO<sub>2</sub> powder were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 2.4  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 369, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 42, and the intensity ratio thereof was 8.8.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered

onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 36 and favorable results were obtained.

[0032] (Example 9)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), and a  $\text{Cr}_2\text{O}_3$  powder were prepared, and these powders were weighed to achieve 75(55Fe-45Pt)-5 $\text{Cr}_2\text{O}_3$ -20BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill, the BN powder and the  $\text{Cr}_2\text{O}_3$  powder were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 3.2  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 252, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to

the sputtering surface was 48, and the intensity ratio thereof was 5.3.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 76 and favorable results were obtained.

[0033] (Example 10)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), a Ag powder, and a TiN powder were prepared, and these powders were weighed to achieve 75(45Fe-55Pt-10Ag)-3TiN-22BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill, the BN powder and the TiN powder were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering

surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 5  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 289, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 43, and the intensity ratio thereof was 6.7.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 129 and favorable results were obtained.

[0034] (Example 11)

As raw material powders, an Fe-Pt alloy powder, a BN powder (flaky), a Ag powder, and a SiC powder were prepared, and these powders were weighed to achieve 75(45Fe-55Pt-10Ag)-3TiN-22BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill, the BN powder and the SiC powder were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas

pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 4.2  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 304, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 49, and the intensity ratio thereof was 6.2.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 137 and favorable results were obtained.

[0035] (Example 12)

As raw material powders, an Fe-Pt alloy powder and a BN powder (flaky) were prepared, and these powders were weighed to achieve 40(55Fe-45Pt)-60BN (mol%).

Next, the Fe-Pt alloy powder was placed in a medium agitation mill having a capacity of 5L together with Zirconia balls as a grinding medium to be processed in the mill for 2 hours at a rotating speed of 300 rpm. The average grain size of the processed Fe-Pt alloy powder was 10  $\mu\text{m}$ . The powder removed from the medium agitation mill and the BN powder were mixed using a V-type mixer and subject to further mixing with a 150  $\mu\text{m}$  sieve, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time.

After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 950°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 950°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it has a layered structure in a direction that is perpendicular to the sputtering surface, and the BN is oriented therein. Moreover, the average thickness of the hexagonal BN phase was 9.5  $\mu\text{m}$ . Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 810, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 53, and the intensity ratio thereof was 15.3.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 358 and favorable results were obtained.

[0036] (Comparative Example 1)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), and a C powder were prepared. These powders were weighed to achieve 60(30Fe-70Pt)-5BN-35C (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a

vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. The results are shown in Fig. 4. Based on Fig. 4, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 52, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 44, and the intensity ratio thereof was 1.2.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 1100, and considerably increased in comparison to the Examples.

[0037] (Comparative Example 2)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), and a Ag powder were prepared. These powders were weighed to achieve 55(45Fe-45Pt-10Ag)-45BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 67, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 52, and the intensity ratio thereof was 1.3.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 860, and considerably increased in comparison to the Examples.

[0038] (Comparative Example 3)

As raw material powders, an Fe powder having an average grain size of 5

$\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), a Ag powder, and a  $\text{SiO}_2$  powder were prepared. These powders were weighed to achieve 80(50Fe-40Pt-10Ag)-5 $\text{SiO}_2$ -15BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 58, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 46, and the intensity ratio thereof was 1.3.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 712, and considerably increased in

comparison to the Examples.

[0039] (Comparative Example 4)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), and a Cu powder were prepared. These powders were weighed to achieve 80(50Fe-45Pt-5Cu)-20BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 71, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 43, and the intensity ratio thereof was 1.7.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same

conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 616, and considerably increased in comparison to the Examples.

5 [0040] (Comparative Example 5)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), and a Au powder were prepared. These powders were weighed to achieve 80(50Fe-45Pt-5Au)-20BN (mol%).

10 Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

20 An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 64, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 46, and the intensity ratio thereof was 1.4.

35 Subsequently, the obtained sintered compact was cut with a lathe into a

shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 732, and considerably increased in comparison to the Examples.

[0041] (Comparative Example 6)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), a Ru powder, a  $\text{TiO}_2$  powder, and a  $\text{SiO}_2$  powder were prepared. These powders were weighed to achieve 74(48Fe-48Pt-4Ru)-3 $\text{TiO}_2$ -3 $\text{SiO}_2$ -20BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal

to the sputtering surface was 46, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 42, and the intensity ratio thereof was 1.1.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 1047, and considerably increased in comparison to the Examples.

[0042] (Comparative Example 7)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), and a  $\text{Cr}_2\text{O}_3$  powder were prepared. These powders were weighed to achieve 75(55Fe-45Pt)-5 $\text{Cr}_2\text{O}_3$ -20BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the

sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 52, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 48, and the intensity ratio thereof was 1.1.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 823, and considerably increased in comparison to the Examples.

[0043] (Comparative Example 8)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), a Ag powder, and a TiN powder were prepared. These powders were weighed to achieve 75(45Fe-55Pt-10Ag)-3TiN-22BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 53, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 43, and the intensity ratio thereof was 1.2.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 1079, and considerably increased in comparison to the Examples.

[0044] (Comparative Example 9)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , a BN powder (flaky), a Ag powder, and a SiC powder were prepared. These powders were weighed to achieve 75(45Fe-55Pt-10Ag)-3SiC-22BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas

pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 77, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 49, and the intensity ratio thereof was 1.6.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 1055, and considerably increased in comparison to the Examples.

[0045] (Comparative Example 10)

As raw material powders, an Fe powder having an average grain size of 5  $\mu\text{m}$ , a Pt powder having an average grain size of 6  $\mu\text{m}$ , and a BN powder (flaky) were prepared. These powders were weighed to achieve 40(55Fe-45Pt)-60BN (mol%).

Subsequently, the weighed powders were mixed using a V-type mixer and subject to further mixing with a mortar, and this mixed powder was filled in a carbon mold and hot pressed.

As with Example 1, the hot press conditions were as follows; namely, a vacuum atmosphere, rate of temperature increase of 300°C/hour, holding temperature of 1200°C, holding time of 2 hours, and pressure of 30 MPa was applied from the start of temperature increase until the end of the holding time. After the end of holding, the sintered compact was left in the chamber and cooled naturally.

Subsequently, the sintered compact was removed from the carbon mold

and subject to hot isostatic pressing. As with Example 1, the hot isostatic pressing conditions were as follows; namely, rate of temperature increase of 300°C/hour, holding temperature of 1100°C, holding time of 2 hours, Ar gas pressure was gradually increased from the start of temperature increase, and pressure of 150 MPa was applied during holding at 1100°C. After the end of holding, the sintered compact was left in the furnace and cooled naturally.

An end of the thus obtained sintered compact was cut out, and the cut surface was observed using an SEM. Consequently, it was confirmed that it does not have a layered structure in a direction that is perpendicular to the sputtering surface. Subsequently, the X-ray diffraction method (XRD) was used to measure the cross section of the sintered compact. Consequently, the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 82, and the X-ray diffraction peak intensity of the BN (002) plane in a plane that is horizontal to the sputtering surface was 53, and the intensity ratio thereof was 1.5.

Subsequently, the obtained sintered compact was cut with a lathe into a shape having a diameter of 180.0 mm and a thickness of 5.0 mm, and thereafter mounted on a magnetron sputtering equipment (C-3010 Sputtering System manufactured by Canon Anelva) to perform sputtering under the same conditions as Example 1. Subsequently, the number of particles that adhered onto the substrate was measured using a particle counter. The number of particles in the foregoing case was 2530, and considerably increased in comparison to the Examples.

[0046] [Table 1]

|                        | Type                                            | Composition (mol%) | Metal Raw Material                                                | BN Raw Material                                           | Carbon Raw Material                                   | Mixing Method           | BN (002) Peak Intensity of Plane Horizontal to Sputtering Surface | BN (002) Peak Intensity of Cross Section Perpendicular to Sputtering Surface | Peak Intensity Ratio of (Plane Horizontal to Sputtering Surface/Cross Section Perpendicular to Sputtering Surface) | Number of Particles |
|------------------------|-------------------------------------------------|--------------------|-------------------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------|-------------------------|-------------------------------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------|
| Example 1              | Fe-Pt-BN                                        | 70(50-50)-30       | Fe-Pt alloy powder (medium agitation milling process)             | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | 150 $\mu\text{m}$ Sieve | 657                                                               | 54                                                                           | 12.2                                                                                                               | 250                 |
| Example 2              | Fe-Pt-SiO <sub>2</sub> -BN                      | 70(50-50)-5-25     | Fe-Pt alloy powder (medium agitation milling process)             | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | 100 $\mu\text{m}$ Sieve | 566                                                               | 45                                                                           | 12.6                                                                                                               | 30                  |
| Example 3              | Fe-Pt-Ag-BN-C                                   | 58(35-10)-20-20-2  | Fe-Pt alloy powder (medium agitation milling process) + Ag powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | Flaky graphite, average grain size of 7 $\mu\text{m}$ | Mortar                  | 327                                                               | 45                                                                           | 7.3                                                                                                                | 25                  |
| Example 4              | Fe-Pt-Ag-BN                                     | 55(45-45-10)-45    | Fe-Pt alloy powder (medium agitation milling process) + Ag powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | 150 $\mu\text{m}$ Sieve | 713                                                               | 52                                                                           | 13.7                                                                                                               | 83                  |
| Example 5              | Fe-Pt-Ag-SiO <sub>2</sub> -BN                   | 80(50-40-10)-5-15  | Fe-Pt alloy powder (medium agitation milling process) + Ag powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 158                                                               | 46                                                                           | 3.4                                                                                                                | 25                  |
| Example 6              | Fe-Pt-Cu-BN                                     | 80(50-45-5)-20     | Fe-Pt alloy powder (medium agitation milling process) + Cu powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | 150 $\mu\text{m}$ Sieve | 498                                                               | 43                                                                           | 11.6                                                                                                               | 126                 |
| Example 7              | Fe-Pt-Au-BN                                     | 80(50-45-5)-20     | Fe-Pt alloy powder (medium agitation milling process) + Au powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | 150 $\mu\text{m}$ Sieve | 523                                                               | 46                                                                           | 11.4                                                                                                               | 174                 |
| Example 8              | Fe-Pt-Ru-TiO <sub>2</sub> -SiO <sub>2</sub> -BN | 74(48-48-4)-3-3-20 | Fe-Pt alloy powder (medium agitation milling process) + Ru powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 369                                                               | 42                                                                           | 8.8                                                                                                                | 36                  |
| Example 9              | Fe-Pt-Cr <sub>2</sub> O <sub>3</sub> -BN        | 75(55-45)-5-20     | Fe-Pt alloy powder (medium agitation milling process)             | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 252                                                               | 48                                                                           | 5.3                                                                                                                | 76                  |
| Example 10             | Fe-Pt-Ag-TiN-BN                                 | 75(45-55-10)-3-22  | Fe-Pt alloy powder (medium agitation milling process) + Ag powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 289                                                               | 43                                                                           | 6.7                                                                                                                | 129                 |
| Example 11             | Fe-Pt-Ag-SiC-BN                                 | 75(45-55-10)-3-22  | Fe-Pt alloy powder (medium agitation milling process) + Ag powder | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 304                                                               | 49                                                                           | 6.2                                                                                                                | 137                 |
| Example 12             | Fe-Pt-BN                                        | 40(55-45)-60       | Fe-Pt alloy powder (medium agitation milling process)             | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | 150 $\mu\text{m}$ Sieve | 810                                                               | 53                                                                           | 15.3                                                                                                               | 358                 |
| Comparative Example 1  | Fe-Pt-BN-C                                      | 60(30-70)-5-35     | Fe powder, Pt powder                                              | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | Graphite, average grain size of 20 $\mu\text{m}$      | Mortar                  | 52                                                                | 44                                                                           | 1.2                                                                                                                | 1100                |
| Comparative Example 2  | Fe-Pt-Ag-BN                                     | 55(45-45-10)-45    | Fe powder, Pt powder                                              | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 67                                                                | 52                                                                           | 1.3                                                                                                                | 860                 |
| Comparative Example 3  | Fe-Pt-Ag-SiO <sub>2</sub> -BN                   | 80(50-40-10)-5-15  | Fe powder, Pt powder, Ag powder                                   | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 58                                                                | 46                                                                           | 1.3                                                                                                                | 712                 |
| Comparative Example 4  | Fe-Pt-Cu-BN                                     | 80(50-45-5)-20     | Fe powder, Pt powder, Cu powder                                   | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 71                                                                | 43                                                                           | 1.7                                                                                                                | 616                 |
| Comparative Example 5  | Fe-Pt-Au-BN                                     | 80(50-45-5)-20     | Fe powder, Pt powder, Au powder                                   | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 64                                                                | 46                                                                           | 1.4                                                                                                                | 732                 |
| Comparative Example 6  | Fe-Pt-Ru-TiO <sub>2</sub> -SiO <sub>2</sub> -BN | 74(48-48-4)-3-3-20 | Fe powder, Pt powder, Ru powder                                   | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 46                                                                | 42                                                                           | 1.1                                                                                                                | 1047                |
| Comparative Example 7  | Fe-Pt-Cr <sub>2</sub> O <sub>3</sub> -BN        | 75(55-45)-5-20     | Fe powder, Pt powder                                              | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 52                                                                | 48                                                                           | 1.1                                                                                                                | 823                 |
| Comparative Example 8  | Fe-Pt-Ag-TiN-BN                                 | 75(45-55-10)-3-22  | Fe powder, Pt powder, Ag powder                                   | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 53                                                                | 43                                                                           | 1.2                                                                                                                | 1079                |
| Comparative Example 9  | Fe-Pt-Ag-SiC-BN                                 | 75(45-55-10)-3-22  | Fe powder, Pt powder, Ag powder                                   | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 77                                                                | 49                                                                           | 1.6                                                                                                                | 1055                |
| Comparative Example 10 | Fe-Pt-BN                                        | 40(55-45)-60       | Fe powder, Pt powder                                              | Flaky hexagonal BN, average grain size of 8 $\mu\text{m}$ | -                                                     | Mortar                  | 82                                                                | 53                                                                           | 1.5                                                                                                                | 2530                |

## INDUSTRIAL APPLICABILITY

[0047] The Fe-Pt-based sintered compact of the present invention in which BN is used as the nonmagnetic material yields a superior effect of being able to provide a sputtering target capable of reducing the amount of particles that is generated during sputtering. Accordingly, the present invention is useful as a sputtering target that is used in the deposition of a magnetic thin film having a granular structure.

10

## CLAIMS

[Claim 1] An Fe-Pt-based sintered compact sputtering target containing BN, wherein a ratio of an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a cross section that is perpendicular to a sputtering surface relative to an X-ray diffraction peak intensity of a hexagonal BN (002) plane in a plane that is horizontal to a sputtering surface is 2 or more.

[Claim 2] The sintered compact sputtering target according to claim 1, wherein an average thickness of the hexagonal BN phase in a cross section that is perpendicular to the sputtering surface is 30  $\mu\text{m}$  or less.

[Claim 3] The sintered compact sputtering target according to claim 1 or claim 2, wherein a Pt content is 5 mol% or more and 60 mol% or less.

[Claim 4] The sintered compact sputtering target according to any one of claims 1 to 3, wherein a BN content is 1 mol% or more and 60 mol% or less.

[Claim 5] The sintered compact sputtering target according to any one of claims 1 to 4, wherein the sintered compact sputtering target contains, as an additive element, one or more elements selected from a group consisting of C, Ru, Ag, Au, and Cu in an amount of 0.5 mol% or more and 40.0 mol% or less.

[Claim 6] The sintered compact sputtering target according to any one of claims 1 to 5, wherein the sintered compact sputtering target contains, as an additive material, one or more inorganic materials selected from a group consisting of oxide, nitride, carbide, and carbonitride.

[Claim 7] A method of producing the sputtering target according to any one of claims 1 to 6, wherein flaky or tabular raw material powders are mixed and molded, and an obtained compact is subject to uniaxial pressure sintering.