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# Magnetic Recording Medium and Magnetic Recording and Reproducing Device

## Background of the Invention

### Field of the Invention

The present invention relates to a magnetic recording medium, and a magnetic recording and reproducing device in which the magnetic recording medium is used.

This application is based on Japanese Patent Application No. 203947/1999 filed in Japan, the content of which is incorporated herein by reference.

### Description of the Related Art

At the present time, a commercially available magnetic recording medium is typically of an in-plane recording type in which easy magnetization axes in a magnetic film is oriented primarily horizontally with respect to a substrate.

In such an in-plane magnetic recording medium, when recording density is increased, a per-bit volume becomes excessively small and reproduction characteristics may decline as a result of the thermal fluctuation effect. In addition, when recording density is increased, noise attributed to the recording medium may increase as a result of the demagnetizing field effect at a recording bit boundary.

In contrast, a perpendicular magnetic recording medium in which easy magnetization axes in a magnetic film are oriented primarily perpendicularly with respect to a substrate is not easily affected by the demagnetizing field

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at a recording bit boundary even when recording density is increased. Therefore, recording magnetic domains having distinct boundaries are formed, resulting in reduction in noise. In addition, even when a per-bit volume is relatively large, recording density can be increased, and thus the medium is not easily affected by thermal fluctuation. Because of these reasons, a perpendicular magnetic recording medium has recently become of keen interest, and medium structures suitable for perpendicular magnetic recording have been proposed.

For example, Japanese Patent Application Laid-Open (kokai) No. 77025/1983 and No. 141435/1983 disclose that Ti is used for an undercoat layer of a perpendicular magnetization film containing a Co alloy material. In addition, Japanese Patent Application Laid-Open (kokai) No. 180360/1996 discloses that an alloy of Co and Ru is used for the undercoat layer.

Recently, a magnetic recording medium has been demanded to have a higher recording density, and in conjunction with this trend, improvement of noise characteristics has been required.

Moreover, since conventional magnetic recording media are not at all satisfactory in terms of noise characteristics, a magnetic recording medium having excellent noise characteristics is demanded.

## SUMMARY OF THE INVENTION

In view of the foregoing, an object of the present

invention is to provide a magnetic recording medium and a magnetic recording and reproducing device having excellent noise characteristics.

A magnetic recording medium according to the present invention comprises a substrate, a first undercoat film and a second undercoat film formed thereon, and a perpendicular magnetization film formed on the second undercoat film, wherein easy magnetization axes of the perpendicular magnetization film are oriented primarily perpendicularly with respect to the substrate, and the first undercoat film contains a material of B2 structure.

The first undercoat film may contain a material predominantly comprising one or more alloys selected from among NiAl, FeAl, CoFe, CoZr, NiTi, AlCo, and AlMn.

When the first undercoat film contains a material predominantly comprising any bimetallic alloy selected from among NiAl, FeAl, CoFe, CoZr, NiTi, AlCo, and AlMn, the content of each component in the alloy is 40-60 at%, preferably 45-55 at%.

The second undercoat film preferably contains a material of hcp structure which predominantly comprises one or more elements selected from among Ti, Zr, Ru, Re, Y, Gd, and Tb.

The perpendicular magnetization film preferably comprises any alloy selected from among Co/Cr/Pt, Co/Cr/Ta, and Co/Cr/Pt/X (X: one or more species selected from among Ta, Zr, Nb, Cu, Re, Ni, and B).

Preferably, a non-magnetic intermediate film of hcp structure is provided between the second undercoat film and

the perpendicular magnetization film.

The thickness of the first undercoat film is preferably 500 Å or less.

The thickness of the perpendicular magnetization film is preferably 100-1000 Å.

The magnetic recording and reproducing device according to the present invention comprises a magnetic recording medium, and a magnetic head for recording and reproducing information, wherein said magnetic recording medium comprises a substrate, a first undercoat film and a second undercoat film formed thereon, and a perpendicular magnetization film formed on the second undercoat film, wherein easy magnetization axes in the perpendicular magnetization film are oriented primarily perpendicularly with respect to the substrate, and the first undercoat film contains a material of B2 structure.

In the case of employment of a ring-type head as the magnetic head, it is preferable that a thickness of the first undercoat film is 80-500 Å.

As is described above, the magnetic recording medium according to the present invention comprises the first undercoat film containing a material of B2 structure, and therefore, coercive force and squareness ratio may be increased and noise characteristics may be improved.

The magnetic recording and reproducing device comprises the above-described magnetic recording medium, and therefore, the coercive force and squareness ratio may be increased to thereby improve the noise characteristics and achieve high recording density.

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## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partial sectional view showing an embodiment of the magnetic recording medium of the present invention.

Fig. 2 is a graph showing the relation between the thickness of the first undercoat film and orientation of the plane (0002) of the perpendicular magnetization film.

Fig. 3 is a graph showing the results of measurement of coercive force (Hc) and SNR of the above-described magnetic recording medium, when a magnetic head that is used for a typical in-plane magnetic recording medium is used.

Fig. 4 is a partial sectional view showing the second embodiment of the magnetic recording medium of the present invention.

Fig. 5 is a diagram showing a structural outline of an embodiment of a magnetic recording and reproducing device of the present invention.

Fig. 6 is a partial sectional view showing third embodiment of the magnetic recording medium of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a schematic representation showing an embodiment of the magnetic recording medium according to the present invention. The magnetic recording medium shown in Fig. 1 comprises a substrate 1, a first undercoat film 2, a

second undercoat film 3, a non-magnetic intermediate film 4, a perpendicular magnetization film 5, and a protective film 6, with the films 2-6 being successively formed on the substrate 1.

Example materials for the substrate 1 include an aluminum alloy having a NiP-plated film (hereinafter referred to as "NiP-plated Al") which is generally used for forming a substrate for magnetic recording media.

The materials for the substrate 1 comprise glass, ceramic, a carbon material, and a flexible resin material. These substrates may be coated with a NiP film through plating or sputtering.

The first undercoat film 2 is used for increasing coercive force, increasing squareness ratio, and improving noise characteristics of the magnetic recording medium, and the film comprises a material of B2 structure.

Preferably, the material of B2 structure predominantly comprises one or more alloys selected from among NiAl, FeAl, CoFe, CoZr, NiTi, AlCo, and AlMn, and these alloys may additionally contain elements such as Cr, Nb, V, W, and Mo.

When the first undercoat film contains a material predominantly comprising any one of the above-described bimetallic alloys (NiAl, FeAl, CoFe, CoZr, NiTi, AlCo, and AlMn), the preferable content of each component in the alloy is 40-60 at%, preferably 45-55 at%.

When the content is below or in excess of the above range, B2 structure in the first undercoat film 2 may be disordered, to thereby lower noise characteristics.

The thickness of the first undercoat film 2 is

preferably determined as described below.

Fig. 2 is a graph showing the relation between the thickness of the first undercoat film 2 and orientation in the plane (0002) of the perpendicular magnetization film 5.

In the graph, the horizontal axis represents the thickness of the first undercoat film 2, and the perpendicular axis represents the intensity of X-ray diffraction corresponding to the plane (0002) of the perpendicular magnetization film 5.

As is shown in the graph, the intensity of X-ray diffraction reaches a peak when the thickness of the first undercoat film 2 is 25 Å, and the intensity decreases with increasing thickness.

As is apparent from the graph, perpendicular orientation of the perpendicular magnetization film 5 becomes significant when the thickness of the first undercoat film 2 is around 25 Å; i.e., 15-40 Å, particularly 20-30 Å, and thereafter the orientation gradually declines with increasing thickness.

Hereinafter, the region in which the thickness of the first undercoat film 2 is around 25 Å; i.e., 15-40 Å will be referred to as the "A-region."

Fig. 3 is a graph showing the results of measurement of coercive force Hc (Oe) and SNR (dB) of the above-described magnetic recording medium, which are measured by use of a ring-type magnetic head that is used for a typical in-plane magnetic recording medium.

In the graph, the horizontal axis represents the thickness of the above-described first undercoat film 2, and

the vertical axis represents coercive force (Hc) and SNR.

As is apparent from the graph, Hc increases rapidly with thickness until the thickness of the first undercoat film 2 reaches the A-region, and subsequently, Hc increases gradually.

As is also apparent from the graph, SNR increases with thickness until the thickness of the first undercoat film 2 reaches the A-region, and subsequently, SNR maintains an almost constant value. Subsequently, SNR increases again within the region in which the thickness is 80-500 Å, and within the same region, SNR decreases slightly and thereafter maintains an almost constant value.

Hereinafter the region in which the thickness of the first undercoat film 2 is 80-500 Å will be referred to as the "B-region." In the B-region, particularly when the thickness is 80-300 Å, more particularly 80-150 Å, SNR becomes very high.

As is also apparent from the graph, in the case of a magnetic head (ring-type head) used for a typical in-plane magnetic recording medium, excellent SNR characteristic can be obtained in the B-region—which is characterized by having low perpendicular orientation of the perpendicular magnetization film 5—as compared with the A-region, which is characterized by having high perpendicular orientation.

As is described above, SNR characteristic improves in the B-region, which has low perpendicular orientation. The reasons for this are considered to be as follows. In the A-region, which has high perpendicular orientation, most magnetic domains have a perpendicular magnetization

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orientation, whereas in the B-region, magnetization orientation of magnetic film 5 is randomized to some extent. Therefore, in the B-region, magnetization in an in-plane direction becomes significant, and further, loop-like magnetization curves having perpendicular and in-plane directional magnetization curves are formed. As a result, stable magnetization is obtained, and output level may increase.

Hc becomes higher, as compared with the B region, in the region in which the thickness of the first undercoat film 2 is higher than in the B-region. In this case, reproduction output level may increase with the increase in Hc.

Therefore, in the region in which the thickness of the undercoat film 2 is higher than in the B-region, SNR; i.e., the ratio of reproduction output to noise, decreases slightly, whereas noise level may increase considerably.

On the basis of the above-described reasons, when the thickness of the first undercoat film 2 is set at a value within the B-region, noise level may be suppressed as compared with the case where the thickness is set at a value in excess of the B-region.

As is apparent from the above results, the thickness of the first undercoat film 2 is preferably determined as described below.

In the case of employment of a ring-type head used for a typical in-plane magnetic recording medium, SNR characteristic may be improved when the first undercoat film 2 has a thickness of 80-500 Å, which corresponds to the above-described B-region, preferably 80-300 Å, more

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preferably 80-150 Å.

A thickness below the above range may cause poor SNR characteristics, for the reasons described below. When the thickness is below the above range, the perpendicular magnetization film favors perpendicular orientation, to thereby hamper magnetization in an in-plane direction. As a result, improved output due to the formation of the above-described loop-like magnetization curves may not be obtained.

A thickness in excess of the above range may cause poor noise characteristics, for the reasons described below. When the thickness is in excess of the above range, crystal grains become coarser in the first undercoat film 2. Subsequently, in the non-magnetic intermediate film 4 formed on the undercoat film 2 and in the perpendicular magnetization film 5, crystal grains may become coarser to thereby increase noise level.

The second undercoat film 3 is provided for enhancing the perpendicular orientation of the non-magnetic intermediate film 4 and the perpendicular magnetization film 5, and the film 3 preferably contains a material of hcp structure.

The material of the second undercoat film 3 predominantly comprises one or more species selected from among Ti, Zr, Ru, Re, Y, Gd, and Tb.

The material may comprise a single element selected form among Ti, Zr, Ru, Re, Y, Gd, and Tb, or an alloy of these elements and other elements, including Cr, Co, Fe, and Ni, in consideration of lattice matching with respect to the non-magnetic intermediate film 4 and the perpendicular

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magnetization film 5.

In addition, the second undercoat film 3 may partially comprise a material of fcc structure.

The non-magnetic intermediate film 4 is provided for increasing the coercive force of the medium, and the film comprises a non-magnetic material of hcp structure.

The material of the non-magnetic intermediate film 4 preferably comprises any alloy selected from among Co/Cr, Co/Cr/Pt, Co/Cr/Ta, and Co/Cr/Pt/X (X: one or more species selected form among Ta, Zr, Nb, Cu, Re, Ni, and B).

Preferably, the material of the non-magnetic intermediate film 4 predominantly comprises a Co alloy containing Cr: 25-50 at%, Pt: 0-15 at%, X: 0-10 at%, and Co: balance.

The non-magnetic intermediate film 4 may have either a single-layer structure or a multi-layer structure. In the case of a multi-layer structure, the film 4 may be formed of a plurality of layers comprising a single material or of a plurality of layers comprising different materials, which materials are selected from among the above-described materials.

The non-magnetic intermediate film 4 preferably has a thickness of 500 Å or less.

When the thickness is in excess of 500 Å, magnetic particles in the perpendicular magnetization film 5 tend to become coarser and noise characteristics decline, which is unsatisfactory.

The non-magnetic intermediate film 4 more preferably has a thickness of 20-300 Å. When the non-magnetic

intermediate film 4 has a multi-layer structure, in consideration of the above-described reasons, the film preferably has a total thickness of 500 Å or less, more preferably 50-200 Å.

The perpendicular magnetization film 5 comprises a magnetic material in which easy magnetization axes are oriented primarily perpendicularly with respect to the substrate. Preferred examples of the magnetic material include any alloy selected from Co/Cr/Pt, Co/Cr/Ta, and Co/Cr/Pt/X (X: one or more species selected from Ta, Zr, Nb, Cu, Re, Ni, and B).

The perpendicular magnetization film 5 more preferably comprises a Co alloy containing Cr: 13-28 at%, Pt: 0-15 at%, X: 0-5 at%, and Co: balance. When the amount of any component falls outside the above range, noise characteristics decline or reproduction output decreases, either of which is unsatisfactory.

The perpendicular magnetization film 5 preferably has a thickness of 100-1000 Å. When the thickness of the perpendicular magnetization film 5 is less than 100 Å, insufficient magnetic flux is obtained to thereby reduce reproduction output.

In contrast, when the thickness of the perpendicular magnetization film 5 is in excess of 1000 Å, the magnetic particles in the film 5 become coarser and noise characteristics decline, which is unsatisfactory.

The perpendicular magnetization film 5 more preferably has a thickness of 200-700 Å, for the reasons described below. When the thickness falls within the above range, reproduction

output may be further improved, and the magnetic particles in the film 5 may be prevented from becoming coarser, to thereby improve noise characteristics.

The protective film 6 is provided for preventing corrosion of the perpendicular magnetization film 5, protecting the surface of the medium from any damage when a head contacts the medium, and maintaining lubrication between the head and the medium. Known materials may be used for the film 5, and examples of the materials include a single composition of C, $SiO_2$, or $ZrO_2$, and a composition comprising C, $SiO_2$, or $ZrO_2$ as a primary component and other elements.

The protective film 6 preferably has a thickness of 10-100 Å.

On the surface of the protective film 6, a lubrication film formed of perfluoropolyether, fluorinated alcohol, or fluorinated carboxylic acid is preferably provided.

In order to produce the magnetic recording medium comprising the above-described components, firstly, the first undercoat film 2, the second undercoat film 3, the non-magnetic intermediate film 4, and the perpendicular magnetization film 5 are successively formed on the substrate 1 by means of a technique such as sputtering, vacuum deposition, or ion-plating. Subsequently, the protective film 6 is formed on the film 5 preferably through plasma CVD, irradiation with an ion-beam, or sputtering.

It is preferable to use sputtering to form the first undercoat film 2, with a sputtering target made of a material of B2 structure. The material comprises the above-described materials.

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Meanwhile, a lubrication film is formed by means of a known technique such as dipping or spin-coating.

In the magnetic recording medium comprising the above-described components, the first undercoat film 2 contains a material of B2 structure, and therefore, coercive force and squareness ratio may be increased to thereby improve noise characteristics.

The reasons why the above-described effect is obtained by provision of the first undercoat film 2 containing a material of B2 structure are not elucidated, but the reasons may be assumed to be as described below.

The perpendicular magnetization film 5 is formed on the first undercoat film 2 by the mediation of the second undercoat film 3 and the non-magnetic intermediate film 4, and the film 5 is grown under the effects of the first undercoat film 2 having B2 structure.

In the perpendicular magnetization film 5 that is grown under the effects of the first undercoat film 2 having B2 structure, crystal grains may be pulverized, isolated, and homogenized.

Thus, coercive force and squareness ratio may be increased and recording magnetic domains having distinct boundaries may be formed, to thereby reduce noise level.

Moreover, by provision of the second undercoat film 3 formed of a material of hcp structure, perpendicular orientation of the perpendicular magnetization film 5 formed on the second undercoat film 3 by the mediation of the non-magnetic intermediate film 4 is enhanced, to thereby improve noise characteristics and coercive force.

This effect is considered to be obtained from improved lattice matching between the first undercoat film 2 and the non-magnetic intermediate film 4, which is attributed to provision of the second undercoat film 3 having hcp structure.

In addition, by provision of the non-magnetic intermediate film 4 having hcp structure between the second undercoat film 3 and the perpendicular magnetization film 5, crystal orientation of the film 5 may be prevented from becoming disordered during initial growth, providing an improvement in crystal orientation, to thereby realize an enhanced coercive force and a reduced noise level.

As shown in Fig.4, it is preferable to form a soft magnetic layer 12 between the substrate 1 and the first undercoat film 2.

The material of the soft magnetic layer 12 comprises amorphous material containing Co (alloys of CoZrNb, CoTaNb, permalloy, sendust, for example).

The thickness of the soft magnetic layer 12 is preferably 50 nm or more (preferably 100 nm or more, more preferably 200 nm or more).

When the thickness of the soft magnetic layer 12 is below the above range, it becomes difficult to form the loop-like magnetization curves.

Fig.5 is a diagram showing an embodiment of the magnetic recording and reproducing device using the magnetic recording medium described above.

The magnetic recording and reproducing device comprises the magnetic recording medium 7 shown in Fig.1, medium driving device 8 for rotating the medium 7, magnetic head 9

for recording and reproducing information, head driving device 10, and recording/reproducing signal processing system 11.

Recording/reproducing signal processing system 11 is for processing a inputting data and sending a signal to be recorded to the magnetic head 9. Signal processing system 11 is also used for processing a signal to be reproduced from the magnetic head 9, and outputting a data.

The magnetic head 9 comprises a ring-type magnetic head used for a typical in-plane magnetic recording medium.

The material of the portion of the gap, the length of the gap, and the condition of the recording are determined properly.

For example, the gap length of the element of the recording portion is preferably 0.08 $\mu$m or more, preferably 0.1 $\mu$m or more, more preferably 0.12 $\mu$m or more.

The gap length of the element of the recording portion is preferably 0.4 $\mu$m or less.

In the magnetic recording medium comprising the above-described components, the non-magnetic intermediate film 4 containing a material of hcp structure is provided, but the film 4 is not a required component of the magnetic recording medium of the present invention. The magnetic recording medium without the non-magnetic intermediate film 4 is shown in Fig. 6. As used herein, the term "predominantly comprising" refers to containing in a composition in an amount of more than 50 at%.

(Test Example 1)

The working mechanism and effects of the present

invention will next be described in more detail by way of specific examples.

A glass substrate 1 (Ohara TS-10SX) was set in the chamber of a DC magnetron sputtering apparatus (model 3010: product of ANELVA).

The chamber was evacuated to $2 \times 10^{-7}$ Pa, and the substrate 1 was heated to 200°C. Subsequently, on the substrate 1, a first undercoat film 2 containing Ni - 50at%Al (Al content: 50 at%, Ni: balance, hereinafter Ni - 50at%Al will be referred to as "Ni50Al"), a second undercoat film 3 containing Ru and having hcp structure, a non-magnetic intermediate film 4 containing Co - 40at%Cr (Co40Cr), and a perpendicular magnetization film 5 containing Co - 22at%Cr - 12at%Pt - 2at%Ta (Co22Cr12Pt2Ta) were successively formed through sputtering.

On the perpendicular magnetization film 5, a carbon protective film 6 having a thickness of 70 Å was formed through plasma CVD.

(Test Examples 2 to 24)

The procedure of Test Example 1 was repeated, except that the materials and thicknesses of the films were changed as shown in Table 1, to thereby prepare respective magnetic recording media.

The magnetic recording media prepared in Test Examples 1 to 24 were subjected to measurement of static magnetic characteristics by use of a vibrating sample magnetometer (VSM).

In addition, the magnetic recording media were subjected to measurement of electromagnetic conversion

characteristics by use of read/write analyzer RWA1632 and spin stand S1701MP (products of GUZIK).

In order to evaluate electromagnetic conversion characteristics, measurement was performed by use of a complex-type thin film magnetic recording head containing a giant magnetoresistance (GMR) device at a reproduction portion, and track recording density was set at 250 kFCI.

The magnetic head used for evaluation of the above electromagnetic conversion characteristics is that used for a typical in-plane magnetic recording medium. Meanwhile, the results of X-ray diffraction show that in all test examples the first undercoat film 2 has a B2 structure.

Table 1 shows the results of measurement of the magnetic recording media prepared in Test Examples 1 to 24 in terms of static magnetic characteristics and electromagnetic conversion characteristics.

In Table 1, Mr/Ms represents the squareness ratio. Co(0002) intensity represents the intensity of X-ray diffraction corresponding to the plane (0002) of the perpendicular magnetization film 5.

[Table 1]

| Test Ex. No. | First undercoat film | | Second undercoat film | | Non-magnetic intermediate film | | Perpendicular magnetization film | | Static magnetic characteristic | | Electro-magnetic conversion characteristic SNR (dB) | Co (0002) intensity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Composition | Thickness (Å) | Composition | Thickness (Å) | Composition | Thickness (Å) | Composition | Thickness (Å) | Hc (Oe) | Mr/Ms | | |
| 1 | Ni50Al | 500 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4900 | 0.90 | 10.50 | 500 |
| 2 | - | - | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 3200 | 0.68 | 7.20 | 3200 |
| 3 | Fe50Al | 500 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4300 | 0.82 | 9.20 | 350 |
| 4 | Ni50Ti | 500 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4500 | 0.84 | 9.40 | 300 |
| 5 | Al50Mn | 500 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4000 | 0.80 | 9.10 | 600 |
| 6 | Ni50Al | 20 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 3900 | 0.78 | 8.80 | 7200 |
| 7 | Ni50Al | 100 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4200 | 0.82 | 10.10 | 1300 |
| 8 | Ni50Al | 800 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 5100 | 0.88 | 9.80 | 200 |
| 9 | Ni50Al | 1500 | Ru | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 5000 | 0.90 | 9.80 | 100 |
| 10 | Ni50Al | 500 | Ru40Co | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 5000 | 0.90 | 10.30 | 650 |
| 11 | Ni50Al | 500 | Zr | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4600 | 0.82 | 9.80 | 480 |
| 12 | Ni50Al | 500 | Ti | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4900 | 0.84 | 9.60 | 650 |
| 13 | Ni50Al | 500 | Re | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4500 | 0.86 | 10.20 | 700 |
| 14 | Ni50Al | 500 | Ga | 100 | Co40Cr | 100 | Co22Cr12Pt2Ta | 500 | 4200 | 0.80 | 10.50 | 400 |
| 15 | Ni50Al | 500 | Ru | 100 | Co40Cr | 500 | Co22Cr12Pt2Ta | 500 | 4800 | 0.78 | 10.10 | 800 |
| 16 | Ni50Al | 500 | Ru | 100 | Co35Cr5Pt | 1000 | Co22Cr12Pt2Ta | 500 | 4600 | 0.82 | 9.20 | 900 |
| 17 | Ni50Al | 500 | Ru | 100 | Co35Cr5Pt | 100 | Co22Cr12Pt2Ta | 80 | 2000 | 0.58 | 4.60 | - |
| 18 | Ni50Al | 500 | Ru | 100 | Co35Cr5Pt | 100 | Co22Cr12Pt2Ta | 1000 | 5200 | 0.86 | 9.10 | 1500 |
| 19 | Ni50Al | 500 | Ru | 100 | Co35Cr5Pt | 100 | Co22Cr12Pt2Ta | 1500 | 5000 | 0.84 | 7.10 | 2000 |
| 20 | Ni50Al | 500 | Ru | 100 | Co35Cr5Pt | 100 | Co20Cr10Pt | 500 | 4400 | 0.90 | 9.30 | 800 |
| 21 | Ni50Al | 500 | Ru | 100 | Co35Cr5Pt | 100 | Co20Cr8Pt4B | 500 | 4200 | 0.82 | 9.40 | 700 |
| 22 | NiAlW | 500 | Ru | 100 | Co35Cr5Pt2Ta | 100 | Co21Cr10Pt2Ta2Cu | 500 | 5300 | 0.86 | 9.60 | 600 |
| 23 | Ni50Al | 500 | Ru | 100 | Co35Cr5Pt2Ta | 100 | Co21Cr12Pt2Zr | 500 | 4000 | 0.82 | 9.50 | 800 |
| 24 | Ni50Al | 500 | Ru | 100 | - | - | Co22Cr12Pt4B | 500 | 4000 | 0.80 | 10.50 | 300 |

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As is apparent from Table 1, the magnetic recording media comprising the first undercoat film 2 have excellent noise characteristics (SNR) and coercive force (Hc), as compared with a magnetic recording medium which does not comprise the film 2 (Test Example 2).

What is claimed:

1. A magnetic recording medium comprising a substrate, a first undercoat film and a second undercoat film formed thereon, and a perpendicular magnetization film formed on the second undercoat film, wherein easy magnetization axes in the perpendicular magnetization film are oriented primarily perpendicularly with respect to the substrate, and the first undercoat film contains a material of B2 structure.

2. A magnetic recording medium according to claim 1, wherein the first undercoat film contains a material predominantly comprising one or more alloys selected from among NiAl, FeAl, CoFe, CoZr, NiTi, AlCo, and AlMn.

3. A magnetic recording medium according to claim 1 or 2, wherein the second undercoat film contains a material of hcp structure.

4. A magnetic recording medium according to any one of claims 1 through 3, wherein the second undercoat film contains a material predominantly comprising one or more elements selected from among Ti, Zr, Ru, Re, Y, Gd, and Tb.

5. A magnetic recording medium according to any one of claims 1 through 4, wherein the perpendicular magnetization film comprises any alloy selected from among Co/Cr/Pt, Co/Cr/Ta, and Co/Cr/Pt/X (X: one or more species selected from among Ta, Zr, Nb, Cu, Re, Ni, and B).

6. A magnetic recording medium according to any one of claims 1 through 5, wherein a non-magnetic intermediate film of hcp structure is provided between the second undercoat

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film and the perpendicular magnetization film.

7. A magnetic recording medium according to any one of claims 1 through 6, wherein a thickness of the first undercoat film is 500 Å or less.

8. A magnetic recording medium according to any one of claims 1 through 7, wherein a thickness of the perpendicular magnetization film is 100-1000 Å.

9. A magnetic recording and reproducing device comprising a magnetic recording medium, and a magnetic head for recording and reproducing information, wherein said magnetic recording medium comprises a substrate, a first undercoat film and a second undercoat film formed thereon, and a perpendicular magnetization film formed on the second undercoat film, wherein easy magnetization axes in the perpendicular magnetization film are oriented primarily perpendicularly with respect to the substrate, and the first undercoat film contains a material of B2 structure.