

SOFT MAGNETIC ALLOY FOR MAGNETIC RECORDING PURPOSES, SPUTTERING
TARGET MATERIAL, AND MAGNETIC RECORDING MEDIUM

TECHNICAL FIELD

5 [0001]

The present invention relates to amorphous alloys for thin soft magnetic layers of magnetic recording media, sputtering target materials, and magnetic recording media.

BACKGROUND ART

10 [0002]

Recent advances in perpendicular magnetic recording are remarkable, and efforts to provide drives with higher capacities have been directed to the development of high-density magnetic recording media. Under such circumstances, perpendicular magnetic recording has been put to practical use, which provides higher recording densities than conventional in-plane magnetic recording media. Perpendicular magnetic recording, which is suitable for high recording density, uses a perpendicular magnetic recording medium including a magnetic film having an easy magnetization axis oriented perpendicular to the surface of the medium.

[0003]

20 Recently, thin soft magnetic films composed of alloy compositions with a relatively low magnetic property (Bs) of about 10 kG have increasingly been used. For example, JP2011-181140A (PTL 1) discloses a Fe-Co alloy soft magnetic film for magnetic recording media with high amorphousness and high crystallization temperature. This soft magnetic film is composed of a Fe-Co alloy containing Nb and/or Ta and B, which are selected as optimum elements for increasing the amorphousness and the crystallization temperature.

[0004]

JP2011-86356A (PTL 2) discloses a perpendicular magnetic recording medium and a

magnetic recording and playback apparatus including such a perpendicular magnetic recording medium. This perpendicular magnetic recording medium makes it possible to exert a high overwrite (OW) characteristics by enhancing the saturation magnetic flux density (Ms) and suppressing nucleation in an interlayer

5 [0005]

JP2008-299905A (PTL 3) discloses an alloy for soft magnetic layers of perpendicular magnetic recording media with high saturation magnetic flux density, amorphousness, and atmospheric corrosion resistance. This alloy composition, however, is a Fe-Co alloy containing Al and Cr in addition to Zr, Hf, Nb, and Ta, but not a Fe-Co alloy containing Mo and W as the major components.

[0006]

JP2011-208265A (PTL 4) and JP2011-214039A (PTL 5) each discloses a method for manufacturing a sputtering target with high pass-through flux (PTF) used for the manufacture of magnetic recording media and magneto-optical (MO) recording media.

15 According to these methods, a powder feedstock containing a major proportion of Fe, Co, and/or Ni and an element other than these elements is hot-formed and then cooled to produce a target. In addition, the formed body is machined and then annealed to produce a target with a reduced permeability. The compositions according to these methods have significantly high Bs because of low Mo and W contents and thus differ from that according to the present invention, which has a low Bs of 10 kG or less.

[0007]

JP2012-48767A (PTL 6) discloses a Co-(Zr,Hf)-B alloy for soft magnetic layer films of perpendicular magnetic recording media, a sputtering target material, and a magnetic recording medium. This patent, however, is directed to a composition having a high total content of Zr and Hf of 5 at.% or more.

[0008]

JP2012-108997A (PTL 7) discloses a Co-(Ti,Zr,Hf) alloy for soft magnetic layer films of perpendicular magnetic recording media, a sputtering target material, and a magnetic

recording medium. This alloy composition, however, as in PTL 6, is directed to a composition having a high total content of Ti, Zr, and Hf of 5 at.% or more.

CITATION LIST

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PATENT LITERATURE

[0009]

PTL 1: JP2011-181140A

PTL 2: JP2011-86356A

PTL 3: JP2008-299905A

10 PTL 4: JP2011-208265A

PTL 5: JP2011-214039A

PTL 6: JP2012-48767A

PTL 7: JP2012-108997A

SUMMARY OF INVENTION

15 [0010]

In the meantime, a sputtering target containing Ta and Nb in large amounts exceeding 10% and a sputtering target containing elements such as Ti, Zr, and Hf in large amounts exceeding 5% may crack during use, that is, during sputtering. Although the reason for this phenomenon is not fully understood, the cracking of a sputtering target is attributed to its severe thermal environments: the surface of the sputtering target being sputtered is presumably heated to several hundreds to more than 1,000°C while the opposite surface in contact with a cooling plate of the sputtering system is maintained at room temperature, which causes a large thermal gradient across the thickness of the sputtering target; and the sputtering is repeatedly switched on and off every several seconds. The characteristics of a sputtering target not cracking in such thermal environments are hereinafter referred to as "thermal shock resistance".

25

[0011]

The inventors, who have conducted intensive research to overcome the foregoing

problem, have discovered that MoW dissolves in the FeCo solid, with formation of a reduced amount of intermetallic compound, and that MoW dissolves in the FeCo solid solution to bring its thermal expansion coefficient closer to that of the intermetallic compound, thus improving the thermal shock resistance. This discovery has led to the present invention.

[0012]

Accordingly, it is an object of the present invention to provide a soft magnetic alloy with high thermal shock resistance and a sputtering target material comprising the alloy.

[0013]

10 According to an aspect of the present invention, there is provided a soft magnetic alloy, for magnetic recording, having an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$ of 0 to 70 and comprising, in at. %:

(A) at least one element selected from the group consisting of Mo and W in an amount of 10% to 30%;

15 (B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount of 0% to 5%;

(C) at least one element selected from the group consisting of V, Nb, and Ta in an amount of 0% to 0.5%;

(D) at least one element selected from the group consisting of Ni and Mn in an amount of 20 0% to 30%;

(E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount of 0% to 10%; and

(F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 0% to 10%,

25 the balance being Co and incidental impurities.

[0014]

According to another aspect of the present invention, there is provided a sputtering target material comprising the soft magnetic alloy of the present invention for magnetic recording.

[0015]

According to still another aspect of the present invention, there is provided a magnetic recording medium comprising the soft magnetic alloy of the present invention for magnetic recording.

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DESCRIPTION OF EMBODIMENTS

[0016]

A soft magnetic alloy of the present invention for magnetic recording will now be described in detail. The symbol "% (percent)" indicating the content of each constituent refers to at.% (atomic percent) unless otherwise specified.

10 [0017]

A soft magnetic alloy of the present invention for magnetic recording has an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$ of 0 to 70 and comprises, in at.%, (A) at least one element selected from the group consisting of Mo and W in an amount of 10% to 30%; (B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount of 0% to 5%; (C) at least one element selected from the group consisting of V, Nb, and Ta in an amount of 0% to 0.5%; (D) at least one element selected from the group consisting of Ni and Mn in an amount of 0% to 30%; (E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount of 0% to 10%; and (F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 0% to 10%, the balance being Co and incidental impurities. Typically, the soft magnetic alloy of the present invention consists essentially of, or consists of, these elements.

20

[0018]

The soft magnetic alloy of the present invention has an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$ of 0 to 70. Fe and/or Co is compounded to provide a soft magnetic material. The maximum atomic ratio, however, is limited to 70 because an atomic ratio of more than 70 would result in low corrosion resistance.

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[0019]

The soft magnetic alloy of the present invention contains (A) at least one element selected

from the group consisting of Mo and W in an amount of 10% to 30%. These group (A) elements, which are compounded to form an amorphous Co alloy, are present in an amount of 10% to 30% because a total content of the group (A) elements of less than 10% would result in excess magnetic property, whereas a total content of the group (A) elements of more than 30% would result in non-magnetic property.

[0020]

The soft magnetic alloy of the present invention may optionally contain (B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount of less than 5%, preferably 1% or more and less than 5%. These group (B) elements are compounded to enhance the thermal shock resistance. The maximum content of the group (B) elements, however, is limited to less than 5% because a content of the group (B) elements of not less than 5% would decrease the thermal shock resistance.

[0021]

The soft magnetic alloy of the present invention may optionally contain (C) at least one element selected from the group consisting of V, Nb, and Ta in an amount of less than 0.5%, preferably 0.1% or more and less than 0.5%. These group (C) elements are compounded to enhance the thermal shock resistance, like the group (B) elements. The maximum content of the group (C) elements, however, is limited to less than 0.5% because a content of the group (C) elements of not less than 0.5% would decrease the thermal shock resistance.

[0022]

The soft magnetic alloy of the present invention may optionally contain (D) at least one element selected from the group consisting of Ni and Mn in an amount of 30% or less, preferably 5% to 30%. These group (D) elements are compounded to adjust the saturation magnetic flux density of the Co alloy. The maximum total content of the group (D) elements is limited to 30% because a total content of the group (D) elements of more than 30% would decrease the magnetic property.

[0023]

The soft magnetic alloy of the present invention may optionally contain (E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount of 10% or less, preferably 1% to 10%. These group (E) elements are compounded to enhance the corrosion resistance of the Co alloy. The maximum total content of the group (E) elements, however, is limited to 10% because a total content of the group (E) elements of more than 10% would decrease the thermal shock resistance.

[0024]

The soft magnetic alloy of the present invention may optionally contain (F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 10% or less, preferably 1% to 10%. These group (F) elements are compounded to enhance the amorphousness. The maximum total content of the group (F) elements, however, is limited to 10% because a total content of the group (F) elements of more than 10% would decrease the thermal shock resistance.

[0025]

A sputtering target material can be made of the soft magnetic alloy for magnetic recording. The soft magnetic alloy for magnetic recording can also be used to provide a magnetic recording medium. The resulting sputtering target material with high thermal shock resistance can be used to manufacture a desirable magnetic recording medium.

Examples

[0026]

The alloy according to the present invention will now be described in more detail with reference to the following examples. A thin film of a perpendicular magnetic recording medium is typically formed by sputtering a sputtering target material having the same composition as the thin film onto a glass substrate or any other substrate. The sputtered thin film is quenched. In the present invention, quenched ribbons formed with a single-roller liquid-quenching apparatus were used as samples in the examples and comparative examples. These quenched ribbons from liquid are used to evaluate the influence of the compositions of actually sputtered and quenched thin films on their properties in a simple

manner.

[0027]

Manufacturing Conditions of Quenched Ribbon

A water-cooled copper mold having an inner diameter of 10 mm and a depth of about 40
 5 mm was charged with 30 g of each feedstock prepared according to the compositions
 shown in Tables 1 to 3. The feedstock was arc-melted and then solidified in an Ar
 atmosphere at reduced pressure to prepare a melting base material for a quenched ribbon.
 A quenched ribbon was formed with a single-roller system by setting the melting base
 material in a quartz pipe with an inner diameter of 15 mm and then melting and tapping
 10 the melting base material through a tapping nozzle with an inner diameter of 1 mm at an
 atmospheric pressure of 61 kPa, a spraying pressure difference of 69 kPa, a rotational
 speed of a copper roller (diameter: 300 mm) of 3,000 rpm, and a gap between the copper
 roller and the tapping nozzle of 0.3 mm. The tapping temperature was the temperature
 of each melting base material immediately after burning-through. The resulting
 15 quenched ribbons were used as samples for evaluation of the following items.

[0028]

Evaluation of Saturation Magnetic Flux Density of Quenched Ribbon

Samples weighing about 15 mg cut from the quenched ribbons were evaluated for
 saturation magnetic flux density (B_s) with a vibrating sample magnetometer (VSM) at an
 20 applied magnetic field of 1,200 kA/m.

[0029]

Structure of Quenched Ribbon

The X-ray diffraction pattern of an amorphous material generally includes no distinct
 diffraction peak but a halo pattern inherent in amorphous material. Although an
 25 incompletely amorphous material shows a diffraction pattern in addition to a halo pattern,
 the diffraction pattern has a lower peak height than that of a crystalline material.
 Accordingly, the amorphousness of the quenched ribbons was evaluated by the following
 procedure.

[0030]

Evaluation of Amorphousness

For the evaluation of the amorphousness, each sample was fixed to a glass plate with a double-sided tape and was analyzed with an X-ray diffractometer to acquire a diffraction pattern. The sample was fixed such that the surface of the quenched ribbon that was in contact with the copper roller was subjected to the measurement. The measurement was performed using the Cu- α line as the X-ray source at a scanning rate of 4°/min. In the evaluation of the amorphousness, a sample that showed a diffraction pattern containing a visible halo pattern was evaluated as having high amorphousness, whereas a sample that showed a diffraction pattern containing no visible halo pattern was evaluated as having low amorphousness.

[0031]

Evaluation of Corrosion Resistance (NaCl) of Quenched Ribbon

A sample of a quenched ribbon fixed to a glass pellet with a double-sided tape was subjected to a salt spray test (by spraying with 5% aqueous NaCl solution at 35°C for 16 hours). An unrusted sample was evaluated as having high corrosion resistance, whereas a rusted sample was evaluated as having low corrosion resistance.

[0032]

The thermal shock resistance was evaluated by preparing a target and checking whether the target is cracked by being water-cooled from a predetermined temperature.

Method for Fabricating Target

Soft magnetic alloy powders having the compositions shown in Tables 1 to 3 were prepared by gas atomization. The resulting powders were classified into 500 μm or less for use as powder feedstocks for consolidation by hot isostatic pressing (HIP). Billets for HIP were prepared by placing the powder feedstocks into carbon steel cans with a diameter of 250 mm and a length of 50 mm, capping the cans, degassing the cans in a vacuum, and sealing the vent. The billet filled with the powder were heated to 1,150°C, were placed into restraining containers with an inner diameter of 230 mm, and were

consolidated at a pressure of 500 MPa. The resultant consolidated bodies were then cut by wire cutting. The diameter and the thickness were adjusted with a lathe machine, and the thickness and the surface roughness were adjusted by surface polishing to give disk-shaped sputtering target materials with a diameter of 180 mm and a thickness of 7 mm.

5 [0033]

Evaluation of Thermal Shock Resistance

After the resulting targets were maintained at predetermined temperatures varying in an increment of 50°C within the range of 300°C to 700°C for 1 hour, they were quenched in water and were inspected for cracks. The temperature at which cracks were found was
10 defined as the cracking temperature. A target having a cracking temperature of 450°C or higher was evaluated as having high thermal shock resistance.

[0034]

[Table 1]

No.	Composition (at.%)																			Fe-Co ratio (Co+Fe)	Bs (kG)	Amorphousness	Corrosion resistance	Cracking temperature (°C)	Notes
	Mo	W	Ti	Zr	Hf	V	Nb	Ta	Ni	Mn	Cr	Al	Cu	Si	Ge	P	B	C	Fe						
1	10																		63	27	70	10	High	500	Inventive example
2	12																		61.6	26.4	70	9	High	500	
3	15	15																	49	21	70	4	High	500	
4	18																		57.4	24.6	70	7	High	500	
5	20																		56	24	70	6	High	500	
6	25																		52.5	22.5	70	5	High	500	
7	30																		49	21	70	4	High	500	
8		10																	63	27	70	10	High	500	
9		12																	61.6	26.4	70	9	High	500	
10		15																	59.5	25.5	70	8	High	500	
11		18																	57.4	24.6	70	7	High	500	
12		20																	56	24	70	6	High	500	
13		25																	52.5	22.5	70	5	High	500	
14		30																	49	21	70	4	High	500	
15	10																		27	63	30	10	High	550	
16	12																		26.4	61.6	30	9	High	500	
17	15	15																	21	49	30	4	High	500	

[[Table 1 (continued)]]

No.	Composition (at.%)																				Bs (kG)	Amor- phous- ness	Corrosion resis- tance	Cracking tem- perature (°C)	Notes	
	Mo	W	Ti	Zr	Hf	V	Nb	Ta	Ni	Mn	Cr	Al	Cu	Si	Ge	P	B	C	Fe	Co						Fe-Co ratio 100Fe/ (Co+Fe)
18	18																		24.6	57.4	30	7	High	High	500	Inventive example
19	20																		24	56	30	6	High	High	500	
20	25																		22.5	52.5	30	5	High	High	500	
21	30																		21	49	30	4	High	High	500	
22		10																	27	63	30	10	High	High	550	
23		12																	26.4	61.6	30	9	High	High	500	
24		15																	25.5	59.5	30	8	High	High	500	
25		18																	24.6	57.4	30	7	High	High	500	
26		20																	24	56	30	6	High	High	500	
27		25																	22.5	52.5	30	5	High	High	500	
28		30																	21	49	30	4	High	High	450	
29	10																		0	90	0	8	High	High	550	
30	12																		0	88	0	7	High	High	500	
31	10	10																	0	80	0	4	High	High	500	
32	18																		0	82	0	5	High	High	500	
33	20																		0	80	0	4	High	High	500	
34		10																	0	90	0	8	High	High	550	

[0035]

[Table 2]

No.	Composition (at.%)																				Fe-Co ratio 100Fe/ (Co+Fe)	Bs (kG)	Amor- phous -ness	Corrosion resis- tance	Cracking tem- perature (°C)	Notes
	Mo	W	Ti	Zr	Hf	V	Nb	Ta	Ni	Mn	Cr	Al	Cu	Si	Ge	P	B	C	Fe	Co						
35		12																	0	88	0	7	High	High	500	Inventive example
36		15																	0	85	0	6	High	High	500	
37		18																	0	82	0	5	High	High	500	
38		20																	0	80	0	4	High	High	450	
39	10				4.9														59.6	25.5	70	7	High	High	550	
40	12			4.5															25.1	58.5	30	6	High	High	550	
41	15		1	3															0	81	0	4	High	High	600	
42	15	15	1	1	1														46.9	20.1	70	3	High	High	550	
43	7	5	4.9																24.9	58.2	30	4	High	High	550	
44		25		1	3														0	71	0	3	High	High	600	
45		30	3	1															46.2	19.8	70	3	High	High	550	
46	10					0.4													26.9	62.7	30	10	High	High	450	
47	12						0.4												0	87.6	0	9	High	High	450	
48	15			4			0.4												0	80.6	0	8	High	High	450	
49	14	14				0.1	0.1	0.2											50.1	21.5	70	4	High	High	450	
50	10	10	1			0.2		0.2											0	78.6	0	4	High	High	450	
51		25			4			0.4											21.2	49.4	30	4	High	High	450	

[Table 2 (continued)]

No.	Composition (at.%)																				Fe-Co ratio (Co+Fe)	Bs (kG)	Amorphousness	Corrosion resistance	Cracking temperature (°C)	Notes
	Mo	W	Ti	Zr	Hf	V	Nb	Ta	Ni	Mn	Cr	Al	Cu	Si	Ge	P	B	C	Fe	Co						
52		30					0.4	0.2											20.8	48.6	30	3	High	High	450	Inventive example
53	12			1					2										59.5	25.5	70	8	High	High	500	
54	15									30									0	55	0	6	High	High	500	
55		18	4				0.4	30											0	47.6	0	4	High	High	500	
56	10	10							5	5									21	49	30	4	High	High	500	
57		10									10								0	80	0	8	High	High	550	
58		30											10						18	42	30	7	High	High	550	
59		15		4		0.4				2	5	5							48	20.6	70	6	High	High	550	
60	10											10							0	80	0	5	High	High	550	
61	25		1				0.4					1	5						40.6	27	60	5	High	High	550	
62	5	20									5		5						0	65	0	4	High	High	550	
63	10	10							5		2	2	2						20.7	48.3	30	4	High	High	550	
64	20	10			1						1								47.6	20.4	70	3	High	High	500	
65	5	5		1												10			0	79	0	5	High	High	500	
66	12			4			0.4		30		4	1						10	12.8	29.8	30	6	High	High	500	
67		30				0.1					1						1	1	46.8	20.1	70	8	High	High	500	

[0036]

[Table 3]

No.	Composition (at.%)																				Fe-Co ratio (Co+Fe)	Bs (kg)	Amorphousness	Corrosion resistance	Cracking temperature (°C)	Notes
	Mo	W	Ti	Zr	Hf	V	Nb	Ta	Ni	Mn	Cr	Al	Cu	Si	Ge	P	B	C	Fe	Co						
68	15												2	10					51.1	21.9	70	4	High	450	Inventive example	
69	18		4				0.4										10		0	67.6	0	4	High	500		
70	5	10								30				1	1	1	1	1	0	50	0	6	High	550		
71	20	5			4												1		49	21	70	5	High	550		
72		10				0.4			2		5				10				50.8	21.8	70	3	High	550		
73		25		4											1	1			0	69	0	5	High	500		
74		30												1	1				20.4	47.6	30	5	High	500		
75	5	5																76	18	80	10	High	500	Comp. example		
76	5	5																81	9	90	10	High	500			
77	9																	63.7	27.3	70	12	High	550			
78	15	16																48.3	20.7	70	4	High	400			
79	31																	20.7	48.3	30	4	High	400			
80		31																0	69	0	4	High	400			
81	10		5															59.5	25.5	70	6	High	400			
82		30		5														19.5	45.5	30	6	High	400			
83	10	10			5													0	75	0	6	High	400			

[Table 3 (continued)]

No.	Composition (at.%)																				Fe-Co ratio 100Fe/(Co+Fe)	Bs (kG)	Amorphous-ness	Corrosion resistance	Cracking temperature (°C)	Notes
	Mo	W	Ti	Zr	Hf	V	Nb	Ta	Ni	Mn	Cr	Al	Cu	Si	Ge	P	B	C	Fe	Co						
84		10					<u>1</u>												0	89	0	9	High	400	Comp. example	
85	20	10		4				<u>1</u>										19.5	45.5	30	9	High	400			
86		10	1			<u>1</u>												26.4	61.6	30	9	High	400			
87	10						<u>5</u>	<u>5</u>										56	24	70	6	High	300			
88		12						0.2		<u>31</u>								17	39.8	30	Non-magnetic	High	500			
89	30				4				<u>31</u>									24.5	10.5	70		High	500			
90	30			4							<u>11</u>							16.5	38.5	30	5	High	400			
91	10					0.1				2		<u>11</u>						0	76.9	0	6	High	350			
92		30											<u>11</u>					17.7	41.3	30	6	High	400			
93		10	4				0.4					<u>5</u>	<u>6</u>					52.2	22.4	70	5	High	400			
94	15	15									<u>5</u>	<u>6</u>						41.3	17.7	70	6	High	400			
95	5	5							30		<u>5</u>		<u>6</u>					0	49	0	6	High	400			
96		10			1			0.4	2					<u>11</u>				52.9	22.7	70	3	High	400			
97		30									2				<u>11</u>			39.9	17.1	70	3	High	400			
98	30			1												<u>11</u>		0	58	0	6	High	400			
99	20	10					0.1			30	8						<u>11</u>	0	20.9	0	6	High	340			
100	10		4										2					<u>11</u>	0	73	0	5	High	400		

In Tables 1 to 3, Nos. 1 to 74 are inventive examples, and Nos. 75 to 100 are comparative examples.

[0037]

- 5 In Comparative Example Nos. 75 and 76 shown in Table 3, which have a high Fe content, the corrosion resistance is low. In Comparative Example No. 77, which has a low content of the group (A) element, i.e., Mo, the Bs is high. In Comparative Example Nos. 78, 79, and 80, which have a high content of the group (A) elements, i.e., Mo and W, the cracking temperature is low. In Comparative Example Nos. 81, 82, and 83, which have a high
- 10 content of the group (B) elements, i.e., Ti, Zr, and Hf, the cracking temperature is low, like Comparative Example Nos. 78, 79, and 80. In Comparative Example Nos. 84, 85, and 86, which have a high content of the group (C) elements, i.e., V, Nb, and Ta, the cracking temperature is low, like Comparative Example Nos. 78 to 83.

[0038]

- 15 In Comparative Example No. 87, which has a high total content of the group (C) elements, i.e., Nb and Ta, the cracking temperature is low. Comparative Example Nos. 88 and 89, which have a high content of the group (D) elements, i.e., Ni and Mn, result in non-magnetic property. In Comparative Example Nos. 90, 91, and 92, which have a high content of the group (E) elements, i.e., Cr, Al, and Cu, the cracking temperature is low. In
- 20 Comparative Example Nos. 93, 94, and 95, which have a high total content of the group (E) elements, i.e., Cr, Al, and Cu, the cracking temperature is low, like Comparative Example Nos. 90, 91, and 92. In Comparative Example Nos. 96 to 100, which have a high content of any of the group (F) elements, i.e., Si, Ge, P, B, and C, the cracking temperature is low, like Comparative Example Nos. 90 to 95.

25 [0039]

In contrast, the inventive examples, i.e., Nos. 1 to 74, all of which satisfy the conditions according to the present invention, provide an alloy with high thermal shock resistance that has a relatively low saturation magnetic flux density (Bs) of 10 kG or less, and also

has high amorphousness, high corrosion resistance, and high cracking temperature, which is the most distinctive feature of the present invention.

[0040]

As described above, the present invention has the great advantage of providing a soft
5 magnetic alloy for magnetic recording with sufficient saturation magnetic flux density, amorphousness, and corrosion resistance and high thermal shock resistance and also providing a sputtering target material and a magnetic recording medium comprising such a soft magnetic alloy.

CLAIMS

1. A soft magnetic alloy for magnetic recording having an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$ of 0 to 70, comprising, in at.%.
 - 5 (A) at least one element selected from the group consisting of Mo and W in an amount of 10% to 30%;
 - (B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount of less than 5%;
 - (C) at least one element selected from the group consisting of V, Nb, and Ta in an amount
10 of 0% to 0.5%;
 - (D) at least one element selected from the group consisting of Ni and Mn in an amount of 0% to 30%;
 - (E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount of 0% to 10%; and
 - 15 (F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 0% to 10%,
the balance being Co and incidental impurities, .
2. A soft magnetic alloy for magnetic recording having an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$
20 of 0 to 70, comprising, in at.%.
 - (A) at least one element selected from the group consisting of Mo and W in an amount of 10% to 30%;
 - (B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount of 0% to 5%;
 - 25 (C) at least one element selected from the group consisting of V, Nb, and Ta in an amount of less than 0.5%;
 - (D) at least one element selected from the group consisting of Ni and Mn in an amount of 0% to 30%;
 - (E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount

of 0% to 10%; and

(F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 0% to 10%,

the balance being Co and incidental impurities.

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3. A soft magnetic alloy for magnetic recording having an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$ of 0 to 70, comprising, in at. %:

(A) at least one element selected from the group consisting of Mo and W in an amount of 10% to 30%;

10 (B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount of 0% to 5%;

(C) at least one element selected from the group consisting of V, Nb, and Ta in an amount of 0% to 0.5%;

15 (D) at least one element selected from the group consisting of Ni and Mn in an amount of 30% or less;

(E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount of 0% to 10%; and

(F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 0% to 10%,

20 the balance being Co and incidental impurities.

4. A soft magnetic alloy for magnetic recording having an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$ of 0 to 70, comprising, in at. %:

25 (A) at least one element selected from the group consisting of Mo and W in an amount of 10% to 30%;

(B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount of 0% to 5%;

(C) at least one element selected from the group consisting of V, Nb, and Ta in an amount

of 0% to 0.5%;

(D) at least one element selected from the group consisting of Ni and Mn in an amount of 0% to 30%;

(E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount

5 of 10% or less; and

(F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 0% to 10%,

the balance being Co and incidental impurities.

10 5. A soft magnetic alloy for magnetic recording having an atomic ratio $100\text{Fe}/(\text{Fe}+\text{Co})$ of 0 to 70, comprising, in at. %:

(A) at least one element selected from the group consisting of Mo and W in an amount of 10% to 30%;

(B) at least one element selected from the group consisting of Ti, Zr, and Hf in an amount
15 of 0% to 5%;

(C) at least one element selected from the group consisting of V, Nb, and Ta in an amount of 0% to 0.5%;

(D) at least one element selected from the group consisting of Ni and Mn in an amount of 0% to 30%;

20 (E) at least one element selected from the group consisting of Cr, Al, and Cu in an amount of 0% to 10%; and

(F) at least one element selected from the group consisting of Si, Ge, P, B, and C in an amount of 10% or less,

the balance being Co and incidental impurities.

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6. A sputtering target material comprising the soft magnetic alloy for magnetic recording according to Claim 1.

7. A sputtering target material comprising the soft magnetic alloy for magnetic recording according to Claim 2.

8. A sputtering target material comprising the soft magnetic alloy for magnetic recording according to Claim 3.

9. A sputtering target material comprising the soft magnetic alloy for magnetic recording according to Claim 4.

10. A sputtering target material comprising the soft magnetic alloy for magnetic recording according to Claim 5.

11. A magnetic recording medium comprising the soft magnetic alloy for magnetic recording according to Claim 1.

12. A magnetic recording medium comprising the soft magnetic alloy for magnetic recording according to Claim 2.

13. A magnetic recording medium comprising the soft magnetic alloy for magnetic recording according to Claim 3.

14. A magnetic recording medium comprising the soft magnetic alloy for magnetic recording according to Claim 4.

15. A magnetic recording medium comprising the soft magnetic alloy for magnetic recording according to Claim 5.