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METAL PLATE MATERIAL AND ELECTRONIC MACHINERY
/ AND TOOLS OR ITS PARTS USING THE METAL PLATE MATERIAL

FIELD OF THE INVENTION

5 The present invention relates to a metal plate material, for example, for a case of a hard disk drive (HDD) apparatus, and to parts of electronic machinery and tools or apparatuses utilizing the metal plate material.

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BACKGROUND OF THE INVENTION

A hard disk drive (HDD) is used as a storage medium of a computer, a word processor, and the like, and as a case member of the hard disk drive, aluminum diecast materials are conventionally used.

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However, aluminum diecast materials have the disadvantage of their heavy weight, making devices made from them difficult to carry with. Further, since, for treatment of corrosion-prevention and for coloring treatment, the members made of an aluminum diecast material are to be coated or subjected to Alumite (Alumirite) treatment one by one, the productivity and cost are not advantageous.

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Therefore, there was proposed an aluminum alloy plate improved in formability and/or workability

(hereinbelow, abbreviated to formability, in some cases),
by forming a chromate film on an aluminum alloy plate and
then by forming an organic resin film containing a
lubricant on the chromate film (JP-A-6-55137 ("JP-A" means
5 unexamined published Japanese patent application)).

However, since the aluminum alloy plate has the
organic resin film coated on both surfaces of it, when it
is used for parts of electronic machinery and tools and
the like, the organic resin film releases a certain amount
10 of gases, to cause the problem that the parts fail to
function properly or do not work.

Further, there was proposed another aluminum
plate for a floppy disk drive case that was light in
weight and excellent in strength, formability, and
15 electromagnetic shielding properties, which was made by
forming an organic resin film on one surface of an
aluminum alloy plate (JP-B-6-70870 ("JP-B" means examined
Japanese patent publication)). However, it is accompanied
by the problem that the alloy plate ruptures (fractures)
20 during deep drawing processing to form it into a hard disk
case.

SUMMARY OF THE INVENTION

An object of the present invention is to provide

a metal plate material for electronic machinery and tools, which is excellent in formability and does not release gases, which hamper the function of parts or apparatuses of the electronic machinery and tools, during the use of the electronic machinery and tools, and to provide parts or apparatuses for electronic machinery and tools wherein the above metal plate material is used.

Other and further objects, features, and advantages of the invention will appear more fully from the following description.

DETAILED DESCRIPTION OF THE INVENTION

Taking the above into consideration, the inventors of the present invention, having intensively investigated to improve the formability of metal plate materials.

The foregoing object of the present invention has been attained by the following means:

(1) A metal plate material for electronic machinery and tools, comprising a metal blank that has a tensile strength (pulling strength) of 75 MPa or more, a proof stress (load-bearing capacity) of 25 MPa or more, and an elongation of 10% or more, one surface of which is covered with an organic resin film having a friction coefficient of 0.3 or less, a surface roughness Ra of 1.0

to 30 μm , and a thickness of 6 μm or more.

(2) The metal plate material for electronic machinery and tools as stated in the above (1), wherein an undercoat is formed on the metal blank, and the said
5 organic resin film is formed on the said undercoat.

(3) The metal plate material for electronic machinery and tools as stated in the above (1) or (2), wherein the said organic resin film contains a lubricant, and the said lubricant comprises one or more of waxes,
10 fluororesins, and inorganic lubricants.

(4) The metal plate material for electronic machinery and tools as stated in the above (1), (2), or (3), wherein the said organic resin film contains an aggregate whose particle diameter value is greater than
15 the value of the thickness of the organic resin film.

(5) The metal plate material for electronic machinery and tools as stated in the above (4), wherein the said aggregate comprises at least one of polyamide(nylon, trade name)-series aggregates or acrylic
20 aggregates. Herein, the term "aggregate" means a finely divided powder of resins contained in the said organic resin film.

(6) The metal plate material for electronic machinery and tools as stated in the above (1), (2), (3),
25 (4), or (5), wherein the said organic resin film is

composed of at least one of acrylic resins, ester-series resins, ethylene-series resins, epoxy-series resins, phenol-series resins, fluororesins, or polyamide-series resins.

5 (7) A part of electronic machinery and tools, comprising a metal plate material as stated in any one of the above (1), (2), (3), (4), (5), and (6), the said metal plate material being formed with the surface having the said organic resin film placed outside.

10 (8) An apparatus of an electronic machinery and tools, comprising a metal plate material as stated in any one of the above (1), (2), (3), (4), (5), and (6), the said metal plate material being formed with the surface having the said organic resin film placed outside.

15 In the present invention, the metal plate material may be made of any metal material, such as steel, stainless steel, copper, and aluminum, and particularly aluminum alloys are suitable, because they have a desired strength, they can be readily colored, and they are
20 lightweight.

In the present invention, the reason the tensile strength is defined to be 75 MPa or more, and the proof stress is defined to be 25 MPa or more, is that if the tensile strength is less than 75 MPa, or if the proof
25 stress is less than 25 MPa, the metal plate material is

deformed when it is formed or is assembled into a hard disk case. Further, the reason the elongation is defined to be 10% or more is that, if the elongation is less than 10%, the metal plate material is ruptured when it is
5 formed to a hard disk case.

In the present invention, the organic resin film is formed only on one surface of the metal plate material, to prevent the harmful influence of gases otherwise released from the organic resin, by forming the metal
10 plate material with the surface on which the organic resin film is formed placed outside.

In the present invention, although the organic resin film may be formed directly on the metal plate material that has been degreased, preferably an undercoat
15 is formed on the metal plate material, and then the organic resin film is formed on the undercoat, because the corrosion resistance and the adhesion are improved. To form the undercoat, for example, chemical conversion treatment, Alumite treatment, and the plating method can
20 be employed.

In the above chemical conversion treatment, any treatment liquid, for example, of a reactive-type or coating-type chromate-series, zirconium-series, titanium-series, and phosphate-series, can be used. Among them,
25 the chemical conversion treatment wherein use is made of a treatment liquid of a chromate-series, a zirconium-series,

or a titanium-series is preferable in view, for example, of the productivity, the cost, and the performance stability (for example, the adhesion property).

The organic resin film may be made of acrylic
5 resins, ester resins, ethylene-series resins, epoxy-series resins, phenol-series resins, fluororesins, polyamide resins, and the like, or copolymers of these resins.

The organic resin film may be formed, for example, by a coating method as a coating, or by a method
10 wherein a film resin is bonded (laminated).

When the organic resin film is formed by the coating method, a good result can be obtained if suitable amounts of a surface-active agent, a leveling agent, a suspension stabilizer, an antistatic agent, and a
15 thickening agent are added.

In the present invention, by making the friction coefficient of the organic resin film to 0.3 or less, excellent formability can be secured.

To bring the friction coefficient to 0.3 or
20 less, for example, a method wherein an organic resin film itself having a low coefficient is used, or a method wherein an organic resin with a lubricant added thereto is used, may be employed.

As the above lubricant, for example, a petroleum
25 wax, such as a polyethylene wax and a polypropylene wax; a

natural wax, such as carnauba wax; a fluororesin compound, such as a polyethylene tetrafluoride (PTFE) and a polyvinylidene fluoride; an inorganic lubricant, such as graphite and molybdenum disulfide; or a mixture thereof
5 can be used.

If the amount of the lubricant that is contained in the organic resin film is less than 0.5% by weight, a satisfactory lubricating effect cannot be obtained, in some cases. The larger the amount of the lubricant is, the
10 lower the friction coefficient is. However, if the amount of the lubricant is over 30% by weight, the adhesion power between the organic resin film and the metal plate material is lowered, in some cases. Accordingly, the amount of the above lubricant is preferably 0.5 to 30% by
15 weight.

In the present invention, by adding a coloring pigment or a dye to the organic resin film, for example, the resulting metal plate material can have the property of design or a step of painting the resulting metal plate
20 material can be omitted. Further, by adding a silica compound or an alumina compound, the organic resin film can be strengthened and the formability can be improved. Since the addition of an excessive amount of those compounds may lower the film performance, it is required
25 to be careful in the amount for use.

In the present invention, the reason the surface

roughness Ra of the organic resin film is defined to be 1.0 to 30 μm , is that if the surface roughness Ra is less than 1.0 μm , recesses for keeping the lubricant are too shallow to keep the lubricant satisfactory, while if the surface roughness Ra is over 30 μm , the lubricant goes into the recesses and has difficulty coming out of the recesses to the surface, leaving parts near the tops of projections on the surface almost free from the lubricant. Thus both cases make the formability poor.

To control the surface roughness of the organic resin film to 1.0 to 30 μm , use can be made of any method, such as a method wherein an aggregate whose particle diameter value is greater than the value of the thickness of the organic resin film, is incorporated in the organic resin film, and a method of rolling by using a roll having a rough surface. As the aggregate, any aggregate can be used, such as an acrylic resin aggregate and a polyamide (nylon) aggregate.

The inclusion of the aggregate improves the formability and provides decoration. In passing, the surface roughness Ra of the resin film is most desirably 5 to 20 μm .

The high formability in the present invention is attained by the synergistic effect of the mechanical properties of the metal blank and the friction coefficient

and the surface roughness of the organic resin film.

In the present invention, the reason the thickness of the organic film is defined to be 6 μm or more is as follows. If the thickness is less than 6 μm ,
5 when the forming is carried out, the resin film cannot be spread uniformly and the resin film on projections is separated, to lower the formability. However, when the organic resin film is too thick, the internal stress of the film is increased and the organic resin film cannot
10 follow the deformation of the metal blank being formed, and it will separate, in some cases. Therefore, the thickness of the organic resin film is desirably 50 μm or less. The organic resin layer may be made up of two or more layers, to improve the adhesion and the corrosion
15 resistance. When two more layers are formed, the adhesion and the corrosion resistance are improved more.

As is described above, since the metal plate material of the present invention use a metal blank excellent in mechanical properties, on one surface of
20 which is formed an organic resin film having a thickness of 6 μm or more, a prescribed friction coefficient, and a prescribed surface roughness, the metal plate material is excellent in formability. By forming the metal plate material into a part with the surface on which the organic
25 resin film is formed placed outside, parts or the like

will not be soiled with gases that will otherwise be released from the organic resin film, and therefore the parts or apparatuses function favorably for a long period of time.

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EXAMPLES

Hereinbelow the present invention is described with reference to Examples in detail.

Example 1

10 The aluminum alloy plates (metal blanks), having a thickness of 0.75 mm, shown in Table 1 were degreased and were washed with water, and an undercoat was applied. Then, organic resin films were formed on the aluminum alloy plates, to make metal plates for electronic
15 machinery and tools. For the above degreasing, Fine Cleaner 364S (trade name), manufactured by Nihon Parkerizing Co., Ltd., was used. The undercoat was applied by the methods shown in Table 2. For the organic resin films, the organic resins shown in Table 3 were
20 used. The organic resin films were formed by the coating method or the laminating method. With respect to the organic resins containing aggregate, the roughness of the surfaces of the organic resin films varies depending on the thickness of the formed organic resin films.
25 Additionally stated, cases that were not to be subjected to the application of an undercoat were included.

Samples were cut out from the obtained metal plates, and the formability and the outgassing resistance were investigated by the below-shown methods. For comparison, those falling outside the conditions of the present invention were investigated in the same manner. The results are shown in Tables 4 to 6.

(1) Formability

A volatile lubricant (G-6281, manufactured by Nihon Kosakuyu Co.) was applied to the surface of each of the samples on which the organic resin film was formed, and the sample was subjected to deep drawn process, to be formed into a cylinder having a diameter of 33 mm, with the surface on which the organic resin film was formed placed outside, thereby finding the limiting drawing rate (L.D.R.). L.D.R. is a value given by the following formula, and it shows that the higher the value is, the better its formability is.

$$\text{L.D.R.} = \frac{\text{maximum drawn blank diameter}}{\text{diameter of the punch (33 mm)}}$$

One showing a limiting drawing ratio (L.D.R.) of 2.12 or more was rated "◎", one showing a limiting drawing ratio (L.D.R.) of 1.91 or more but no more than 2.09 was rated "○", and one showing a limiting drawing ratio (L.D.R.) of 1.88 or less was rated "×".

(2) Outgassing resistance

The outgassing resistance of the surface of each of the samples on which the organic resin film was not formed (the surface that would constitute the inner surface of a case) was investigated. The investigation was carried out as follows: the surface of the sample, on which the organic resin film was formed, was sealed. The sealed sample was allowed to stand, in a sealed container kept at 80 °C, for 24 hours; thereafter the container was brought to room temperature, to allow the released gases to condense on the inner surfaces of the container; then the inner surfaces of the container were washed with a solvent (isopropyl alcohol), so that the condensed gases might be dissolved in the solvent; the solvent was condensed, and gas analysis was carried out by FT-IR (Fourier transformation-infrared spectrometry). One, in which an organic compound was found, was rated "X", and one, in which no organic compound was found, was rated "O".

In passing, for comparison, metal plates, on both surfaces of each of which an organic resin film was formed, were also tested, with only one surface of the organic resin film sealed and the other surface of the organic resin film exposed.

Table 1

Alloy No.	Kind of alloy of metal blank	Refining	Strength MPa	Proof stress MPa	Elongation %
(a)	1100	○	75	25	20
(b)	3003	○	108	40	30
(c)	3003	H12	133	123	10
(d)	5052	○	192	89	25
(e)	5182	○	290	148	21
(f)	5182	H34	329	231	18
(g)	1050	○	60	20	25
(h)	5052	H38	290	255	7

Table 2

No.	Application of an undercoat
A	Phosphoric acid•chromate treatment
B	Chromic acid•chromate treatment
C	Alumite treatment
D	Degreasing (aluminum matrix)

Table 3

No.	Organic resin film	Additive (aggregate)
a	Polyester	Acrylic aggregate
b	Polyethylene	Acrylic aggregate
c	Polyurethane	Acrylic aggregate
d	Polyacryl	Acrylic aggregate
e	Epoxy	Acrylic aggregate
f	Nylon	Nylon aggregate
g	Polyester	Nylon aggregate
h	Polyester	Acrylic aggregate, and PTFE
i	Polyester	Acrylic aggregate, PTFE, and black pigment
j	Polyester	—
k	Epoxy	—

Table 4

Classification	No.	Surface							Undersurface		Evaluation results	
		Kind of alloy	Application of an under-coat	Kind and thickness of organic resin film μm	Method of forming film	Roughening surface	Surface roughness Ra	Friction coefficient	Application of an under-coat	Resin film	Formability	Out-gassing resistance
Example of the present invention	1	(a)	A	a 20	coating	#	12.3	0.27	A	-	○	○
	2	(b)	A	a 20	coating	#	12.3	0.27	A	-	○	○
	3	(c)	A	a 20	coating	#	12.3	0.27	A	-	○	○
	4	(d)	A	a 20	coating	#	12.3	0.27	A	-	○	○
	5	(e)	A	a 20	coating	#	12.3	0.27	A	-	○	○
	6	(f)	A	a 20	coating	#	12.3	0.27	A	-	○	○
	7	(e)	B	a 20	coating	#	12.3	0.27	B	-	○	○
	8	(e)	C	a 20	coating	#	12.3	0.27	C	-	○	○
	9	(e)	D	a 20	coating	#	12.3	0.27	D	-	○	○

Note # : Roughening made by the aggregate

Table 5

Classification	No.	Surface							Undersurface		Evaluation results	
		Kind of alloy	Application of an under-coat	Kind and thickness of organic resin film μm	Method of forming film	Roughening surface	Surface roughness Ra	Friction coefficient	Application of an under-coat	Resin film	Formability	Out-gassing resistance
Example of the present invention	10	(e)	A	b 20	coating	#	18.2	0.21	A	-	○	○
	11	(e)	A	c 20	coating	#	12.3	0.26	A	-	○	○
	12	(e)	A	d 20	coating	#	12.3	0.26	A	-	○	○
	13	(e)	A	e 20	coating	#	12.3	0.29	A	-	○	○
	14	(e)	A	f 20	laminating	#	12.3	0.18	A	-	◎	○
	15	(e)	A	g 20	coating	#	12.3	0.27	A	-	○	○
	16	(e)	A	h 20	coating	#	12.3	0.15	A	-	◎	○
	17	(e)	A	i 20	coating	#	12.3	0.15	A	-	◎	○
	18	(e)	A	j 20	coating	b	12.3	0.27	A	-	○	○

Note # : Roughening made by the aggregate
 b : Roughening made by a roll (by transferring by a roll)

Table 6

Classi- fication	No.	Surface							Undersurface		Evaluation results	
		Kind of alloy	Appli- cation of an under- coat	Kind and thick- ness of organic resin film μm	Method of forming film	Rough- ening surface	Surface rough- ness Ra	Friction coeffici- ent	Appli- cation of an under- coat	Resin film	Form- ability	Out- gassing resis- tance
Example of the present inven- tion	19	(e)	A	lower side: j 5 upper side: a 15	coating	#	21.8	0.24	A	-	○	○
Compara- tive example	20	(e)	-	-	-	-	1.5	-	-	-	X	○
	21	(e)	A	-	-	-	1.5	-	A	-	X	○
	22	(g)	A	a 20	coating	#	12.3	0.21	A	-	X	○
	23	(h)	A	a 20	coating	#	12.3	0.21	A	-	X	○
	24	(e)	A	a 4	coating	#	12.3	0.27	A	-	X	○
	25	(e)	A	h 20	coating	#	0.8	0.15	A	-	X	○
	26	(e)	A	d 10	coating	#	38.8	0.26	A	-	X	○
	27	(e)	A	k 20	coating	-	1.8	0.48	A	-	X	○
	28	(e)	A	a 20	coating	#	12.3	0.27	A	a	◎	X

Note # : Roughening made by the aggregate

As is apparent from the results shown in Tables 4 to 6, each of the cases of Example of the present invention (Nos. 1 to 19) is excellent both in formability and outgassing resistance.

5 In contrast, the metal plates of Nos. 20 and 21 of Comparative Example ruptured when they were formed, since an organic resin film was not formed. Since in No. 22, the metal blank was low in proof stress, and in No. 23, the metal blank was low in elongation, they were poor
10 in formability. In No. 24, since the organic resin film was thin, the resin film separated and the metal plate ruptured when the forming was carried out. Since, in No. 25, the organic resin film did not contain aggregate, the surface roughness was small, and since, in No. 26, in
15 comparison to the value of the diameter of the aggregate, the value of the thickness of the film was small, the surface roughness became excessive, in either case, a satisfactory lubricity could not be obtained, and therefore the metal plate ruptured when the forming was
20 carried out. In No. 27, since the friction coefficient of the organic resin film was large, the metal plate ruptured when the forming was carried out. In No. 28, since the organic resin film was formed on both surfaces, a large volume of gases was released.

25 Example 2

The metal plates of the present invention obtained in Example 1 were subjected to deep drawing process to form boxes, with the surface on which the organic resin film was formed placed outside, and the
5 boxes were used as outer frames of HDD cassettes.

They were used for a long period of time, and there was no sign whatsoever that the function of the cassettes was lowered.

Although the present invention has been
10 described in the case wherein, as a metal plate, aluminum alloy metals were used, and they were used for cases of HDD cassettes, the same effect can be obtained when the present invention using copper plates or steel plates, instead of aluminum alloy plates, is applied to
15 constitutional members of apparatuses, such as computers and word processors.

Having described our invention as related to the present embodiments, it is our intention that the
20 invention not be limited by any of the details of the description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.



WHAT WE CLAIM IS

1. A metal plate material for electronic machinery and tools, comprising a metal blank that has a tensile strength of 75 MPa or more, a proof stress of 25 MPa or more, and an elongation of 10% or more, wherein one surface of the metal blank is covered with an organic resin film having a friction coefficient of 0.3 or less, a surface roughness Ra of 1.0 to 30 μm , and a thickness of 6 μm or more.
2. The metal plate material for electronic machinery and tools as claimed in claim 1, wherein an undercoat is formed on the metal blank, and the said organic resin film is formed on the said undercoat.
3. The metal plate material for electronic machinery and tools as claimed in claim 1, wherein the said organic resin film contains a lubricant, and the said lubricant comprises one or more of waxes, fluororesins, and inorganic lubricants.
4. The metal plate material for electronic machinery and tools as claimed in claim 1, wherein the said organic resin film contains an aggregate whose



particle diameter value is greater than the value of the thickness of the organic resin film.

5. The metal plate material for electronic
5 machinery and tools as claimed in claim 4, wherein the said aggregate comprises at least one of polyamide-series aggregates or acrylic aggregates.

6. The metal plate material for electronic
10 machinery and tools as claimed in claim 1, wherein the said organic resin film is composed of at least one of acrylic resins, ester-series resins, ethylene-series resins, epoxy-series resins, phenol-series resins, fluororesins, or polyamide-series resins.

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7. A part of an electronic machinery and tools, comprising a metal plate material, wherein the metal plate material comprises a metal blank that has a tensile strength of 75 MPa or more, a proof stress of 25 MPa or
20 more, and an elongation of 10% or more, and wherein one surface of the metal blank is covered with an organic resin film having a friction coefficient of 0.3 or less, a surface roughness Ra of 1.0 to 30 μm , and a thickness of 6 μm or more, the said metal plate material being formed
25 with the surface having the said organic resin film placed



outside.

8. The part of an electronic machinery and tools as claimed in claim 7, wherein an undercoat is
5 formed on the metal blank, and the said organic resin film is formed on the said undercoat.

9. The part of an electronic machinery and tools as claimed in claim 7, wherein the said organic
10 resin film contains a lubricant, and the said lubricant comprises one or more of waxes, fluororesins, and inorganic lubricants.

10. The part of an electronic machinery and
15 tools as claimed in claim 7, wherein the said organic resin film contains an aggregate whose particle diameter value is greater than the value of the thickness of the organic resin film.

20 11. The part of an electronic machinery and tools as claimed in claim 10, wherein the said aggregate comprises at least one of polyamide-series aggregates or acrylic aggregates.

25 12. The part of an electronic machinery and



tools as claimed in claim 7, wherein the said organic resin film is composed of at least one of acrylic resins, ester-series resins, ethylene-series resins, epoxy-series resins, phenol-series resins, fluororesins, or polyamide-series resins.

13. An apparatus of an electronic machinery and tools, comprising a metal plate material, wherein the metal material comprises a metal blank that has a tensile strength of 75 MPa or more, a proof stress of 25 MPa or more, and an elongation of 10% or more, and wherein one surface of the metal blank is covered with an organic resin film having a friction coefficient of 0.3 or less, a surface roughness Ra of 1.0 to 30 μm , and a thickness of 6 μm or more, the said metal plate material being formed with the surface having the said organic resin film placed outside.

14. The apparatus of an electronic machinery and tools as claimed in claim 13, wherein an undercoat is formed on the metal blank, and the said organic resin film is formed on the said undercoat.

15. The apparatus of an electronic machinery and tools as claimed in claim 13, wherein the said organic



resin film contains a lubricant, and the said lubricant comprises one or more of waxes, fluororesins, and inorganic lubricants.

5 16. The apparatus of an electronic machinery and tools as claimed in claim 13, wherein the said organic resin film contains an aggregate whose particle diameter value is greater than the value of the thickness of the organic resin film.

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17. The apparatus of an electronic machinery and tools as claimed in claim 14, wherein the said aggregate comprises at least one of polyamide-series aggregates or acrylic aggregates.

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18. The apparatus of an electronic machinery and tools as claimed in claim 13, wherein the said organic resin film is composed of at least one of acrylic resins, ester-series resins, ethylene-series resins, epoxy-series
20 resins, phenol-series resins, fluororesins, or polyamide-series resins.