(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 088 215 A1

(12) EUROPEAN PATENT APPLICATION

published in accordance with Art. 153(4) EPC

(43) Date of publication:
12.08.2009 Bulletin 2009/33

(21) Application number: **07829424.6**

(22) Date of filing: **09.10.2007**

(51) Int Cl.:
C22C 9/06 (2006.01) ***B21B 1/22*** (2006.01)
B21B 3/00 (2006.01) ***C22F 1/08*** (2006.01)
H01B 1/02 (2006.01) ***H01B 5/02*** (2006.01)
H01B 13/00 (2006.01) ***C22F 1/00*** (2006.01)

(86) International application number:
PCT/JP2007/069686

(87) International publication number:
WO 2008/044680 (17.04.2008 Gazette 2008/16)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR

(30) Priority: **10.10.2006 JP 2006276808**
03.10.2007 JP 2007260386

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(54) COPPER ALLOY MATERIAL FOR ELECTRICAL/ELECTRONIC PART AND PROCESS FOR PRODUCING THE SAME

(57) A copper alloy material for electric/electronic parts, which is produced by the steps containing: finish rolling a copper alloy at a reduction ratio of 40% or less, subjecting the copper alloy finish-rolled to a heat treatment under the conditions at a temperature from 500°C to 800°C for a time period from 1 second to 100 seconds by means of a continuous annealing line, and strain relief annealing the copper alloy heat-treated under the conditions at a temperature from 400°C to 600°C for a time period from 30 seconds to 1000 seconds,
wherein the copper alloy material for electric/electronic parts has rates of dimensional changes before and after the strain relief annealing in both directions parallel to and perpendicular to the rolling direction within the range from -0.02% to +0.02%.

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Description

[TECHNICAL FIELD]

[0001] The present invention relates to a copper alloy material for electric/electronic parts and to a method of producing the same.

[BACKGROUND ART]

[0002] Sheet and strip materials of copper-based alloys that can be used for electric/electronic parts, such as lead frames, terminals, connectors, relays and switches, are required to be compatible between high strength and high electric conductivity as well as highly precise workability.
For example, the lead frame that can be used for a circuit board in an integrated circuit is produced as a frame body having the required number of leads, by press-punching of the sheet and strip materials of the copper-based alloy.
[0003] In accordance with high density integration of electric/electronic parts in recent years, fine and precise press-punching is necessary for connectors, while press-punching is applied at least twice in the course of working a complicated lead frame in which the number of leads is increased. In this case, a strain relief annealing is applied after the first press-punching step, and strain by working provided via press-punching is relieved, and then a final lead frame is produced by applying press-punching again.
[0004] However, the conventional materials for electric/electronic parts have such problems that high precession punching is difficult due to dimensional changes of the material before and after the above-mentioned strain relief annealing, and that automatic conveyance to a press machine becomes difficult due to deformation of the space between conveyance pilot pins.
[0005] Conventional techniques proposed by taking the dimensional change before and after the strain relief annealing in working the lead frame into consideration are as follows.
[0006] In an example of production methods of lead frames made of Fe-Ni based alloys or Fe-Ni-Co based alloys, a lead frame material having a contraction ratio of 0.03% or less as a ratio of the length of the material heated at 650°C for 10 minutes to the length of the original material is produced by strain relief annealing without applying a tensile strength or by strain relief annealing by suppressing the tensile strength to 5.0 kg/mm^2 or less, in the course of the production in which the alloy is subjected to cold rolling to a thickness of a desired product and then subjected to cutting into slits having a predetermined width followed by strain relief annealing. Herein, the contraction ratio is defined by {(the length of the original material - the length of the material after heating)/the length of the original material} $\times$ 100 (for example, see JP-A-5-109960 ("JP-A" means unexamined published Japanese patent application)).
[0007] Further, in an example of production methods of lead frames made of copper or copper alloys, a lead frame material having a difference of the contraction ratio of 0.01 % or less before and after the heat treatment at a strain relief annealing temperature or at a recrystallization temperature in the course of working the material is produced by controlling the tensile strength in a furnace for allowing the frame sheet to pass through a continuous annealing furnace to be from 1.0 to 8.5% or less of the 0.2% yield strength of the material of the original sheet in the course of production of the material. Herein, the contraction ratio is defined as a rate of change of the reference length in the longitudinal direction after heating (for example, see JP-A-2003-286527).

[DISCLOSURE OF INVENTION]

[0008] It has been noticed to reduce the contraction ratio in metal materials for the electric/electronic parts for applying fine working, and the above-mentioned conventional measures were employed. However, the methods disclosed in JP-A-5-109960 and JP-A-2003-286527 are insufficient for solving the above-mentioned problems, since only contraction ratios in the direction parallel to the rolling direction have been noticed and there are no descriptions on the rate of dimensional change in the direction perpendicular to the rolling direction. Further, JP-A-2003-286527 prescribes the tensile strength in a continuous annealing furnace. The temperature in the furnace is only described as the conditions in the examples, so that the method described in JP-A-2003-286527 is insufficient for solving the problems. Furthermore, only C194 alloy is used as the copper alloy in the examples of JP-A-2003-286527, there are no descriptions or suggestions on whether the conditions in the examples are generally applicable to other copper alloys.
[0009] In view of these problems, the present invention contemplates for providing a copper alloy material for electric/electronic parts in which the rates of dimensional changes before and after strain relief annealing after press-punching are simultaneously controlled in both directions parallel to and perpendicular to the rolling direction.
[0010] The inventors of the present invention have found the following facts as a result of investigations for simultaneously controlling the rates of dimensional changes in both directions parallel to and perpendicular to the rolling direction before and after strain relief annealing of the copper alloy material.

[0011] It was found from various experimental studies for simultaneously controlling the rates of dimensional changes in both directions parallel to and perpendicular to the rolling direction before and after strain relief annealing during or after press-punching that the rates of dimensional changes in both directions parallel to and perpendicular to the rolling direction is to be controlled in the range from -0.02% to +0.02% in minimum, preferably in the range from -0.01% to +0.01%, for stable automatic conveyance when the clearance between conveyance pins and pilot holes is, for example, about 5 μm in one side. In particular, when an outer lead portion of the lead frame having a narrow pitch is press-punched with high precision of about ±3 μm so as to protrude in four directions, the rate of dimensional change in the direction perpendicular to the rolling direction is particularly important, and it was shown to be necessary to control the rates of dimensional changes in both directions parallel to and perpendicular to the rolling direction in the range from -0.02% to +0.02% in minimum, preferably in the range from -0.01 % to +0.01%.

[0012] Further, the inventors of the present invention have noted (1) quenching (displacement) of lattice defects that have been introduced by rolling and (2) precipitating Ni_2Si, and forming solid solution of Ni_2Si in a matrix phase again, with respect to the phenomenon of dimensional changes before and after heat treatment. In other words, dimensional changes in the matrix phase are presumed to occur as a result of changes of aggregate structures, which are caused by quenching (displacement) of lattice defects introduced by rolling, by heat hysteresis. Thus, the behavior of the dimensional change is different between the directions parallel to and perpendicular to the rolling direction, since the arrangement of the lattice defects introduced by rolling is directional. The behavior of the dimensional change was investigated in various manners, and it was found that the behavior largely contributes to the dimensional change in the direction parallel to the rolling direction. It was also presumed that the dimensional change of the matrix phase becomes large by preferential growth and precipitation of Ni_2Si and by forming solid solution of the compound again. Since precipitation grows in a preferentially grown direction, the behavior of the dimensional change is different between the directions parallel to and perpendicular to the rolling direction. It was found from various studies that the contribution of the dimensional change caused by preferential growth and precipitation of Ni_2Si and formation of solid solution of Ni_2Si again is particularly large in the direction perpendicular to the rolling direction. The present invention has been accomplished based on the above-mentioned findings.

[0013] According to the present invention, there is provided following means:

(1) A copper alloy material for electric/electronic parts, which is produced by the steps comprising: finish rolling a copper alloy at a reduction ratio of 40% or less, subjecting the copper alloy finish-rolled to a heat treatment under the conditions at a temperature from 500°C to 800°C for a time period from 1 second to 100 seconds by means of a continuous annealing line, and strain relief annealing the copper alloy heat-treated under the conditions at a temperature from 400°C to 600°C for a time period from 30 seconds to 1000 seconds,
wherein the copper alloy material for electric/electronic parts has rates of dimensional changes before and after the strain relief annealing in both directions parallel to and perpendicular to the rolling direction within the range from -0.02% to +0.02%;
(2) The copper alloy material for electric/electronic parts according to the item (1), wherein the strain relief annealing is conducted in mid course of a material working process for electric/electronic parts;
(3) The copper alloy material for electric/electronic parts according to the item (1) or (2), wherein the copper alloy material for electric/electronic parts is a lead frame material or a connector material;
(4) The copper alloy material for electric/electronic parts according to any one of the items (1) to (3), wherein the copper alloy material for electric/electronic parts comprises Ni from 1.5 mass% to 4.5 mass% and Si from 0.35 mass% to 1.0 mass%, and further comprises at least one or plural elements selected from Mg from 0.05 mass% to 0.15 mass%, Sn from 0.05 mass% to 0.5 mass%, Zn from 0.05 mass% to 1 mass%, Ag from 0.01% to 0.1 mass%, and Cr from 0.05 mass% to 0.4 mass%, with the balance being made of copper and inevitable impurities;
(5) A method of producing a copper alloy material for electric/electronic parts, comprising the steps of:

finish rolling a copper alloy at a reduction ratio of 40% or less;
subjecting the copper alloy finish-rolled to a heat treatment under the conditions at a temperature from 500°C to 800°C for a time period from 1 second to 100 seconds by means of a continuous annealing line; and
strain relief annealing the copper alloy heat-treated under the conditions at a temperature from 400°C to 600°C for a time period from 30 seconds to 1000 seconds,
to thereby produce the copper alloy material for electric/electronic parts having rates of dimensional changes before and after the strain relief annealing in both directions parallel to and perpendicular to the rolling direction within the range from -0.02% to +0.02%, and

(6) The method of producing a copper alloy material for electric/electronic parts according to the item (5), wherein the strain relief annealing is conducted in mid course of a material working process for electric/electronic parts.

[0014] Other and further features and advantages of the invention will appear more fully from the following description.

[BEST MODE FOR CARRYING OUT THE INVENTION]

[0015] The copper alloy material for electric/electronic parts of the present invention is produced by the steps comprising: finish rolling a copper alloy at a reduction ratio of 40% or less in a material producing process, subjecting the copper alloy finish-rolled to a heat treatment in the continuous annealing line (furnace) under the conditions at a temperature from 500°C to 800°C for a time period from 1 second to 100 seconds thereafter followed by further working the material in a material working process. The material producing process in the present invention refers to the steps of producing the material for electric/electronic parts (such as sheet materials and strip materials) from an ingot, and includes a step of finish rolling and heat treatment in the continuous annealing furnace.
The material working process in the present invention refers to the steps before producing the electric/electronic parts by working the material (such as sheet materials and strip materials) for the electric/electronic parts, which material is produced in said material producing process. The material working process includes, for example, pressing.
When the reduction ratio by finish rolling in the material producing process is too large, many surface cracks may be formed or lattice defects are introduced in excess. Consequently, the rate of dimensional change in the direction parallel to the rolling direction before and after heat treatment in the steps thereafter (for example, the material working process) becomes so large that it is difficult to simultaneously control the rates of dimensional changes in the directions parallel to and perpendicular to the rolling direction within proper ranges. Accordingly, the reduction ratio by finish rolling in the material producing process is 40% or less, preferably from 10% to 20%.
[0016] When the temperature for continuous annealing in the material producing process is too low, lattice defects introduced by rolling are left behind to make the rate of dimensional change in the direction parallel to the rolling direction before and after heat treatment in the material producing process to be particularly large, and it may be difficult to simultaneously control the rates of dimensional changes in the directions parallel to and perpendicular to the rolling direction within proper ranges. Productivity may be also decreased when the continuous annealing temperature is too low since a long heat treatment time is necessary for quenching lattice defects. When the continuous annealing temperature is too high, on the contrary, the rate of dimensional change in the direction perpendicular to the rolling direction becomes particularly large since precipitation rapidly advances before and after the heat treatment in the steps (for example, the material working process) thereafter. Consequently, it is difficult to simultaneously control the rates of dimensional changes in the directions parallel to and perpendicular to the rolling direction within proper ranges. It may be also difficult to obtain desired mechanical characteristics when the continuous annealing temperature is too high since softening of the material advances. Accordingly, the continuous annealing temperature in the material producing process is from 500°C to 800°C, preferably from 600°C to 750°C.
[0017] Too long continuous annealing time in the material producing process makes it impossible to obtain desired mechanical characteristics since softening of the material advances to cause remarkable decrease of productivity. Accordingly, the continuous annealing time in the material producing process is preferably 100 seconds or less, more preferably 60 seconds or less. Since a stable temperature distribution in the material is not obtained when the continuous annealing time is too short, stable solid solutions are not formed again and strain provided via rolling is not relieved to make it impossible to obtain desired mechanical characteristics. Therefore, the continuous annealing time is 1 second or more, preferably 10 seconds or more.
[0018] While the thickness of the material produced in the material producing process is not particularly restricted, the thickness is preferably in the range from 0.25 to 0.05 mm. The material in the present invention usually refers to those called as sheet materials and strip materials.
[0019] The material produced in the material producing process is formed into a processed material by the material working process including strain relief annealing at a temperature from 400°C to 600°C for a time period from 30 seconds to 1000 seconds. The material working process is preferably a material working process for electric/electronic parts. Further, the material working process preferably includes a step of pressing.
Strain provided via pressing is unable to be completely removed when the temperature of strain relief annealing in the material working process is too low. On the other hand, desired mechanical characteristics are not obtained due to advance of softening of the material when the strain relief annealing temperature is too high. Accordingly, the strain relief annealing temperature in the material working process is from 400°C to 600°C, preferably from 450°C to 550°C.
[0020] Strain provided via pressing is not sufficiently removed when the strain relief annealing time in the material working process is too short. Desired mechanical characteristics are not obtained due to the progress of softening of the material while productivity may be decreased when the strain relief annealing time is too long. Accordingly, the strain relief annealing time in the material working process is a time period from 30 seconds to 1000 seconds, preferably a time period from 180 seconds to 600 seconds.
[0021] The rates of dimensional changes before and after heat treatment for strain relief annealing in both directions parallel to and perpendicular to the rolling direction is from -0.02% to +0.02% in the copper alloy material for electric/

electronic parts of the present invention. The preferable rates of dimensional changes before and after heat treatment for strain relief annealing in both directions parallel to and perpendicular to the rolling direction is also in the range from -0.01 % to +0.01%.

[0022] The preferable composition of the copper alloy of the copper alloy material for electric/electronic parts of the present invention will be described below.

An example of the copper alloy comprises Ni from 1.5 mass% to 4.5 mass% and Si from 0.35 mass% to 1.0 mass%, and further comprises any one or two or more elements selected from Mg from 0.05 mass% to 0.15 mass%, Sn from 0.05 mass% to 0.5 mass%, Zn from 0.05 mass% to 1 mass%, Ag from 0.01 % to 0.1 mass% and Cr from 0.05 mass% to 0.4 mass%, with the balance being made of copper and inevitable impurities.

Ni and Si have an effect for enhancing the strength of the alloy by forming a solid solution in the copper alloy, while the strength as well as electric conductivity of the alloy are remarkably improved by forming precipitates of a Ni_2Si composition by applying appropriate aging treatment. However, the alloy may fail in obtaining desired mechanical characteristics when the content of Ni is less than 1.5 mass% or the content of Si is less than 0.35%. When the content of Ni exceeds 4.5 mass% or the content of Si exceeds 1.0 mass%, on the other hand, simultaneous control of the rates of dimensional changes in the direction parallel to and perpendicular to the rolling direction in proper ranges may be difficult since electric conductivity remarkably decreases and coarse Ni-Si particles are generated in the matrix phase. The Ni content is further preferably from 2.0 mass% to 4.0 mass%, while the Si content is further preferably from 0.4 mass% to 0.90 mass%. It is desirable to allow the atomic ratio of the contents of Ni and Si in the alloy to be close to the atomic ratio of the stoichiometric composition of Ni_2Si for simultaneously controlling the rate of dimensional change in the direction parallel to or perpendicular to the rolling direction. Accordingly, the ratio of the content of Si to the content of Ni (Ni content / Si content) is preferably in the range from 2 to 8, and a ratio of 4 is most preferable.

[0023] Further, the copper alloy material comprises any one or two or more elements selected from Mg from 0.05 mass% to 0.15 mass%, Sn from 0.05 mass% to 0.5 mass%, Zn from 0.05 mass% to 1 mass%, Ag from 0.01 mass% to 0.1 mass%, and Cr from 0.05 mass% to 0.4 mass%, in addition to the above-mentioned components. Permitting these metals in the amounts described above may serve for enhancing the mechanical strength. More preferably, the alloy contains any one or two or more elements selected from Sn from 0.1 mass% to 0.125 mass% and Zn from 0.1 mass% to 0.5 mass%.

[0024] The rate of dimensional change in the present invention is defined as follows using the reference length before annealing and the reference length after annealing in the direction parallel to or perpendicular to the rolling direction:

$$((\text{reference length after annealing}) - (\text{reference length before annealing})) / (\text{reference length before annealing}) \times 100$$

Herein, a plus value of the rate of the dimensional change corresponds to expansion, while a minus value of the rate of the dimensional change corresponds to contraction.

[0025] Usual production steps and treatment methods in the material producing process of the copper alloy material for electric/electronic parts and in the material working process may be directly applied except the above-mentioned items. For example, the reduction ratio by hot rolling applied before finish rolling is preferably from 90 to 99% in the present invention. The reduction ratio by cold rolling applied before finish rolling is preferably from 90 to 99%.

While the electric/electronic parts in the present invention may be lead frames, connectors, terminals, relays and switches, preferable parts are lead frames and connectors for which fine and precise working is necessary.

[0026] The copper alloy material of the present invention is able to simultaneously reduce or control the rates of dimensional changes in both directions of parallel to and perpendicular to the rolling direction before or after strain relief annealing in mid course of or after press-punching in the material producing process of electric/electronic parts. The copper alloy material of the present invention is particularly suitable as a material for connectors that are necessary to apply fine and precise press-punching in accordance with miniaturization of lead frames and portable phones.

The method of the present invention enables the copper alloy material for electric/electronic parts having above-described excellent physical properties to be industrially produced.

[EXAMPLES]

[0027] The present invention will be described in more detail based on examples given below, but the invention is not meant to be limited by these.

[Examples (examples of the present invention) and comparative examples]

[0028] Copper alloys having the chemical compositions shown in Table 1 were used as lead frame materials. An ingot was obtained by melting and cooling each material by a usual method. The ingot was hot rolled and annealed, and cold rolled materials with a thickness from 0.05 mm to 0.25 mm were obtained by finish rolling at a reduction ratio of 3%, 10%, 20%, 40% or 45%, as shown in Table 2, after repeating cold rolling and annealing.

[0029] Materials No. 1 to 44 shown in Table 2 were obtained by heat treatment of the cold rolled materials obtained above by controlling the tensile strength in the continuous annealing furnace at 0.7 kg/mm^2, the temperature in the furnace at 450, 500, 600, 700, 800 or 850°C, and the annealing time at 10, 60, 100 or 120 seconds.

[0030] Then, the above-mentioned materials with a width of 55 mm were subjected to heat treatment in argon atmosphere at 500°C for 180 seconds as a simulation of strain relief annealing in mid course of or after press-punching in the working process of the lead frame. The rates of dimensional changes were calculated by measuring, after the heat treatment, the dimensional changes of a reference length 100 mm in the direction parallel to the rolling direction and a reference length 50 mm in the direction perpendicular to the rolling direction marked on the material, respectively, before the heat treatment. The results are shown in Table 2. Nos. 1 to 32 correspond to the examples according to the present invention, while Nos. 33 to 44 correspond to comparative examples.

[Table 1]

[0031]

(Table 1)

Kind of copper alloy	Component (mass%)							
	Ni	Si	Mg	Sn	Zn	Ag	Cr	Cu
A	3.0	0.65	0.15	-	-	-	-	Balance
B	2.6	0.55	-	-	0.5	0.05	-	Balance
C	2.3	0.50	0.10	0.15	0.5	-	-	Balance
D	3.7	0.90	0.10	0.15	0.5	-	0.2	Balance

[Table 2]

[0032]

(Table 2)

	No	Thickness (mm)	Kind of copper alloy	Finish rolling	Continuous annealing		Rate (%) of dimensional change before and after heating (500°C × 180sec)	
				Reduction ratio (%)	Temperature in the furnace(°C)	Heat treatment time (sec)	Direction parallel to the rolling direction	Direction perpendicular to the rolling
	1	0.050	A	3	500	10	0.0131	-0.0094
	2	0.100	B	3	500	100	0.0128	-0.0101
	3	0.150	C	3	800	10	-0.0041	-0.0182
	4	0.200	D	3	800	100	-0.0054	-0.0185
	5	0.250	A	10	500	10	0.0135	-0.0058
	6	0.050	B	10	500	60	0.0137	-0.0061
	7	0.100	C	10	500	100	0.0129	-0.0074
	8	0.150	D	10	600	10	0.0047	-0.0088
	9	0.200	A	10	600	50	0.0044	-0.0078
	10	0.250	B	10	600	100	0.0034	-0.0095
	11	0.050	C	10	700	10	0.0031	-0.0085
	12	0.100	D	10	700	50	0.0025	-0.0091
	13	0.150	A	10	700	100	0.0014	-0.0108
	14	0.200	B	10	800	10	0.0004	-0.0154
	15	0.250	C	10	800	60	-0.0025	-0.0165
Example of this invention	16	0.050	D	10	800	100	-0.0027	-0.0177
	17	0.100	A	20	500	10	0.0157	-0.0049
	18	0.150	B	20	500	60	0.0154	-0.0052
	19	0.200	C	20	500	100	0.0154	-0.0068
	20	0.250	D	20	600	10	0.0068	-0.0074
	21	0.050	A	20	600	60	0.0061	-0.0069

(continued)

	No	Thickness (mm)	Kind of copper alloy	Finish rolling	Continuous annealing		Rate (%) of dimensional change before and after heating (500°C × 180sec)	
				Reduction ratio (%)	Temperature in the furnace(°C)	Heat treatment time (sec)	Direction parallel to the rolling direction	Direction perpendicular to the rolling
	22	0.100	B	20	600	100	0.0049	-0.0082
	23	0.150	C	20	700	10	0.0044	-0.0072
	24	0.200	D	20	700	60	0.0041	-0.0079
	25	0.250	A	20	700	100	0.0031	-0.0091
	26	0.050	B	20	800	10	0.0024	-0.0142
	27	0.100	C	20	800	60	0.0010	-0.0148
	28	0.150	D	20	800	100	0.0015	-0.0161
	29	0.200	A	40	500	10	0.0184	-0.0014
	30	0.250	B	40	500	100	0.0171	-0.0031
	31	0.050	C	40	800	10	0.0048	-0.0141
	32	0.100	D	40	800	100	0.0031	-0.0151
Comparative example	33	0.150	A	45	500	60	0.0274	0.0021
	34	0.200	B	45	600	60	0.0232	-0.0008
	35	0.250	C	45	700	60	0.0225	-0.0014
	36	0.050	D	45	800	60	0.0221	-0.0021
	37	0.100	A	10	450	60	0.0219	-0.0049
	38	0.150	B	10	850	60	-0.0005	-0.0231
	39	0.200	C	20	450	60	0.0232	-0.0051
	40	0.250	D	20	850	60	0.0021	-0.0215
	41	0.050	A	10	600	120	0.0023	-0.0211
	42	0.100	B	10 D	700	120	0.0024	-0.0231

(continued)

	No	Thickness (mm)	Kind of copper alloy	Finish rolling	Continuous annealing		Rate (%) of dimensional change before and after heating (500°C × 180sec)	
				Reduction ratio (%)	Temperature in the furnace(°C)	Heat treatment time (sec)	Direction parallel to the rolling direction	Direction perpendicular to the rolling
	43	0.150	C	20	600	120	0.0028	-0.0214
	44	0.200	D	20	700	120	0.0032	-0.0227

[0033] As is apparent from Table 2, the rates of dimensional changes before and after heat treatment are in the range from -0.02% to +0.02% in both directions parallel to and perpendicular to the rolling direction in Examples No. 1 to 32 according to the present invention. This shows that the present invention exhibits such an advantageous action that stable automatic conveyance is possible even when, for example, the clearance between the conveyance pins and pilot holes is about 5 μm at one side.
The rates of dimensional changes before and after heat treatment in both directions parallel to and perpendicular to the rolling direction are particularly excellent, since they are in the range from -0.01 % to +0.01% in Examples No. 8, 9, 11, 12, 20, 21, 23 and 24 produced under particularly preferable conditions.
[0034] On the other hand, the rate of dimensional change in the direction parallel to the rolling direction is large in Comparative Examples No. 33 to 36 in which the reduction ratio by finish rolling is larger than the range according to the present invention. The rate of dimensional change in the direction parallel to the rolling direction is large in Comparative Examples No. 37 and 39 in which the temperature in the furnace during continuous annealing is lower than the range according to the present invention. The rate of dimensional change in the direction perpendicular to the rolling direction is particularly large in Comparative Examples No. 38 and 40 in which the temperature in the furnace during continuous annealing is higher than the range according to the present invention. The rate of dimensional change in the direction perpendicular to the rolling direction is particularly large in Comparative Examples No. 41 to 44 in which the annealing time of continuous annealing is longer than the range according to the present invention.

[INDUSTRIAL APPLICABILITY]

[0035] The copper alloy material for electric/electronic parts of the present invention is subjected to strain relief annealing for fine working for producing the electric/electronic parts. Accordingly, the copper alloy material is favorable as a copper alloy material for electric/electronic parts in which the rates of dimensional changes in the direction parallel to and perpendicular to the rolling direction before and after heat treatment for strain relief annealing can be simultaneously controlled. The method of producing a copper alloy material for electric/electronic parts of the present invention is able to favorably produce the copper alloy material for electric/electronic parts of the present invention.
[0036] Having described our present invention as related to the present embodiments, it is our intention that the present 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.
[0037] This application claims priority on Patent Application No. 2006-276808 filed in Japan on October 10, 2006, and Patent Application No. 2007-260386 filed in Japan on October 3, 2007, each of which is entirely herein incorporated by reference.

Claims

1. A copper alloy material for electric/electronic parts, which is produced by the steps comprising: finish rolling a copper alloy at a reduction ratio of 40% or less, subjecting the copper alloy finish-rolled to a heat treatment under the conditions at a temperature from 500°C to 800°C for a time period from 1 second to 100 seconds by means of a continuous annealing line, and strain relief annealing the copper alloy heat-treated under the conditions at a temperature from 400°C to 600°C for a time period from 30 seconds to 1000 seconds,
wherein the copper alloy material for electric/electronic parts has rates of dimensional changes before and after the strain relief annealing in both directions parallel to and perpendicular to the rolling direction within the range from -0.02% to +0.02%.

2. The copper alloy material for electric/electronic parts according to Claim 1, wherein the strain relief annealing is conducted in mid course of a material working process for electric/electronic parts.

3. The copper alloy material for electric/electronic parts according to Claim 1 or 2, wherein the copper alloy material for electric/electronic parts is a lead frame material or a connector material.

4. The copper alloy material for electric/electronic parts according to any one of Claims 1 to 3, wherein the copper alloy material for electric/electronic parts comprises Ni from 1.5 mass% to 4.5 mass% and Si from 0.35 mass% to 1.0 mass%, and further comprises at least one or plural elements selected from Mg from 0.05 mass% to 0.15 mass%, Sn from 0.05 mass% to 0.5 mass%, Zn from 0.05 mass% to 1 mass%, Ag from 0.01% to 0.1 mass%, and Cr from 0.05 mass% to 0.4 mass%, with the balance being made of copper and inevitable impurities.

5. A method of producing a copper alloy material for electric/electronic parts, comprising the steps of:

finish rolling a copper alloy at a reduction ratio of 40% or less;
subjecting the copper alloy finish-rolled to a heat treatment under the conditions at a temperature from 500°C to 800°C for a time period from 1 second to 100 seconds by means of a continuous annealing line; and
strain relief annealing the copper alloy heat-treated under the conditions at a temperature from 400°C to 600°C for a time period from 30 seconds to 1000 seconds,

to thereby produce the copper alloy material for electric/electronic parts having rates of dimensional changes before and after the strain relief annealing in both directions parallel to and perpendicular to the rolling direction within the range from -0.02% to +0.02%.

6. The method of producing a copper alloy material for electric/electronic parts according to Claim 5, wherein the strain relief annealing is conducted in mid course of a material working process for electric/electronic parts.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/069686

A. CLASSIFICATION OF SUBJECT MATTER
C22C9/06(2006.01)i, *B21B1/22*(2006.01)i, *B21B3/00*(2006.01)i, *C22F1/08* (2006.01)i, *H01B1/02*(2006.01)i, *H01B5/02*(2006.01)i, *H01B13/00*(2006.01)i, *C22F1/00*(2006.01)n

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C22C1/00-49/14, C22F1/00-3/02, B21B1/22, B21B3/00, H01B1/02, H01B5/02, H01B13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-131829 A (Nikko Metal Manufacturing Co., Ltd.), 30 April, 2004 (30.04.04), Claims; Par. No. [0030]; table 8 (Family: none)	1-6
X	JP 2002-317231 A (Nippon Mining & Metals Co., Ltd.), 31 October, 2002 (31.10.02), Claims; Par. No. [0018]; table 2 & EP 1134730 A2 & US 6602362 B2	1-4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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Date of the actual completion of the international search 07 December, 2007 (07.12.07)	Date of mailing of the international search report 18 December, 2007 (18.12.07)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/069686

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2001-192793 A (Mitsui Mining & Smelting Co., Ltd.), 17 July, 2001 (17.07.01), Claims; table 1 & WO 2001/049903 A1 & EP 1167581 A1 & US 2001/8091 A1	1-3
X	JP 2000-282156 A (Nippon Mining & Metals Co., Ltd.), 10 October, 2000 (10.10.00), Claims; Par. No. [0017]; Fig. 3 (Family: none)	1-3
X	JP 64-12539 A (Japan Energy Corp.), 17 January, 1989 (17.01.89), Claims; table 1 & EP 281038 A2 & US 4908275 A & US 5004520 A	1-3

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2006276808 A **[0037]**
- JP 2007260386 A **[0037]**