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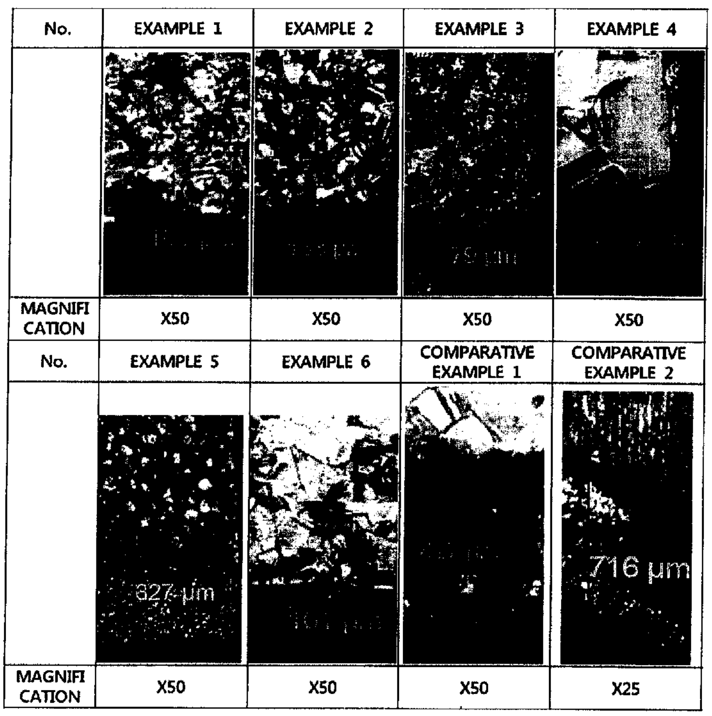
[Continued on next page]

(54) **Title**: COPPER ALLOY MATERIAL FOR SEAWATER AND METHOD FOR PREPARING SAME

【FIG. 1】



(57) **Abstract**: Disclosed are a copper alloy material for seawater comprising 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu), a method for preparing the same and a seawater structure manufactured from the same. In addition, the copper alloy material for seawater further comprises, in an amount of 1% by weight or less, at least one element selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca.

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Description

Title of Invention: COPPER ALLOY MATERIAL FOR SEAWATER AND METHOD FOR PREPARING SAME

Technical Field

[1] The present invention relates to a copper alloy material for use in the seawater, a method for preparing the same and a structure manufactured from the same for use in the seawater. More specifically, the present invention relates to a copper alloy material for use in the seawater comprising 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu), a method for preparing the same and a structure manufactured from the same for use in the seawater. In addition, the copper alloy material for use in the seawater further comprises, in an amount of 1% by weight or less, at least one element selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca.

[2]

Background Art

[3] An aquaculture net made of a metal such as iron, or a chemical fiber such as nylon, polypropylene and polyethylene, is generally used in aquaculture.

[4] However, an aquaculture net made of iron (hereinafter, referred to as an iron net) or an aquaculture net made of a chemical fiber (hereinafter, referred to as a chemical fiber net), marine organisms such as shellfish or algae are readily adhered to the net and the mesh of the net is clogged, causing a deterioration in flow of tidewater, thus limiting supply of oxygen or water-in nutrients to the farm, and thus causing a deterioration in production efficiency and aquaculture yield. In addition, the aquaculture net requires superior strength, since it should be resilient to certain unforeseen circumstances such as tides of seawater and typhoons. The chemical fiber net has a disadvantage of low strength, as compared to the metal net.

[5] Meanwhile, metal nets require sufficient corrosion resistance to seawater, since they are inevitably exposed to ionic components such as salts present in the seawater. Disadvantageously, conventional metal nets are readily corroded by seawater. In addition, other metal nets made of a metal-containing material have economic efficiency problems due to high cost. For this reason, metal nets are preferably made of a material which can be manufactured at a low cost.

[6] Aquaculture nets made of a copper alloy material under recently developed under such a circumference can prevent adhesion of marine organisms thereto due to anti-fouling property derived from silver and copper ions, thus reducing clogging the mesh of the aquaculture net and thereby somewhat solving the high-cost problem caused by

deterioration in production efficiency or yield of cultured fish. However, there is still a need for copper alloys which satisfy the requirements of sufficient strength, corrosion resistance to seawater and anti-fouling property and are made of a cheap material.

[7] Korean Laid-open Patent Publication No. 1993-0019841 discloses a copper alloy material based on Cu-Al-Ni, which has an insufficient strength for use as a structure for use in the seawater, and low economic efficiency, due to use of relatively expensive nickel (Ni). In addition, Korean Laid-open Patent Publication No. 1999-002539 discloses a copper alloy material based on Cu-Al-Zn-Mn-Fe in which aluminum is present in an amount of 5% to 5.3% by weight and zinc is present in an amount of 10% to 20% by weight, thus making it difficult to secure sufficient processability, and in which iron is present in an amount of 2% to 4% by weight, thus making it difficult to secure sufficient corrosion resistance.

[8] Accordingly, there is a need for novel copper alloys which have superior mechanical properties including sufficient strength, superior ductility and low brittleness for use in the seawater, exhibit high corrosion resistance to seawater and anti-fouling property, and is economically inexpensive.

[9]

Disclosure of Invention

Technical Problem

[10] An object of the present invention devised to solve the problem lies on a copper alloy material for use in the seawater which has superior mechanical properties including sufficient strength, superior ductility and low brittleness, and exhibits high corrosion resistance to seawater and anti-fouling property. Another object of the present invention devised to solve the problem lies on a method for preparing the copper alloy material and a structure for use in the seawater manufactured by the copper alloy material.

Solution to Problem

[11] The object of the present invention can be achieved by providing a copper alloy material for use in the seawater comprising 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu). In addition, the copper alloy material further comprises, in an amount of 1% by weight or less, at least one element selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca.

[12] In another aspect of the present invention, provided herein is a method for preparing a copper alloy material for seawater comprising: producing an ingot comprising 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu); annealing the ingot at

600°C to 900°C for 30 minutes to 12 hours, followed by hot extruding and drawing; quenching the resulting product, followed by cold drawing; annealing the resulting product at 500°C to 800°C for 30 minutes to 12 hours; and cold drawing the resulting product.

[13] In the method, the copper alloy material may further comprise, in an amount of 1% by weight or less, at least one element selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca. Final cold drawing ratio may be 10% to 90%.

[14] In another aspect of the present invention, provided herein is a structure for seawater manufactured from a copper alloy material for seawater comprising 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu). The structure for seawater may be an aquaculture net.

Advantageous Effects of Invention

[15] The present invention provides a copper alloy material for seawater which has superior mechanical properties and exhibits superior high anti-fouling property and corrosion resistance to seawater. Further, the present invention provides a method for preparing the copper alloy material.

[16]

Brief Description of Drawings

[17] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and along with the description serve to explain the principles of the invention.

[18] In the drawings:

[19] FIG. 1 shows results observed with an optical microscope after dezincification test using, as samples, copper alloy specimens of Examples and Comparative Examples according to the present invention; and

[20] FIGS. 2 and 3 show results of seawater immersion test using, as samples, copper alloy material specimens of Examples and Comparative Examples according to the present invention. Specifically, FIG. 2 is an image showing variation in the seawater, caused by copper ions eluted from copper alloys after immersion for 20 days. FIG. 3 shows color observation results of specimens after immersion for 20 days. In FIG. 2, Example #1 means test results of the sample prepared in Example 1, Example #6 means test results of the sample prepared in Example 6, Comparative Example #1 means test results for the sample of Comparative Example 1, and Comparative Example #2 means test results for the sample of Comparative Example 2.

[21]

Best Mode for Carrying out the Invention

[22] The term "copper alloy material for seawater" or "copper alloy material for use in the seawater," as used herein, refers to a copper alloy material which is partially or entirely immersed in the seawater for a long period and, for example, a fish net for aquaculture.

[23]

[24] Copper alloy material for seawater according to the present invention

[25] The present invention is directed to a copper alloy material for seawater comprising 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu).

[26] In the copper alloy material, zinc (Zn) is present in an amount of 25% to 40% by weight, based on the weight of the copper alloy material. Zinc improves the strength and hardness of the copper alloy material obtained by alloying a copper metal and enhances heat resistance. In the copper alloy material, when zinc is less than 25% by weight, sufficient hardness cannot be secured and economic efficiency decreases due to an increased amount of copper with respect to zinc, and when zinc exceeds 40% by weight, the second phase, beta (β) phase, indicating brittleness of materials in the obtained copper alloy material, increases and ductility is thus deteriorated, thus causing problems, such as cracking during processing. In the copper alloy material, zinc is preferably present in an amount of 35% to 40% by weight.

[27] In the copper alloy material in accordance with the present invention, manganese (Mn) is present in an amount of 0.5% to 10% by weight, based on the weight of the copper alloy material. As mentioned above, the second phase, beta (β) phase, increases and ductility is thus deteriorated, as the content of zinc in the copper alloy material increases. In this regard, manganese reduces deterioration in ductility. When the content of manganese is less than 0.5% by weight, reduction of ductility through addition of manganese is insufficient, and when the content exceeds 10% by weight, the materials are brittle.

[28] In the copper alloy material, nickel (Ni) is present in an amount of 0.1% to 5% by weight, based on the weight of the copper alloy material. Nickel improves hardness of the obtained copper alloy material. When the content of nickel is less than 0.1% by weight, hardness is not sufficiently improved, and when the content of nickel exceeds 5% by weight, hardness improvement is slowed. Although nickel is added in an amount of 5% by weight or higher, considerable improvement in hardness cannot be obtained. Accordingly, as the amount of nickel increases, economic efficiency is considerably deteriorated.

[29] In the copper alloy material, copper (Cu) is a main component. The copper is present in an amount of the remainder, except for which the afore-mentioned other

components are present in amounts defined above.

[30] In addition, the copper alloy material for seawater may further comprise, in an amount of 1% by weight or less, at least one element selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca. The copper content is decreased in an amount corresponding to the content of the further added element. The further added element exhibits effects, comparable to the copper alloy material of the present invention, without causing in deterioration in hardness and softening resistance of the copper alloy material and having a negative effect on corrosion resistance to seawater and eluted amount of ions.

[31] The copper alloy material may further comprise trace impurities in an amount that does not effect characteristics of the copper alloy material. Accordingly, the copper alloy material for seawater may further comprise trace impurities of at least one selected from the group consisting of As, Ti, S, Cr, Nb and Sb of 0.1% by weight. The impurities may be added during a general process for preparing a copper alloy material and are present in trace amounts, thus having no great effect on the properties of the copper alloy material.

[32] Meanwhile, in the case where a metal is used as a structure for seawater, corrosion may occur due to salt ingredients present in the seawater and the corrosion resistance to seawater of the metal used is considerably important. The copper alloy material in accordance with the present invention exhibits considerably improved corrosion resistance to seawater when a structure for seawater made of the copper alloy material is used in the seawater, compared with a conventional copper alloy material in which a corrosion promoter is readily produced by seawater.

[33] In addition, due to action of copper ions eluted from the copper alloy material according to the present invention, adhesion of marine organisms to the structure for seawater is prevented, the seawater region, in which the structure for seawater is immersed, is sterilized, and anti-fouling of the corresponding seawater region is improved. The common anti-fouling property of copper ions is known in the art and, for example, antibacterial properties thereof can be confirmed from the website (http://www.copper.org/antimicrobial/homepage.html) of the Copper Development Association (CDA).

[34] Meanwhile, it is known that the eluted amount of copper ions in the copper alloy material should be 60% or higher, based on the eluted amount of copper ions of pure copper, in order to impart sufficient anti-fouling property to the structure for seawater manufactured from the copper alloy material. When the eluted amount of copper ions of copper alloy material is 60% or less of the eluted amount of copper ions of pure copper, the pollution prevention effects cannot be sufficiently realized. Accordingly, it can be seen that the amount of copper ions eluted from the copper alloy material in the

seawater should be 415.8 mg/m²/day or more, in order to secure sufficient antibacterial properties, since the amount of copper ions eluted from pure copper in the seawater is about 693 mg/m²/day. As can be seen from Examples mentioned below, the copper alloy material in accordance with the present invention exhibits an amount of eluted copper ions which is 60% or more of copper ions eluted from pure copper.

[35] The strength of the copper alloy material according to the present invention may be evaluated in terms of hardness and softening resistance. The hardness of the copper alloy material may vary depending on the percentage reduction in thickness after annealed in the preparation process. The copper alloy material according to the present invention has a hardness ranging from 120 to 160 Hv when processed at a percentage reduction in thickness of about 10% to 30%, immediately after annealing. Within the range defined above, the copper alloy material has a sufficient strength required for the structure for sea water such as aquaculture nets. The softening resistance may be evaluated from a hardness measured after the copper alloy material is reduced in thickness to at most 70% due to an increased processing ratio, placed in a annealing furnace at 400℃ and maintained for 30 minutes. The hardness should be within a range from about 95 to about 120 Hv.

[36]

[37] <u>Method for preparing copper alloy material for seawater according to the present invention</u>

[38] The copper alloy material for seawater according to the present invention is prepared by the method comprising: producing an ingot from 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu); annealing the ingot at 600°C to 900℃ for 30 minutes to 12 hours, followed by hot extruding and drawing; quenching the resulting product to room temperature, followed by cold drawing; annealing the resulting product at 500℃ to 800℃ for 30 minutes to 12 hours; and cold drawing the resulting product.

[39] In accordance with the method for preparing a copper alloy material for seawater, first, an ingot (billet) is produced by mold casting 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni), and the remainder of copper (Cu). The ingot may further comprise 1% by weight or less of at least one selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca.

[40] The ingot thus obtained is annealed in a continuous annealing furnace at a temperature of 600℃ to 900℃ for 30 minutes to 12 hours, hot-extruded and drawn in a linear or rod shape. When the annealing is performed at 600℃ or lower, sufficient effects of annealing cannot be obtained, recrystallization in the metal structure is difficult and excessive hot load occurs. When the annealing is performed at 900℃ or

higher, coarse structures are formed and abnormal structures are thus produced in the metal structure. When the annealing is performed for 30 minutes or less, softening of metal structures is not sufficient, and when the annealing is performed for 12 hours, disadvantageously, metal structures are excessively softened and production efficiency is deteriorated.

[41] Then, the annealed product is quenched to room temperature of about 21℃ to about 30℃ and is then cold drawn.

[42] Then, the resulting product is annealed at 500℃ to 800℃ for 30 minutes to 12 hours. The annealing may be carried out in a bell or batch annealing furnace. The annealing temperature ranges from 500℃ to 800℃, since the product annealed once in the previous step is recrystallized at a relatively low temperature. When annealing is performed at 500℃ or lower, recrystallization in the metal structure is disadvantageously difficult, and when the annealing is performed at 800℃ or higher, coarse structures are grown, abnormal structures are thus generated, and production efficiency is deteriorated to the excessively high temperature. When the annealing is performed for 30 minutes or less, softening of metal structures is not sufficient, and when annealing is performed for 12 hours or longer, disadvantageously, metal structures are excessively softened and production efficiency is deteriorated.

[43] Then, the resulting product is cold drawn. In the cold drawing step, a drawing ratio ranges from 10% to 90%. When the drawing ratio is lower than 10%, sufficient mechanical strength cannot be secured, and when the drawing ratio exceeds 90%, a percentage cold reduction in thickness disadvantageously reaches a limit due to the excessive processing ratio. In order to obtain the drawing ratio or a specific target drawing ratio range in accordance with the intended use of the final product, the annealing and cold drawing steps may be repeated.

[44]

[45] **EXAMPLES**

[46] Now, the present invention will be described in more detail with reference to the following examples. These examples are provided only for illustrating the present invention and should not be construed as limiting the scope and spirit of the present invention.

[47] <u>Examples 1 to 14</u>

[48] In order to prepare the copper alloy material in accordance with the present invention, an ingot with a chemical composition shown in the following Table 1 was prepared and annealed at 600℃ for 6 hours, hot-extruded and drawn to a thickness of 1.5 mm. The resulting product was quenched to room temperature, cold-drawn and annealed at 600℃ for one hour. The resulting specimen was cut and then cold drawn at a percentage reduction in thickness of at most 30% after immediately annealing, to

obtain a final sample.

[49] Comparative Examples 1 to 3

[50] The sample of Comparative Example 1 was a brass product (UR30) commercially available from Mitsubishi (Japan) and the sample of Comparative Example 2 was a brass (alloy of copper and zinc in a ratio of 6:4), and the sample of Comparative Example 3 was pure copper.

[51] Table 1

[Table 1]

TYPE	SampleNo.	Alloy composition (% by weight)				
		Cu	Zn	Mn	Ni	Others
Examples	1	Remainder	36	3	1	-
	2	Remainder	36	3	0.1	-
	3	Remainder	36	3	3	-
	4	Remainder	36	0.5	1	-
	5	Remainder	36	6	1	-
	6	Remainder	25	3	1	-
	7	Remainder	36	3	1	Sn 0.2
	8	Remainder	36	3	1	Al 0.1
	9	Remainder	36	3	1	Co 0.2
	10	remainder	36	3	1	Fe O.2
	11	remainder	36	3	1	P 0.04
	12	remainder	36	3	1	Mg 0.05
	13	remainder	36	3	1	Pb 0.03
	14	remainder	36	3	1	Ca 0.1
Comparative Examples	1	remainder	35	-	0.4	Sn 0.6
	2	remainder	40	-	-	
	3	100	-	-	-	-

[52]

[53] Experimental Example

[54] The hardness, softening resistance, dezincification, ion elution properties and corrosion resistance to seawater of the specimens of Examples 1 to 14 and the samples of Comparative Examples 1 to 3 obtained in accordance with Preparation Example, as samples, were tested in order to confirm mechanical properties, anti-bioattachment and

corrosion resistance to seawater of copper alloys.

[55] In order to measure hardness, hardness testing was performed using a micro Vickers hardness tester meter. The results thus obtained are shown in Table 2.

[56] In order to measure softening resistance, the material subjected to reduction in thickness at an increased processing ratio, that is, at a percentage (at most 70%) was placed in a furnace at 400℃, held for 30 minutes and removed. The decrease in hardness of the material was measured using a micro Vickers hardness tester. The results are shown in Table 2. As can be seen from Table 2, the samples of Examples 1 to 14 fall within the range of about 98 to 119 Hv.

[57] In order to confirm dezincification, respective specimens were immersed in a 75℃ aqueous $CuCl_2$ solution for 24 hours and then removed. The cut surface of the material was polished and etched, and corrosion thickness was measured with an optical microscope. Results shown in Table 2 and FIG. 1 confirmed that the samples of Examples 1 to 14 exhibited considerably improved dezincification, as compared to the sample of Comparative Example 1.

[58] KS D9502 salt water spray test was performed to evaluate corrosion resistance to seawater and salt water prepared by dissolving sodium chloride in distilled water was used. The specimens were placed in a salt water spray tester, sprayed for 24 hours at an interval of several hours and removed. Corrosion of the specimen was observed. The results are shown in Table 2. The notation is based on ○: good, △: insufficient and X: bad, in accordance with a naked eye examination standard. In order to confirm copper ion elution properties in seawater, the respective specimens were immersed in a beaker containing 200 ml of seawater for 24 hours and the amount of eluted copper ions was measured. The results are shown in Table 2. For pure copper, the amount of eluted copper ions was 693 mg/m^2/day and 60% of the amount of eluted copper ions was 415.8 mg/m^2/day. In all of the samples of Examples 1 to 14, 60% of the amount of eluted copper ions for pure copper was 415.8 mg/m^2/day or more, which indicates that the samples can provide sufficient anti-bioattachment.

[59] Table 2

[Table 2]

TYPE	Sample No.	Hardness (Hv)	Softening resistance (Hv)(heating at 400℃ for 30 min)	Dezincification (thickness, ㎛)	Corrosion resistance to seawater	Amount of eluted ions (mg/㎡/day)
Examples	1	138	100	161	○	489
	2	136	103	163	○	465
	3	143	108	79	○	457
	4	122	98	120	○	456
	5	147	128	327	○	446
	6	139	119	101	○	497
	7	140	110	170	○	480
	8	141	103	175	○	459
	9	137	105	183	○	460
	10	138	107	204	○	472
	11	136	105	200	○	493
	12	140	101	197	○	470
	13	135	100	230	○	480
	14	138	103	221	○	469
Comparative Examples	1	140	111	427	○	486
	2	126	85	716	△	420
	3	110	70	-	-	693

[60] As demonstrated by the tests, the samples of Example 1 to 14 exhibited considerably superior dezincification and good corrosion resistance to seawater, as compared to the samples of Comparative Examples 1 to 3. Further, in the samples of Examples 1 to 14, 60% of the amount of eluted copper ions for pure copper was 415.8 mg/㎡/day or more, which indicates that the samples satisfy the requirements for anti-bioattachment.

[61] Meanwhile, as can be seen from the results of FIG. 2, variation in color was confirmed when immersed in seawater. The sample of Example 1 and the sample of Example 6 were added to beakers and were marked 'Example #1' and 'Example #6', respectively. It was confirmed that the Example #1 and the Example #6 were transparent and variation in color could not be confirmed by the naked eye, while 'Comparative

Example #1' and 'Comparative Example #2', to which the sample of Comparative Example 1 and the sample of Comparative Example 2 were added, turned blue. Further, FIG. 3 shows color observation results of specimens after immersed for 20 days. As can be seen from FIG. 3, the sample of Example 1 and the sample of Example 6 were not greatly varied, as compared to prior to immersion, while the sample of Comparative Example 1 turned blue and the sample of Comparative Example 2 was partially corroded and turned gray.

[62] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

[Claim 1] A copper alloy material for seawater comprising 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu).

[Claim 2] The copper alloy material according to claim 1, wherein the copper alloy material further comprises, in an amount of 1% by weight or less, at least one element selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca.

[Claim 3] A method for preparing a copper alloy material for seawater comprising:
producing an ingot from 25% to 40% by weight of zinc (Zn), 0.5% to 10% by weight of manganese (Mn), 0.1% to 5% by weight of nickel (Ni) and the remainder of copper (Cu);
annealing the ingot at 600°C to 900°C for 30 minutes to 12 hours, followed by hot extruding and drawing;
quenching the resulting product to room temperature, followed by cold drawing;
annealing the resulting product at 500°C to 800°C for 30 minutes to 12 hours; and
cold drawing the resulting product.

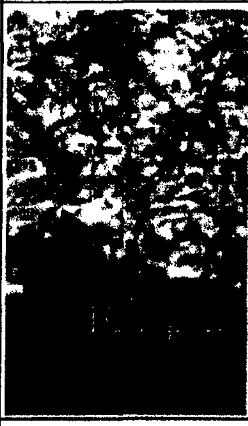
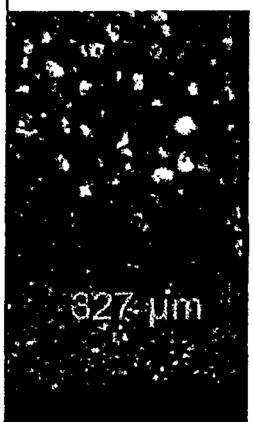
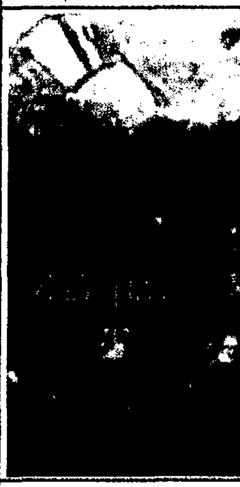
[Claim 4] The method according to claim 3, wherein the copper alloy material further comprises, in an amount of 1% by weight or less, at least one element selected from the group consisting of Sn, Al, Si, Co, Fe, P, Mg, Pb and Ca.

[Claim 5] The method according to claim 3 or 4, wherein a final drawing ratio is 10% to 90%.

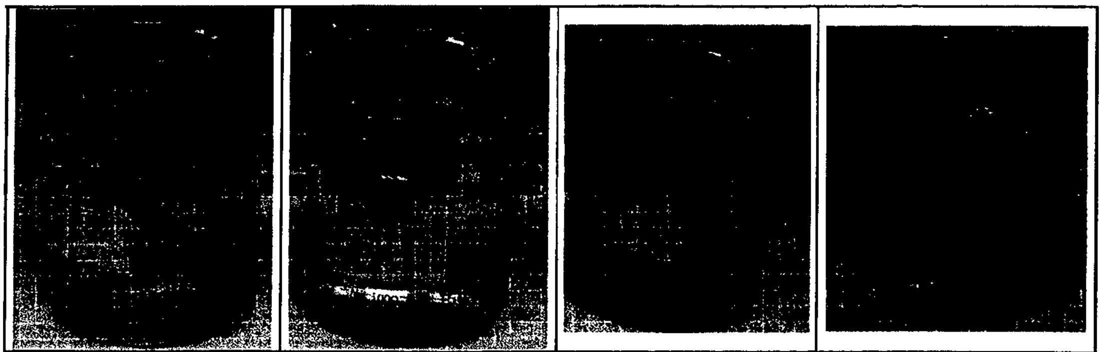
[Claim 6] A structure for seawater manufactured from the copper alloy material for seawater according to claim 1 or 2.

[Claim 7] The structure according to claim 6, wherein the structure for seawater is an aquaculture net.

【FIG. 1】

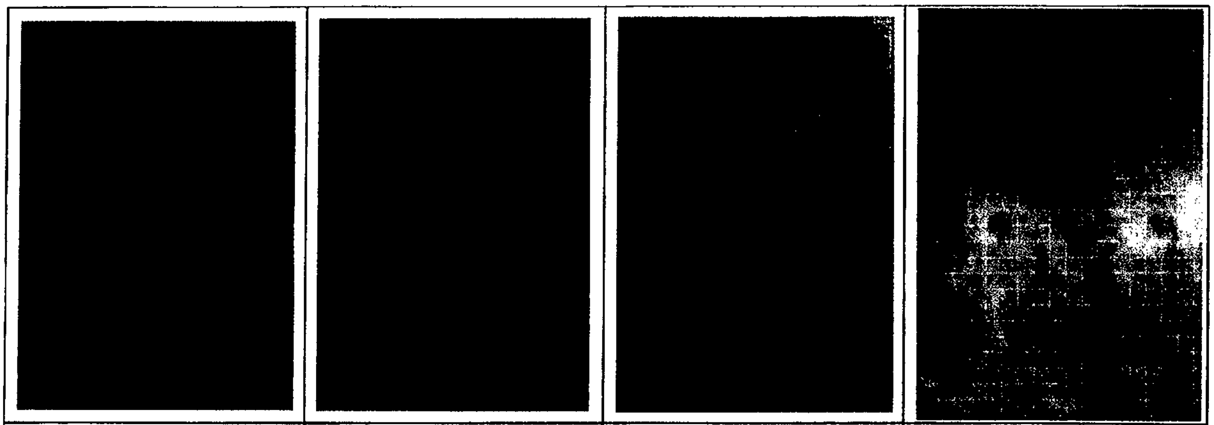
No.	EXAMPLE 1	EXAMPLE 2	EXAMPLE 3	EXAMPLE 4
				
MAGNIFICATION	X50	X50	X50	X50
No.	EXAMPLE 5	EXAMPLE 6	COMPARATIVE EXAMPLE 1	COMPARATIVE EXAMPLE 2
				
MAGNIFICATION	X50	X50	X50	X25

【FIG. 2】



No change	No change	Blue	Blue
EXAMPLE 1	EXAMPLE 6	COMPARATIVE EX. 1	COMPARATIVE EX. 2

【FIG. 3】



No change	No change	Blue	Grey
EXAMPLE 1	EXAMPLE 6	COMPARATIVE EXAMPLE 1	COMPARATIVE EXAMPLE 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2011/003449

A. CLASSIFICATION OF SUBJECT MATTER

C22C 9/04(2006.01)i, C22F 1/08(2006.01)i

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)
C22C 9/04; B21C 37/06; C22C 9/05; C22C 9/01

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: seawater; corrosion; Zn; Ni; Mn; and cold drawing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010-0061884 A1 (CLARK CRAIG et al.) 11 March 2010 See abstract; paragraphs [0003], [0013]-[0026]; and claims 1-24.	1-7
A	US 4631171 A (MCDONALD; ALLEN S. et al.) 23 December 1986 See abstract; column 1 lines 10-42; and claims 1-8.	1-7
A	KR 10-1999-0002539 A (MIN; BYONG KWON) 15 January 1999 See abstract and claims 1-4.	1-7
A	KR 10-2000-0077017 A (OLIN CORP.) 26 December 2000 See abstract and claims 1-3.	1-7
A	US 2009-0022620 A1 (WEBER KAI) 22 January 2009 See abstract and claims 1-3.	1-7

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

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 FEBRUARY 2012 (13.02.2012)	**15 FEBRUARY 2012 (15.02.2012)**

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Facsimile No. 82-42-472-7140

Authorized officer
OH, Jun Cheol
Telephone No. 82-42-481-8506

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2011/003449

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