

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
17 January 2002 (17.01.2002)

PCT

(10) International Publication Number
WO 02/04688 A1

(51) International Patent Classification⁷: **C22C 14/00**

HUR, Shin, Goo [KR/KR]; 116 Woobong-ri, Onsan-eup, Wulju-gun, Ulsan-shi 689-890 (KR).

(21) International Application Number: PCT/KR01/01045

(22) International Filing Date: 19 June 2001 (19.06.2001)

(74) Agents: **KIM, Byung, Jin** et al.; #201 Hwajin Building, 828 Yoksam-dong, Gangnam-gu, Seoul 135-080 (KR).

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2000/38920 7 July 2000 (07.07.2000) KR

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(71) Applicant (*for all designated States except US*):
BIO-SMART, LTD. [KR/KR]; 116 Woobong-ri, Onsan-eup, Wulju-gun, Ulsan-shi 689-891 (KR).

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

(72) Inventors; and

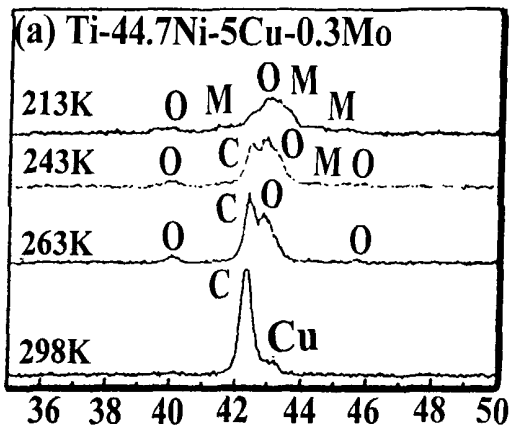
(75) Inventors/Applicants (*for US only*): **NAM, Tae, Hun** [KR/KR]; #101-503 Hyundai Apt., 20 Shinan-dong, Jinju-shi, Kyunsangnam-do 660-110 (KR). **KIM, Ji, Soon** [KR/KR]; #402 Sunkyoung Apt., 833-1, Moogeo-2-dong, Nam-gu, Ulsan-shi 680-192 (KR). **KANG, Seung, Baik** [KR/KR]; #102-1103 Hongje-Hyundai Apt., 331 Hongje-1-dong, Seodaemun-gu, Seoul 120-091 (KR). **PARK, Dong, Keun** [KR/KR]; Ga 201 Mugunghwa Apt., 1623-1, Shinjung-dong, Nam-gu, Ulsan-shi 680-010 (KR).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: Ti-Ni-Cu-Mo SHAPE MEMORY ALLOYS



C : Cubic
O : B19 Orthorhombic
M : B19' Monoclinic

(57) Abstract: The present invention relates to a Ti-Ni-Cu-Mo shape memory alloys to provide Ti-Ni-Cu alloys in essential in which Mo of below 1 at% is added to make separate B2-B19 deformation and B19-B19' deformation and to improve slip critical stress by using the solution treatment material, thereby achieving good shape memory effect by B2-B19 deformation without plastic deformation in carrying out the thermal cycle under the load stress of 120 Mpa.

WO 02/04688 A1

Ti-Ni-Cu-Mo SHAPE MEMORY ALLOYSTECHNICAL FIELD

The present invention relates to a Ti-Ni-Cu-Mo shape
5 memory alloys, more specifically, a Ti-Ni-Cu-Mo shape
memory alloys in which B2-B19 transformation and B19-B19'
transformation are divided in essential and to obtain
shape memorizing properties by B2-B19 deformation by
partial replacement of Ni by Mo, thereby improving slip
10 critical stress.

BACKGROUND ART

The shape memory alloys are classified to Ti-Ni
alloys, Cu alloys or Fe alloys and Ti-Ni alloys with
15 equivalent atomic ratio is being put to wide use. The
shape memorizing properties of the Ti-Ni shape memory
alloys with equivalent atomic ratio are achieved by
thermoelastic type martensite deformation of B2 (Cubic)-
B19' (Monoclinic), and the lattice deformation acts for
20 the excellent shape memorizing properties.

In addition to the B2-B19' deformation, the Ti-Ni
alloys show B2-R (Rhombohedral) deformation occurring
before the B19' martensite by thermomechanical treatment
and thermoseasoning treatment, which also acts for the
25 excellent shape memorizing properties.

However, there exists clear contrast between the B2-B19' deformation effect and the B2-R deformation effect and thus the practical necessity is raised to the shape memory alloys with an intermediate shape memorizing properties such as deformation deterioration volume or deformation hysteresis in practical utilize of the shape memory alloys. Ti-Ni-Cu alloys have been developed by partial substitution of Ni of the Ti-Ni alloys by Cu.

Ti-Ni-Cu alloys perform B2-B19' deformation below 5at% Cu concentration. Above 10at% of Cu concentration, Ti-Ni-Cu alloys perform B2-B19 orthorhombic deformation before B19' martensite, which show the intermediate shape memorizing properties between B2-B19' and B2-R deformations.

With the Cu concentration below 10at% the temperature range for B2-B19 deformation and the temperature range for B19-B19' deformation are definitely divided for suitable and industrial use of the B2-B19 deformation but plastic deformation is not possible to use in this case.

There are a disadvantage to carry out the method to clearly make separate the B2-B19 deformation from the B19-B19' deformation in the alloys below 10at% of Cu concentration of plastic deformation in order to practically utilize the B2-B19 deformation of Ti-Ni-Cu

shape memory alloys.

Another disadvantage is degradation of the shape memory effect due to slip deterioration in use because Ti-Ni-Cu shape memory alloys keep low slip critical stress in the state of solution treatment.

Conventional Ti-Ni-Cu shape memory alloys have been treated by thermomechanical treatment to compliment slip to the alloys but this still has a disadvantage that B2-B19 deformation and B2-B19' deformation become close.

DISCLOSURE OF THE INVENTION

The present invention has an object to provide a Ti-Ni-Cu-Mo shape memory alloys to utilize B2-B19 deformation having good shape memorizing effect by making separation of B2-B19 deformation and B19-B19' deformation and without addition of any thermal treatment such as thermomechanical treatment on the solution treated material by improving slip critical stress.

In order to achieve the above object, the present invention provides the shape memory alloys containing 50Ti-(45-X)Ni-5Cu-XMo(at%) (X=0.3~1.0), 50Ti-(40-X)Ni-10Cu-XMo(at%) (X=0.3~1.0), 50Ti-(35-X)Ni-15Cu-XMo(at%) (X=0.3~1.0), and 50Ti-(30-X)Ni-20Cu-XMo(at%) (X=0.3~1.0).

The shape memory alloys is made of essential Ti-Ni-Cu alloys, to add Mo below 1at% to divide B2-B19 deformation and B19-B19' deformation and to improve slip critical stress by using solution treatment material to carry out
5 the thermal cycle under the load stress of 120Mpa and obtain shape memory effect by only B2-B19 deformation without plastic deformation.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The invention will be described in detail through use of the accompanying drawings in which:

Fig. 1A is a graph showing the electric resistance temperature of 50Ti-44.7Ni-5Cu-0.3Mo alloys;

Fig. 1B is a graph showing the electric resistance
15 temperature of 50Ti-44.5Ni-5Cu-0.5Mo alloys;

Fig. 1C is a graph showing the electric resistance temperature of 50Ti-44.0Ni-5Cu-1.0Mo alloys;

Fig. 2A is a graph showing the X-ray diffraction test of 50Ti-44.7Ni-5Cu-0.3Mo(at%);

20 Fig. 2B is a graph showing the X-ray diffraction test of 50Ti-44.5Ni-5Cu-0.5Mo(at%);

Fig. 2C is a graph showing the X-ray diffraction test of 50Ti-44.0Ni-5Cu-0.1Mo(at%);

Fig. 3 shows a Mo concentration dependency on Ms'

(B2-B19 deformation initiation temperature) and Ms(B19-B19' deformation initiation temperature);

Fig. 4 is a graph showing the load stress dependency on restorable transformation volume of Ti-44.7Ni-5Cu-0.3Mo(at%) alloys and Ti-44.5Ni-5Cu-0.5Mo(at%) alloys;

Fig. 5A is a graph showing the electric resistance temperature of Ti-39.7Ni-10Cu-0.3Mo alloys;

Fig. 5B is a graph showing the electric resistance temperature of Ti-39.5Ni-19Cu-0.5Mo alloys;

Fig. 6A is a graph showing the X-ray diffraction type of Ti-39.7Ni-10Cu-0.3Mo alloys;

Fig. 6B is a graph showing the X-ray diffraction type of Ti-39.5Ni-19Cu-0.5Mo alloys;

Fig. 7A is a graph showing the temperature and transformation volume of Ti-39.7Ni-10Cu-0.3Mo(at%) alloys;

Fig. 7B is a graph showing the temperature and transformation volume Ti-39.5Ni-19Cu-0.5Mo (at%) alloys;

Fig. 8A is a graph of the electric resistance of Ti-34.7Ni-15Cu-0.3Mo(at%) alloys;

Fig. 8B is a graph of the electric resistance of the Ti-34.5Ni-15Cu-0.5Mo(at%) alloys;

Fig. 8C is a graph of the electric resistance of the Ti-34.0Ni-15Cu-1.0Mo(at%) alloys;

Fig. 9 is a graph of the X-ray diffraction test of Ti-34.7Ni-15Cu-0.3Mo(at%) alloys;

Fig. 10 is a graph of the constant load thermal cycle test to measure the shape memory effect of Ti-34.7Ni-
5 15Cu-0.3Mo(at%) alloys and the Ti-39.5Ni-19Cu-0.5Mo(at%) alloys;

Fig. 11A is a graph showing the electric resistance temperature of Ti-29.7Ni-20Cu-0.3Mo alloys;

Fig. 11B is a graph showing the electric resistance
10 temperature of Ti-29.5Ni-20Cu-0.5Mo alloys;

Fig. 11C is a graph showing the electric resistance temperature of Ti-29.0Ni-20Cu-1.0Mo alloys;

Fig. 12 is a graph of the X-ray diffraction test of Ti-27.7Ni-20Cu-0.3Mo alloys; and

15 Fig. 13 is a graph of the constant load thermal cycle test to measure the shape memory effect of the Ti-29.7Ni-20Cu-0.3Mo(at%) alloys.

BEST MODE FOR CARRYING OUT THE INVENTION

20 In the invention, Mo below 1 at% is added to the Ti-45Ni-5Cu(at%), Ti-40Ni,10Cu9at%), and Ti-35Ni-20Cu(at%) alloys. Because the melting point of Mo is at 26°C, hardening alloys of T and Mo is fabricated by using a plasma solution method. Fabricated hardening alloys and

sponge Ti (99.6% purity), pure Ni (99.9% purity) and pure Cu (99.9% purity) are charged to the graphite crucible to perform vacuum melting of high frequency.

Cast ingot is given by hot rolling at 1123K in the
5 alloys of Cu concentration below 10at% and worked with a rod wire of 1.2mm diameter at 298K. Cold worked volume is made below 25% at this time.

The alloys with Cu concentration above 15 at% cannot perform rolling and drawing and the specimen is directly
10 given by the ingot.

Setting the volume of Mo below 1 at% is to avoid low deformation temperature when the volume exceeds 1 at%, which is out of the usual temperature range, and to avoid deterioration of the material workability.

15

[Example 1]

Fig. 1A is a graph showing the electric resistance temperature of 50Ti-44.7Ni-5Cu-0.3Mo alloys to which Ni of Ti-45Ni-5Cu(at%) is replaced by Mo of 0.3%,

20 Fig. 1B is a graph showing the electric resistance temperature of 50Ti-44.5Ni-5Cu-0.5Mo alloys to which Ni of Ti-45Ni-5Cu(at%) is replaced by Mo of 0.5%, and

Fig. 1C is a graph showing the electric resistance temperature of 50Ti-44.0Ni-5Cu-1.0Mo alloys to which Ni

of Ti-45Ni-5Cu(at%) is replaced by Mo of 0.3%. A melting point for Mo is 2610° C. Hardening alloys of Ti and Mo are fabricated by using plasma solution method. Fabricated hardening alloys and sponge Ti(99.6% purity), pure
5 Ni(99.9% purity) and pure Cu(99.9% purity) are charged to the graphite crucible to perform vacuum melting with high frequency. Cold worked volume is set 25%. After cold working, the alloys are kept at 1123K for one hour and solution-treated in the ice water. Then, Ti-44.7Ni-5Cu-
10 0.3Mo(at%) alloys and the Ti-44.5Ni-5Cu-0.5Mo(at%) alloys reveal the two-stage change of electric resistance, while the Ti-44.0Ni-5Cu-1.0Mo(at%) alloys reveal the one-stage of electric resistance.

Fig. 2A is a graph showing the X-ray diffraction test
15 result during temperature change to show the electric resistance of 50Ti-44.7Ni-5Cu-0.3Mo(at%) alloy,

Fig. 2B is a graph showing the X-ray diffraction test result during temperature change to show the electric resistance of 50Ti-44.5Ni-5Cu-0.5Mo(at%) alloy, and

20 Fig. 2C is a graph showing the X-ray diffraction test result during temperature change to show the electric resistance of 50Ti-44.0Ni-5Cu-0.1Mo(at%) alloy.

B19 martensite is found in all 50Ti-44.7Ni-5Cu-0.3Mo(at%) alloys, 50Ti-44.5Ni-5Cu-0.5Mo(at%) alloys and

50Ti-44.0Ni-5Cu-0.1Mo(at%) alloys.

In 50Ti-44.0Ni-5Cu-0.1Mo(at%) alloys, it is found that B2-B19 deformation and B19-B19' deformation are clearly divided.

5 Fig. 3 shows the Mo concentration from Ms' (B2-B19 deformation initiation temperature) and Ms(B19-B19' deformation initiation temperature) from Figs. 1 and 2. Larger volume of Mo is proportional to increase of the temperature range of B19 martensite.

10 Fig. 4 shows a load stress dependency on recoverable stress of Ti-44.7Ni-5Cu-0.3Mo(at%) alloys and Ti-44.5Ni-5Cu-0.5Mo(at%) alloys. As the more load stress is given, the recoverable stress increases. As a result, Ti-44.7Ni-5Cu-0.3Mo(at%) alloys has up to 6.4% transformation and
15 Ti-4.5Ni-5Cu-0.5Mo(at%) has up to 7% transformation.

[Example 2]

Fig. 5A shows an electric resistance temperature change of Ti-39.7Ni-10Cu-0.3Mo alloys, and

20 Fig. 5B shows an electric resistance temperature change of Ti-39.5Ni-19Cu-0.5Mo alloys.

Hardening alloys of Ti and Mo are fabricated by using plasma solution method. Fabricated hardening alloys and sponge Ti(99.6% purity), pure Ni(99.9% purity) and pure

Cu(99.9% purity) are charged to the graphite crucible to perform vacuum melting with high frequency. Cold worked volume is set 25%. After cold working, the alloys are kept in 1123K for one hour and solution treated in the
5 ice water.

Fig. 6 shows a X-ray diffraction test result with temperature changes to examine the electric resistance change reasons of Fig. 5. In the Ti-39.7Ni-10Cu-0.3Mo alloys (Fig. 6A) and Ti-39.5Ni-19Cu-0.5Mo alloys (Fig.
10 6B) B19 martensite is found but B19' martensite is not found even cooling at the temperature of 213K.

This is caused by addition of Mo. Mo acts to divide the temperature range over 100K between the B2-B19 deformation and B19-B19' deformation.

15 Fig. 7 shows the constant load thermal cycle test result to measure the shape memory effect of Ti-39.7Ni-10Cu-0.3Mo(at%) alloys and the Ti-39.5Ni-19Cu-0.5Mo(at%) alloys. Specifically, Fig. 7A shows a transformation temperature change of Ti-39.7Ni-10Cu-0.3Mo(at%) alloys
20 and Fig. 7B shows a transformation temperature change of Ti-39.5Ni-19Cu-0.5Mo(at%) alloys. Although only solution treatment is applied to all specimen, transformation of cooling is restored in 120 Mpa heating.

[Example 3]

Fig. 8A shows an electric resistance change of Ti-34.7Ni-15Cu-0.3Mo(at%) alloys, Fig. 8B shows an electric resistance change of the Ti-34.5Ni-15Cu-0.5Mo(at%) alloys, and Fig. 8C shows an electric resistance change of the Ti-34.0Ni-15Cu-1.0Mo(at%) alloys. The fabricating method is the same as the Example 1 and Example 2. Rolling and drawing are performed and the ingot cuts the specimen. Cut specimen is given by solution treatment same as the Example 1.

Fig. 9 shows a X-ray diffraction test result of Ti-34.7Ni-15Cu-0.3Mo (at%) alloys to explain an electric resistance change in which only B19 martensite is observed at 123K cooling.

Fig. 10 shows a constant load thermal cycle test result to measure the shape memory effect of Ti-34.7Ni-15Cu-0.3Mo (at%) alloys and the Ti-39.5Ni-19Cu-0.5Mo (at%) alloys. Although only solution treatment is applied to all specimens, transformation of cooling is restored in 120 Mpa heating.

[Example 4]

Fig. 11A shows an electric resistance temperature change of Ti-29.7Ni-20Cu-0.3Mo alloys, Fig. 11B shows an

electric resistance temperature change of Ti-29.5Ni-20Cu-0.5Mo alloys, and Fig. 11C shows an electric resistance temperature change of Ti-29.0Ni-20Cu-1.0Mo alloys.

Fabrication method is same as the Example 1 but rolling
5 and drawing are not possible for these alloys. Specimen is directly cut from the ingot. Cut specimen is given by the same solution treatment as the Example 1.

Fig. 12 shows the X-ray diffraction test result of Ti-27.7Ni-20Cu-0.3Mo alloys to explain the electric
10 resistance change. B10 martensite is observed at 88K cooling.

Fig. 13 shows a constant load thermal cycle test result to measure the shape memory effect of the Ti-29.7Ni-20Cu-0.3Mo (at%) alloys. Cooling is restored in
15 120 Mpa heating although only solution treatment is applied to all specimen.

INDUSTRIAL APPLICABILITY

In the invention, Ti-Ni-Cu-Mo shape memory alloys
20 increase stability of the B19 martensite to make clearly separate the B2-B19 deformation and B19-B19' deformation so as to industrially utilize the B2-B19 deformation having superior shape memorizing properties. Further, Ti-Ni-Cu-Mo shape memory alloys of the invention improves

slip critical stress and utilize solution treated material without the additional heat treatment such as thermomechanical treatment. As a result, Ti-Ni-Cu-Mo shape memory alloys of the invention has low temperature hysteresis of 10K and high load stress of 120Mpa, as good driving element material.

The described embodiments are to be considered in all respects only as illustrative, and not restrictive. The scope of the inventions, therefore, indicated by the appended claims, rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

CLAIMS

1. Ti-Ni-Cu-Mo shape memory alloys consisting of 50Ti-
(45-X)Ni-5Cu-XMo(at%) (X=0.3~1.0) .

5

2. Ti-Ni-Cu-Mo shape memory alloys consisting of 50Ti-
(40-X)Ni-10Cu-XMo(at%) (X=0.3~1.0) .

3. Ti-Ni-Cu-Mo shape memory alloys consisting of 50Ti-
10 (35-X)Ni-15Cu-XMo(at%) (X=0.3~1.0) .

4. Ti-Ni-Cu-Mo shape memory alloys consisting of 50Ti-
(30-X)Ni-20Cu-XMo(at%) (X=0.3~1.0) .

FIG.1A

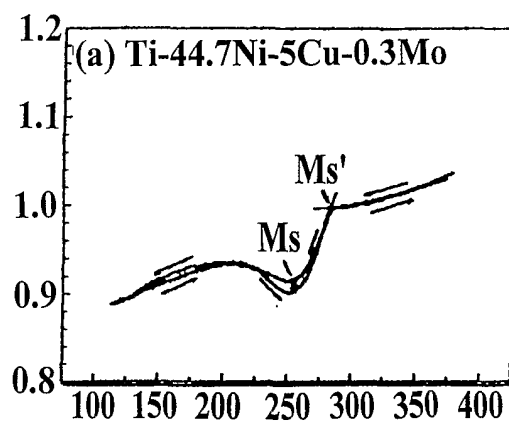


FIG.1B

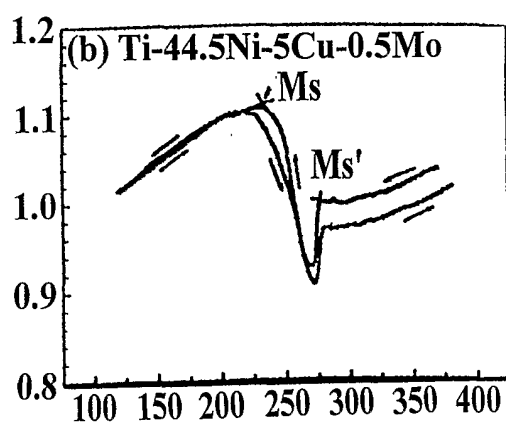


FIG.1C

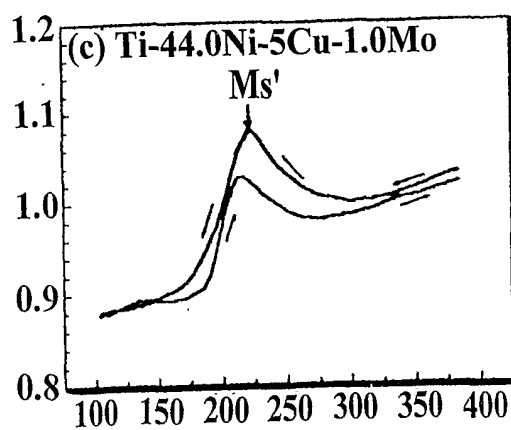


FIG. 2A

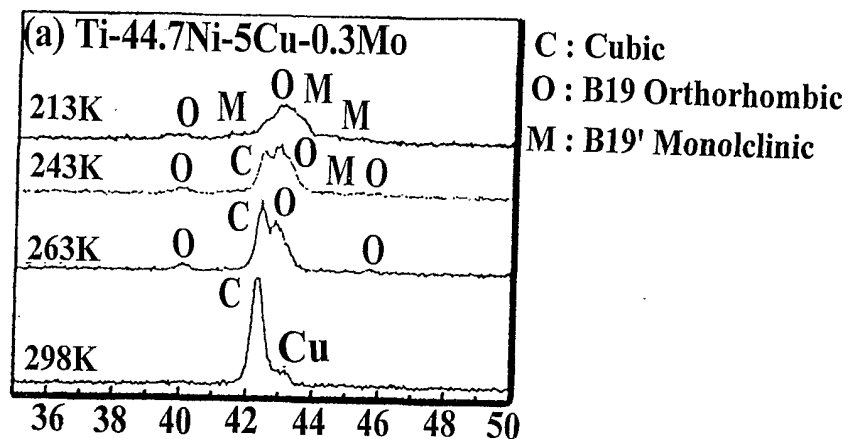


FIG. 2B

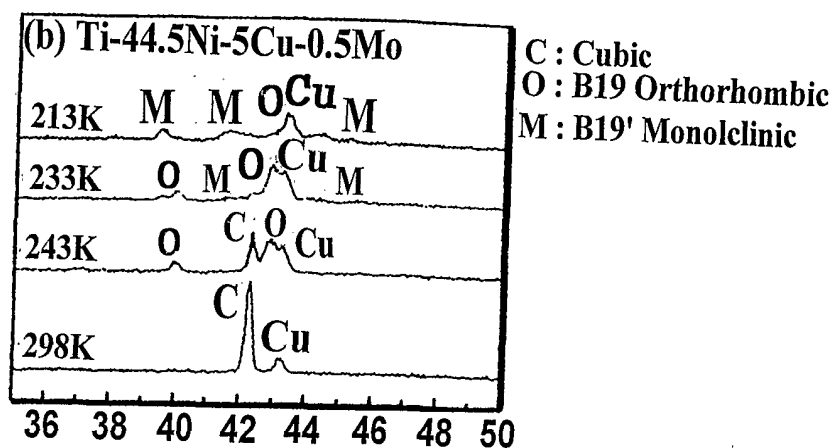


FIG. 2C

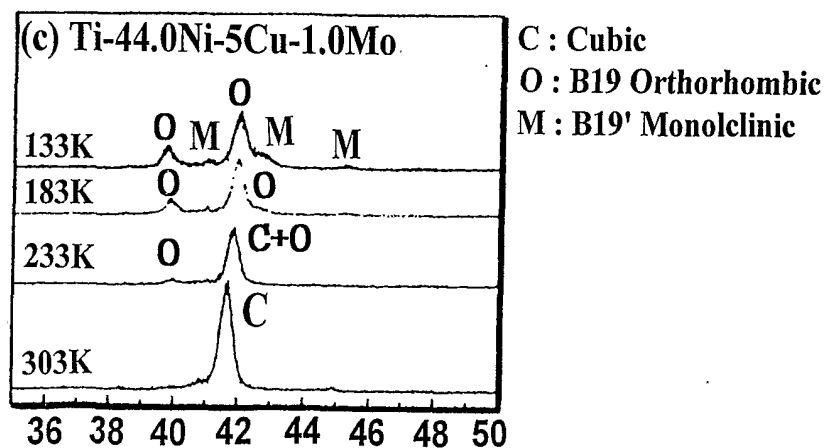


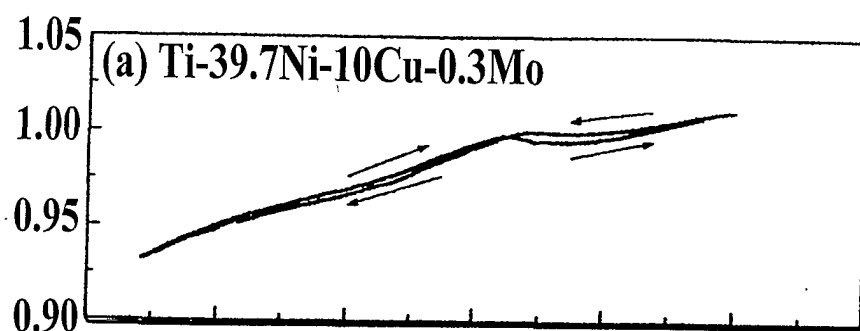
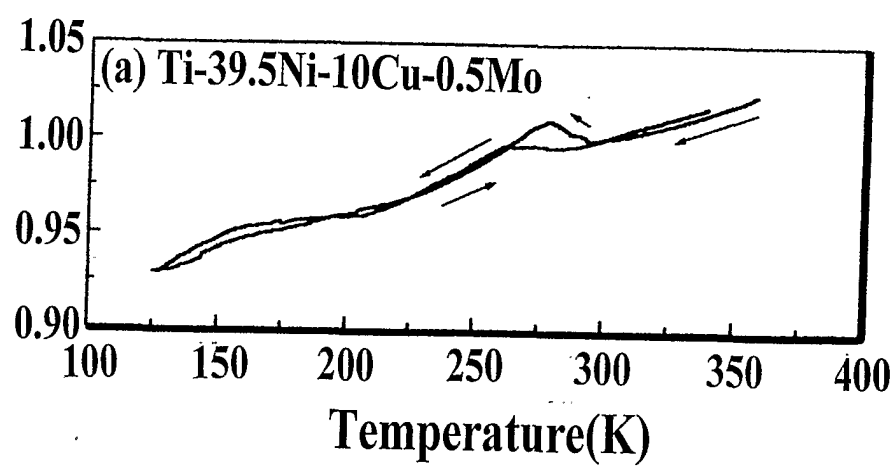
FIG.3A**FIG.3B**

FIG. 4A

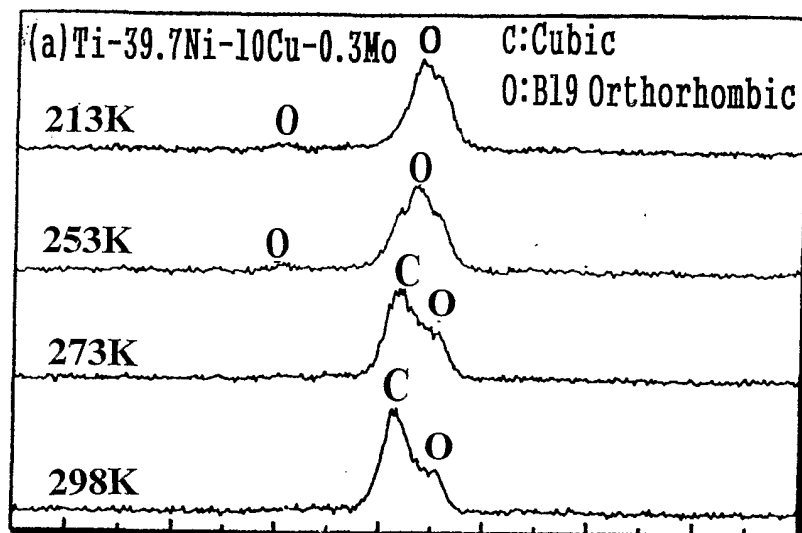


FIG. 4B

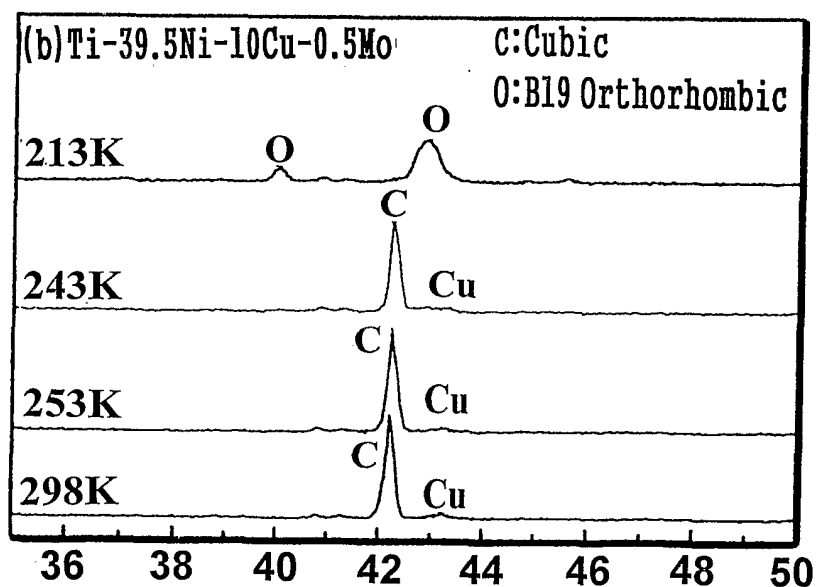


FIG. 5A

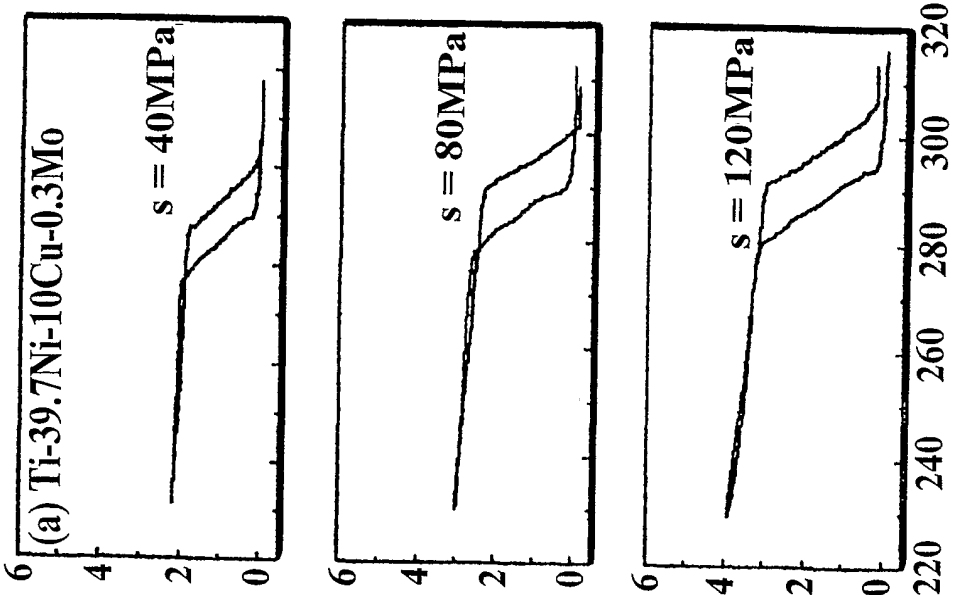


FIG. 5B

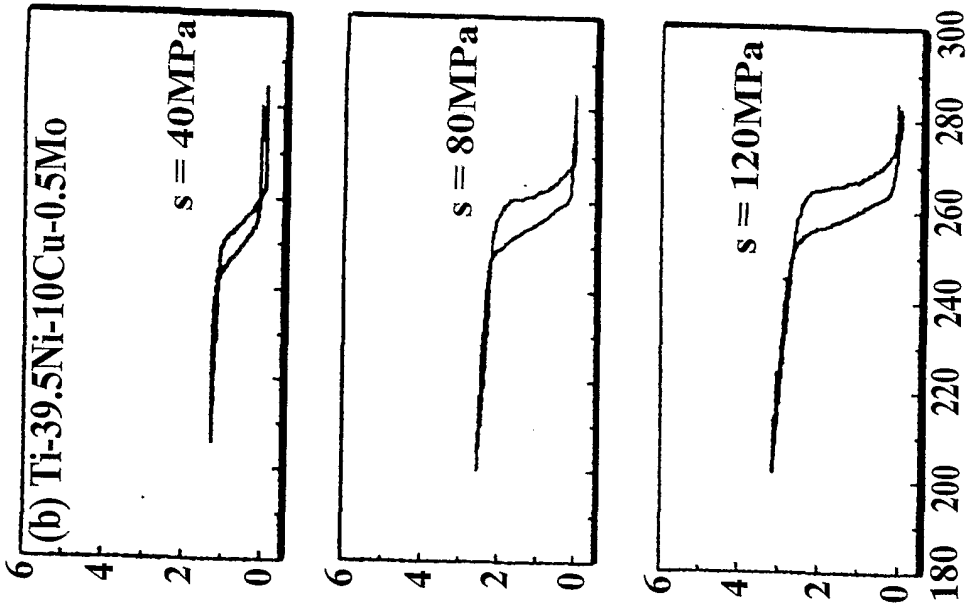


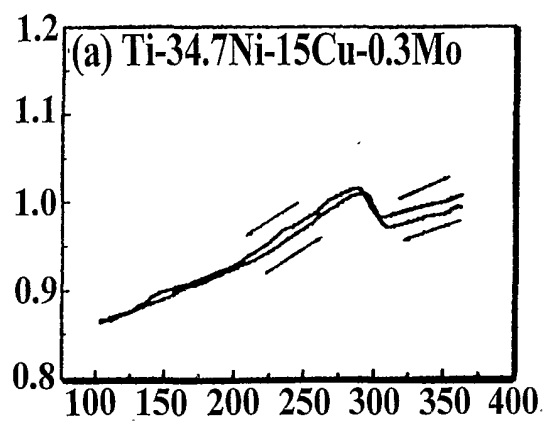
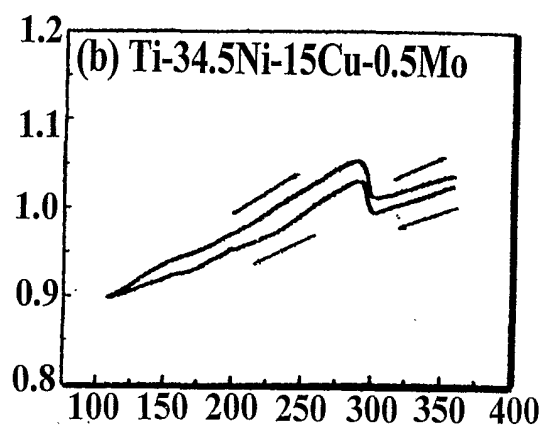
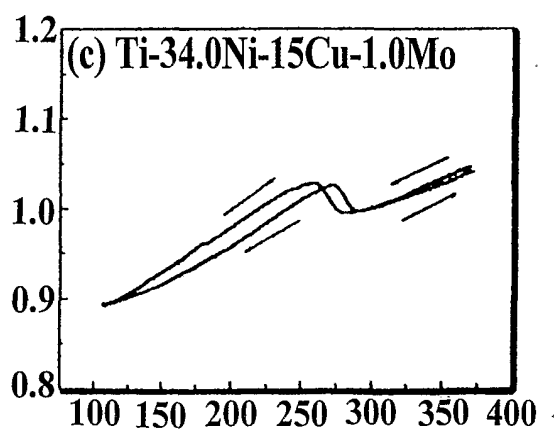
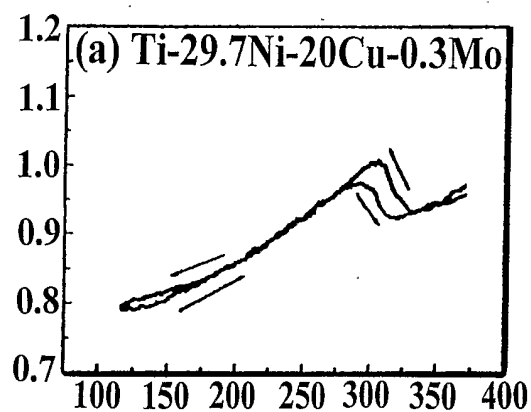
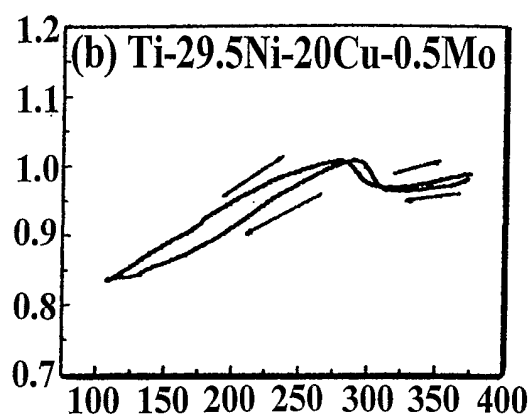
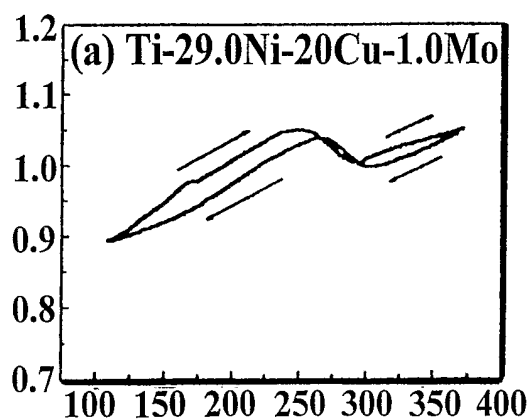
FIG. 6A**FIG. 6B****FIG. 6C**

FIG. 7A**FIG. 7B****FIG. 7C**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 01/01045

CLASSIFICATION OF SUBJECT MATTER

IPC⁷: C22C 14/00

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)

IPC⁷: C22C

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

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

WPI(L)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 62-037353 A (Hitachi Metals Ltd.) 18 February 1987 (18.02.87) . World Patents Index [online]. London U.K.: Derwent Publications Ltd., DW 198713, AN 1987-089040 <i>abstract.</i>	1,2
X	JP 61 177360 A (Kanto Denka Kogyo KK) 9 August 1986 (09.08.86) . World Patents Index [online]. London U.K.: Derwent Publications Ltd., DW198638, AN 1986-249177 <i>abstract.</i>	1-4
A	JP 07 124715 A (Tokin Corp.) 16 May 1995 (16.05.95) . World Patents Index [online]. London U.K.: Derwent Publications Ltd., DW199528, AN 1995-211974 <i>abstract.</i>	1-4

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

* Special categories of cited documents:

„A“ document defining the general state of the art which is not
considered to be of particular relevance„E“ earlier application or patent but published on or after the international
filing date„L“ document which may throw doubts on priority claim(s) or which is
cited to establish the publication date of another citation or other
special reason (as specified)„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

27 July 2001 (27.07.2001)

Date of mailing of the international search report

16 August 2001 (16.08.2001)

Name and mailing address of the ISA/AT

Austrian Patent Office

Kohlmarkt 8-10; A-1014 Vienna

Facsimile No. 1/53424/535

Authorized officer

KOLLER

Telephone No. 1/53424/458

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR 01/01045

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 60 262929 A (Sumitomo Electric Ind. Ltd.) 26 December 1985 (26.12.85) . World Patents Index [online]. London U.K.: Derwent Publications Ltd., DW198607, AN 1986-045100 <i>abstract.</i>	1-4
A	JP 59 150069 A (Hitachi Metals Ltd.) 28 August 1984 (28.08.84) . World Patents Index [online]. London U.K.: Derwent Publications Ltd., DW198440, AN 1984-247564 <i>abstract.</i>	1-4
A	Furuya et al., Improvements of shape memory effect and damping in rapidly solidified TiNiCu Alloys. Shape Mem. Mater. 94, Proc. Int. Symp. (1004), pages 283 - 288. & Chem. Abstr. AN 125:282185 -----	1-2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR 01/01045

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
FU	A	RUYAETAL ., IMPROV		none	
JP	A2	7124715	16-05-1995	none	
JP	A2	59150069	28-08-1984	none	
JP	A2	60262929	26-12-1985	none	
JP	A2	61177360	09-08-1986	none	
JP	A2	62037353	18-02-1987	JP B4 63005465	03-02-1988