# Number of documents: 6

| | |
|---|---|
| CA2069557 | Cr-bearing gamma titanium aluminides and method of making same<br>HAUMETSUTO HOWMET HOWMET RESEARCH LOCKHEED MAACHIN MARIETSUTA MARTIN MARIETTA |
| US5350466 | Creep resistant titanium aluminide alloy<br>ALLIED SIGNAL AVCO HOWMET |
| CA2057373 | Investment casting a titanium aluminide article having net or near-net shape<br>HOWMET |
| US5685924 | Creep resistant gamma titanium aluminide<br>HOWMET RESEARCH |
| US6231699 | Heat treatment of gamma titanium aluminide alloys<br>GENERAL ELECTRIC HOWMET |
| EP1052298 | Creep resistant gamma titanium aluminide<br>HOWMET RESEARCH |

# Cr-bearing gamma titanium aluminides and method of making same
# CA2069557

- **Patent Assignee**
  **HAUMETSUTO HOWMET HOWMET RESEARCH**
  **LOCKHEED MAACHIN MARIETSUTA MARTIN MARIETTA**

- **Inventor**
  LARSEN DONALD E JR
  CHRISTODOULOU LEONTIOS
  KAMPE STEPHEN L

- **International Patent Classification**
  C22C-014/00 C22C-032/00

- **US Patent Classification**
  PCLO=075244000 PCLO=148421000 PCLO=148421000 PCLX=148669000 PCLX=420418000 PCLX=420421000 PCLX=420545000 PCLX=420590000 PCLX=428552000

- **CPC Code**
  C22C-014/00; C22C-032/00/73; C22C-032/00; Y10T-428/12056

- **Publication Information**
  CA2069557 A1 1992-12-19 [CA2069557]

- **Priority Details**
  1991US-07716951 1991-06-18
  1992EP-0420209 1992-06-16
  1993US-08161323 1993-12-02
  1993US-08161324 1993-12-02

- **Fampat family**

| | | | |
|---|---|---|---|
| CA2069557 | A1 | 1992-12-19 | [CA2069557] |
| EP0519849 | A2 | 1992-12-23 | [EP-519849] |
| EP0519849 | A3 | 1993-06-09 | [EP-519849] |
| US5354351 | A | 1994-10-11 | [US5354351] |
| JPH06293928 | A | 1994-10-21 | [JP06293928] |
| US5433799 | A | 1995-07-18 | [US5433799] |
| US5458701 | A | 1995-10-17 | [US5458701] |
| EP0753593 | A1 | 1997-01-15 | [EP-753593] |
| EP0519849 | B1 | 1997-03-05 | [EP-519849] |
| DE69217732 | D1 | 1997-04-10 | [DE69217732] |
| JP2651975 | B2 | 1997-09-10 | [JP2651975] |
| EP0753593 | B1 | 1999-09-08 | [EP-753593] |
| DE69229971 | D1 | 1999-10-14 | [DE69229971] |
| DE69229971 | T2 | 2000-03-30 | [DE69229971] |


- **Abstract:**
  (EP-519849)
  An article comprises a Cr-bearing, predominantly gamma titanium aluminide matrix including second phase dispersoids, such as $TiB_2$ , in an amount effective to increase both the strength and the ductility of the matrix. (see diagramm 1 page 0)

## Claims

(EP-519849)

1. An article comprising a Cr-bearing, predominantly gamma titanium aluminide matrix having second phase dispersoids present in the matrix in an amount effective to increase both the strength and the ductility thereof as compared to the strength and ductility of the matrix devoid of the dispersoids.
2. The article of claim 1 wherein Cr is present in the matrix in an amount of about 0.5 to about 5.0 atomic % of the matrix.
3. The article of claim 2 wherein Cr is present in an amount of about 1.0 to about 3.0 atomic %.
4. The article of claim 1 wherein the second phase dispersoids are present in the matrix in an amount of about 0.5 to about 20.0 volume %.
5. The article of claim 1 wherein the second phase dispersoids are present in an amount of about 0.5 to about 12.0 volume %.
6. The article of claim 5 wherein the second phase dispersoids are present in an amount of about 0.5 to about 7.0 volume %.
7. The article of claim 1 wherein the second phase dispersoids comprise a boride of titanium.
8. An article comprising a Cr-bearing, predominantly gamma titanium aluminide matrix consisting essentially of, in atomic %, about 40 to about 52% Ti, about 44 to about 52% Al, about 0.5 to about 5.0% Mn, and about 0.5 to about 5.0% Cr, and second phase dispersoids present in the matrix in an amount effective to increase both the strength and the ductility thereof as compared to the strength and ductility of the matrix devoid of the dispersoids.
9. The article of claim 8 wherein the second phase dispersoids are present in the matrix in an amount of about 0.5 to about 12.0 volume %.
10. The article of claim 8 wherein the second phase dispersoids comprise a boride of titanium.
11. An article comprising a Cr-bearing, predominantly gamma titanium aluminide matrix consisting essentially of, in atomic %, about 41 to about 50% Ti, about 46 to about 49% Al, about 1 to 3% Mn, about 1 to about 3% Cr up to about 3% V, and up to about 3% Nb, and second phase dispersoids present in the matrix in an amount effective to increase both the strength and the ductility thereof as compared to the strength and ductility of the matrix devoid of the dispersoids.
12. The article of claim 11 wherein the second phase dispersoids are present in the matrix in an amount of about 0.5 to about 12.0 volume %.
13. The article of claim 11 wherein the second phase dispersoids comprise a boride of titanium.
14. A titanium aluminum alloy consisting essentially of, in atomic %, about 40 to about 52% Ti, about 44 to about 52% AI, about 0.5 to about 5.0% Mn and about 0.5 to about 5.0% Cr, said alloy being amenable to an increase in both strength and ductility by virtue of the inclusion of second phase dispersoids therein.
15. A titanium aluminum alloy consisting essentially of, in atomic %, about 41 to about 50% Ti, about 46 to about 49% Al, about 1 to about 3 % Mn, about 1 to about 3% Cr, up to about 3% V, and up to 3% Nb, said alloy being amenable to an increase in both strength and ductility by virtue of the inclusion of second phase dispersoids therein.
16. A method of making a titanium aluminide article, comprising including second phase dispersoids in a Cr-bearing, predominantly gamma titanium aluminide matrix in an amount effective to increase both the strength and ductility of the matrix as compared to the matrix devoid of the dispersoids.
17. The method of claim 16 wherein Cr is included in the matrix in an amount of about 0.5 to about 5 atomic % thereof.
18. The method of claim 16 wherein the second phase dispersoids comprise a boride of titanium present in an amount of about 0.5 to about 20.0 volume %.
19. The method of claim 16 wherein the second phase dispersoids are present in an amount of about 0.5 to about 12.0 volume %.
20. The method of claim 19 wherein the second phase dispersoids are present in an amount of about 0.5 to about 7.0 volume %.
21. The method of claim 16 wherein the dispersoids are included in the matrix by introducing preformed dispersoids into a Cr-bearing titanium-aluminum alloy melt and then solidifying the melt.
22. The method of claim 21 wherein the melt is investment cast to solidify it.
23. A method of making a titanium aluminide article, comprising including second phase dispersoids in a Cr-bearing, predominantly gamma titanium aluminide matrix consisting essentially of, in atomic %, about 40 to 52% Ti, about 44 to about 52% Al, about 0.5 to about 5.0% Mn, and about 0.5 to about 5.0% Cr, said dispersoids being included in an amount effective to increase both strength and ductility of the matrix as compared to the matrix devoid of the dispersoids.
24. The method of claim 23 wherein the second phase dispersoids comprise a boride of titanium present in an amount of about 0.5 to about 12.0 volume %.
25. A method of making a titanium aluminide article, comprising including second phase dispersoids in a Cr-bearing, predominantly gamma titanium aluminide matrix consisting essentially of, in atomic %, about 41 to about 50% Ti, about 46 to about 49% Al, about 1 to about 3% Mm, about 1 to about 3% Cr, up to about 3% V, and up to about 3% Nb, said dispersoids being included in an amount effective to increase both strength and ductility of the matrix as compared to the matrix devoid of the dispersoids.
26. The method of claim 25 wherein the second phase dispersoids comprise a boride of titanium present in an amount of about 0.5 to about 12.0 volume %.

# Creep resistant titanium aluminide alloy
# US5350466

- **Patent Assignee**
  **ALLIED SIGNAL AVCO HOWMET**

- **Inventor**
  LARSEN DONALD E
  BHOWAL PRABIR R
  MERRICK HOWARD F

- **International Patent Classification**
  C22C-014/00

- **US Patent Classification**
  PCLO=148421000 PCLX=148669000 PCLX=148670000 PCLX=420418000 PCLX=420421000

- **CPC Code**
  C22C-014/00

- **Publication Information**
  US5350466 A 1994-09-27 [US5350466]

- **Priority Details**
  1993US-08094297 1993-07-19

- **Fampat family**

| | | | |
|---|---|---|---|
| US5350466 | A | 1994-09-27 | [US5350466] |
| CA2116987 | A1 | 1995-01-20 | [CA2116987] |
| EP0636701 | A2 | 1995-02-01 | [EP-636701] |
| JPH0754085 | A | 1995-02-28 | [JP07054085] |
| EP0636701 | A3 | 1995-03-29 | [EP-636701] |
| EP0636701 | B1 | 1996-11-06 | [EP-636701] |
| DE69400848 | D1 | 1996-12-12 | [DE69400848] |
| DE69400848 | T2 | 1997-04-03 | [DE69400848] |
| CA2116987 | C | 1998-04-21 | [CA2116987] |


- **Abstract:**
  (EP-636701)
  Creep-resistant titanium aluminide alloy for use in gas turbine engines A Ti aluminide alloy comprises (at.%): 44-49 Al, 0.5-4 Nb, 0.25-3 Mn, 0.1 to less than 1 Mo, 0.1 to less than 1 W, 0.1-0.6 Si and the balance Ti. The alloy pref. comprises (at.%): 45-48 Al, 1-3 Nb, 0.5-1.5 Mn, 0.25-0.75 Mo, 0.25-0.75 W, 0.15-0.3 Si and the balance Ti. The most pref. compsn. is (at.%): 47 Al, 2 Nb, 1 Mn, 0.5 W, 0.5 Mo, 0.2 Si and the balance Ti. A creep-resistant alloy article, e.g. a gas turbine engine component (of the pref. compsn.), has a microstructure including a gamma phase and at least one additional phase bearing at least one of W, Mo and Si dispersed as distinct regions in the microstructure. The max. individual amts. of Mo and W are 0.90 at.%. The alloy is formed into an investment casting. The microstructure is predominantly gamma phase with a minority of alpha-two phase present. The additional phase is present as distinct regions located intergranularly of the gamma and alpha-two phases.

## Claims

(EP-636701)

1. Titanium aluminide alloy composition consisting essentially of, in atomic %, about 44 to about 49 Al, about 0.5 to about 4.0 Nb, about 0.25 to about 3.0 Mn, about 0.1 to less than about 1.0 Mo, about 0.1 to less than about 1.0 W, about 0.1 to about 0.6 Si and the balance titanium.
2. The alloy composition of Claim 1 wherein Mo and W each do not exceed about 0.90 atomic %.
3. Titanium aluminide alloy composition consisting essentially of, in atomic %, about 45 to about 48 Al, about 1.0 to about 3.0 Nb, about 0.5 to about 1.5 Mn, about 0.25 to about 0.75 Mo, about 0.25 to about 0.75 W, about 0.15 to about 0.3 Si and the balance titanium.
4. Titanium aluminide alloy composition consisting essentially of, in atomic %, about 47 Al, 2 Nb, 1 Mn, 0.5 W, 0.5 Mo, 0.2 Si and the balance Ti.
5. A creep resistant titanium aluminide alloy article consisting essentially of, in atomic %, about 45 to about 48 Al, about 1.0 to about 3.0 Nb, about 0.5 to about 1.5 Mn, about 0.25 to about 0.75 Mo, about 0.25 to about 0.75 W, about 0.15 to about 0.3 si and the balance titanium, said article having a microstructure including gamma phase and at least one additional phase bearing at least one of W, Mo, and Si dispersed as distinct regions in the microstructure.
6. The article of Claim 5 wherein the microstructure comprises a majority of gamma phase with a minority of alpha-two phase present.
7. The article of Claim 5 wherein the additional phase is present as distinct regions located intergranularly of the gamma and alpha -two phases.
8. A creep resistant gas turbine engine component consisting essentially of, in atomic %, about 45 to about 48 Al, about 1.0 to about 3.0 Nb, about 0.5 to about 1.5 Mn, about 0.25 to about 0.75 Mo, about 0.25 to about 0.75 W, about 0.15 to about 0.3 Si and the balance titanium, said article having a microstructure including gamma phase and at least one additional phase including W, Mo, or Si, or combinations thereof, dispersed as distinct regions in the microstructure.
9. An investment casting having the composition of Claim 1.
10. An investment casting having the composition of Claim 3.

# Investment casting a titanium aluminide article having net or near-net shape
# CA2057373

- **Patent Assignee**
  **HOWMET**
- **Inventor**
  LARSEN JR DONALD E
- **International Patent Classification**
  C22C-014/00 C22C-032/00
- **US Patent Classification**
  PCLO=420590000 PCLO=420590000 PCLX=148421000 PCLX=148669000 PCLX=148670000 PCLX=420418000 PCLX=420421000
- **CPC Code**
  C22C-032/00/73

- **Publication Information**
  **CA2057373 A1 1992-11-07 [CA2057373]**
- **Priority Details**
  1990US-07696184 1990-12-11
  1991US-07696184 1991-05-06
  1993US-08143553 1993-10-26

- **Fampat family**

| | | | |
|---|---|---|---|
| CA2057373 | A1 | 1992-11-07 | [CA2057373] |
| US5284620 | A | 1994-02-08 | [US5284620] |
| US5429796 | A | 1995-07-04 | [US5429796] |


- **Abstract:**
  (US5284620)
  A TiAl alloy base melt including at least one of Cr, C, Ga, Mo, Mn, Nb, Ni Si, Ta, V and W and at least about 0.5 volume % boride dispersoids is investment cast to form a crack-free, net or near-net shape article having a gamma TiAl intermetallic-containing matrix with a grain size of about 10 to about 250 microns as a result of the presence of the boride dispersoids in the melt. As hot isostatically pressed and heat treated to provide an equiaxed grain structure, the article exhibits improved strength.

## Claims

(US5284620)

I claim:

1. A method of investment casting a titanium aluminide alloy article having improved strength and a net or near-net shape for intended service application, comprising the steps of:

a) forming a titanium-aluminum melt, said melt comprising titanium in an amount of about 40 to about 52 atomic %, aluminum in an amount of about 44 to about 52 atomic %, and one or more of Cr, C, Ga, Mo, Mn, Nb, Ni, Si, Ta, V, and W each in an amount of about 0.05 to about 8 atomic %,

b) providing boride dispersoids in the melt in an amount of at least about 0.5 volume % of said melt,

c) providing a melt superheat prior to casting of about 25 (degree) to 200 (degree) F. above the melting point of said alloy to avoid growth of said boride dispersoids to a size harmful to article ductility,

d) casting the melt into a mold cavity of a preheated ceramic investment mold, said mold cavity being configured in the net or near -net shape for the intended service application, and

e) solidifying the melt in the mold cavity to form a crack-free, solidified article, said solidified article having a titanium aluminide-containing matrix with said boride dispersoids uniformly distributed throughout the matrix without dispersoid segregation at grain boundaries thereof, said matrix having a grain size of about 10 to about 250 microns as a result of the presence of said dispersoids in said melt.

2. The method of claim 1 including the additional step of consolidating the solidified article.

3. The method of claim 1 wherein the boride dispersoids are present in an amount of about 0.5 to about 2 volume %.

4. The method of claim 1 wherein the grain size of the matrix is about 50 microns to about 150 microns.

5. The method of claim 1 wherein the melt is subjected to a cooling rate of less than about 102 (degree) F./second during the solidification step.

6. The method of claim 2 wherein the solidified article is consolidated by hot isostatic pressing.

7. The method of claims 1 or 2 including the further step of heat treating the solidified article to provide at least a partially equiaxed grain-structure.

8. A method of investment casting a titanium aluminide alloy article having improved strength and a net or near-net shape for intended service application, comprising the steps of:

a) forming a titanium-aluminum melt, said melt comprising titanium in an amount of about 44 to about 50 atomic %, aluminum in an amount of about 46 to about 49 atomic %, and one or more of Cr, C, Ga, Mo, Mn, Nb, Ni, Si, Ta, V and W, said Cr, Ga, Mo, Mn, Nb, Ta, V, and W, when present, being in an amount of about 1 to about 5 atomic %, said Ni, Si, and C, when present, being in an amount of about 0.05 to about 1 atomic %,

b) providing an effective amount of boron in the melt to form at least about 0.5 volume % of boride dispersoids in-situ in the melt,

c) providing a melt superheat prior to casting of about 25 (degree) to 200 (degree) F. above the melting point of said alloy to avoid growth of said boride dispersoids to a size harmful to article ductility,

d) casting the melt into a mold cavity of a preheated ceramic investment mold, said mold cavity being configured in the net or near -net shape for the intended service application, and

e) solidifying the melt in the mold cavity to form a crack-free, solidified article, said solidified article having a titanium aluminide-containing matrix with said boride dispersoids uniformly distributed throughout the matrix without dispersoid segregation at grain boundaries thereof, said matrix having a grain size of about 10 microns to about 250 microns as a result of the presence of said dispersoids in said melt.

9. The method of claim 8 including the additional step of consolidating the solidified article.

10. The method of claim 8 wherein boron is provided in the melt in an amount effective to form from about 0.5 to about 2 volume % boride dispersoids.

11. The method of claim 8 Wherein the boron is provided in the melt by incorporating boron into a body comprising a titanium-aluminum alloy and melting the body to form said melt.

12. The method of claim 8 wherein the grain size of the matrix is about 50 microns to about 150 microns.

13. The method of claim 8 wherein the solidified article is consolidated by hot isostatic pressing.

14. The method of claim 8 wherein the melt is subjected to a cooling rate of less than about 102 (degree) F./second during the solidification step.

15. The method of claim 11 wherein the body is an electrode that is melted to form said melt.

16. The method of claims 8 or 9 including the further step of heat treating the solidified article to provide at least a partially equiaxed grain structure.

17. A method of investment casting a titanium aluminide alloy article having improved strength and a net or near-net shape for intended service application, comprising the steps of:

a) forming a titanium-aluminum melt, said melt comprising titanium in an amount of about 44 to about 50 atomic %, aluminum in an amount of about 46 to about 49 atomic %, niobium in an amount of about 1 to about 5 atomic %, and manganese in an amount of about 1 to about 5 atomic %,

b) providing an effective amount of boron in the melt to form at least about 0.5 volume % of boride dispersoids in-situ in the melt,

c) providing a melt superheat prior to casting of about 25 to 200 degrees F. above the melting point of said alloy to avoid growth of said boride dispersoids to a size harmful to article ductility,

d) casting the melt into a mold cavity of a preheated ceramic investment mold, said mold cavity being configured in the net or near -net shape for the intended service application, and

e) solidifying the melt in the mold cavity to form a crack-free, solidified article, said solidified article having a titanium aluminide-containing matrix with said boride dispersoids uniformly distributed throughout the matrix without dispersoid segregation at grain boundaries thereof, said matrix having a grain size of about 10 microns to about 250 microns as a result of the presence of said dispersoids in said melt.

# Creep resistant gamma titanium aluminide
# US5685924

- **Patent Assignee**
  **HOWMET RESEARCH**
- **Inventor**
  LARSEN DONALD E
- **International Patent Classification**
  C22C-014/00
- **US Patent Classification**
  PCLO=148421000 PCLX=420418000 PCLX=420421000
- **CPC Code**
  C22C-014/00
- **Publication Information**
  US5685924 A 1997-11-11 [US5685924]
- **Priority Details**
  1995US-08506208 1995-07-24
- **Fampat family**

| | | | |
|---|---|---|---|
| US5685924 | A | 1997-11-11 | [US5685924] |


- **Abstract:**
  (US5685924)
  Creep resistant gamma titanium alumninide comprising titanium in the range of about 55 to about 71 weight % and aluminum in the range of 29 to about 35 weight % by virtue of including oxygen intentionally in the composition in an effective amount to significantly increase the high temperature creep resistance of the alloy. The composition can include greater than about 800 ppm up to about 1500 ppm oxygen to this end.

## Claims

(US5685924)

I claim:

1. Titanium aluminum alloy comprising titanium in the range of about 55 to about 71 weight % and aluminum in the range of about 29 to about 35 weight % having a predominantly gamma titanium aluminide microstructure wherein oxygen is intentionally included in an amount greater than about 800 parts per million by weight to increase high temperature creep resistance.
2. The alloy of claim 1 wherein the oxygen content is from about 900 ppm to about 1500 ppm oxygen.
3. The alloy of claim 1 including $TiB_2$ dispersoids.
4. Predominantly gamma titanium aluminide alloy consisting essentially of, in weight %, about 57 to about 66% Ti, about 30 to about 34% Al, about 3 to about 6% Nb and about 1 to about 3.5% Mn with oxygen present in the range of about 900 to about 1500 parts per million by weight to increase high temperature creep resistance.
5. Predominantly gamma titanium aluminide alloy consisting essentially of, in weight %, about 59.5 to about 63.5% Ti, about 31 to about 33% Al, about 4 to about 5% Nb and about 1.5 to about 2.5% Mn with oxygen present in the range of about 900 to about 1500 parts per million by weight to increase high temperature creep resistance.
6. A predominantly gamma titanium aluminide article comprising titanium in the range of about 55 to about 71 weight % and aluminum in the range of about 29 to 35 weight % wherein oxygen is intentionally included in the article in an amount greater than about 800 parts per million by weight effective to increase high temperature creep resistance of the article.
7. The article of claim 6 wherein the oxygen content is from about 900 ppm to about 1500 ppm oxygen.
8. The article of claim 6 in the heat treated condition.
9. The article of claim 6 including $TiB_2$ dispersoids.
10. A predominantly gamma titanium aluminide article consisting essentially of, in weight %, about 57 to about 66% Ti, about 30 to about 34% Al, about 3 to about 6% Nb and about 1 to about 3.5% Mn with oxygen present in the range of about 900 to about 1500 parts per million by weight to increase high temperature creep resistance.
11. The article of claim 10 in the heat treated condition.
12. The article of claim 10 including $TiB_2$ dispersoids.
13. The article of claim 10 comprising a creep resistant gas turbine engine component.
14. A method of making a titanium aluminide material having improved high temperature creep resistance, comprising forming a melt consisting essentially of about 55 to about 71 weight % Ti and about 29 to about 35 weight % Al and adding an oxygen-containing material to the melt to control the oxygen content thereof in an amount greater than about 800 parts per million by weight to increase high temperature creep resistance of predominantly gamma titanium aluminide solidified from said melt.
15. The method of claim 14 wherein $TiO_2$ particulates are added to the melt.

# Heat treatment of gamma titanium aluminide alloys
# US6231699

- **Patent Assignee**
  **GENERAL ELECTRIC HOWMET**
- **Inventor**
  KELLY THOMAS J
  WEIMER MICHAEL J
  AUSTIN CURTISS M
  LONDON BLAIR
  LARSON JR DONALD E
  WHEELER DEAN A
- **International Patent Classification**
  C22C-014/00 C22F-001/18
- **US Patent Classification**
  PCLO=148670000 PCLX=148421000
- **CPC Code**
  C22C-014/00; C22F-001/18/3
- **Publication Information**
  US6231699 B1 2001-05-15 [US6231699]
- **Priority Details**
  1994US-08262168 1994-06-20
- **Fampat family**
  US6231699 B1 2001-05-15 [US6231699]


- **Abstract:**
  (US6231699)
  A gamma titanium aluminide alloy article, is prepared using a piece of a gamma titanium aluminide alloy having a composition capable of forming alpha, alpha-2, and gamma phases. The alpha transus temperature of the gamma titanium aluminide alloy piece is determined. The gamma titanium aluminide alloy piece is consolidated by hot isostatic pressing at a temperature of from about 50 F. to about 250 F. below the alpha transus temperature and at a pressure of from about 10,000 to about 30,000 pounds per square inch, for a duration of from about 1 to about 20 hours. The piece is heat treated at a temperature of from about 5 F. to about 300 F. below the alpha transus temperature for a time sufficient to refine the microstructure and generate a microstructure comprising from about 10 to about 90 volume percent gamma phase. The step of heat treating is conducted at a temperature of from about 45 F. to about 200 F. above the temperature of the step of hot isostatic pressing.

**Claims**

(US6231699)

What is claimed is:

1.

A method of producing a gamma titanium aluminide alloy article, comprising the steps of:

providing a piece of a gamma titanium aluminide alloy having a composition capable of forming alpha, alpha-2, and gamma phases;

determining the alpha transus temperature of the gamma titanium aluminide alloy piece;

consolidating the gamma titanium aluminide alloy piece at elevated temperature to reduce porosity therein;

wherein the step of consolidating the titanium aluminide piece includes the step of hot isostatic pressing the gamma titanium aluminide alloy piece, and

heat treating the piece at a temperature of from about 5 F. to about 300 F. below the alpha transus temperature for a time sufficient to generate a refined microstructure comprising from about 10 to about 90 volume percent gamma phase.

2. The method of claim 1, wherein the step of hot isostatic pressing is performed at a temperature of from about 50 F. to about 250 F. below the alpha transus temperature and at a pressure of from about 20,000 to about 30,000 pounds per square inch, for a duration of from about 1 to about 20 hours.

3. A method of producing a gamma titanium aluminide alloy article, comprising the steps of:

providing a piece of a gamma titanium aluminide alloy having a composition capable of forming alpha, alpha-2, and gamma phases;

determining the alpha transus temperature of the gamma titanium aluminide alloy piece;

hot isostatic pressing the gamma titanium aluminide alloy piece at a temperature of from about 50 F. to about 250 F. below the alpha transus temperature and at a pressure of from about 20,000 to about 30,000 pounds per square inch, for a duration of from about 1 to about 20 hours;

and

heat treating the piece at a temperature of from about 5 F. to about 300 F. below the alpha transus temperature for a time sufficient to refine the microstructure and generate a microstructure comprising from about 10 to about 90 volume percent gamma phase, the step of heat treating being conducted at a temperature of from about 45 F. to about 200 F. above the temperature of the step of hot isostatic pressing.

4. The method of claim 3, wherein the gamma titanium aluminide piece has a composition, in atomic percent, comprising from about 46 to about 50 percent aluminum.

5. The method of claim 3, wherein the gamma titanium aluminide piece has a composition, in atomic percent, consisting essentially of from about 46 to about 50 percent aluminum, from about 1 to about 3 percent chromium, from about 1 to about 5 percent niobium, balance titanium and incidental impurities.

6. The method of claim 3, wherein the gamma titanium aluminide piece has a composition, in atomic percent, consisting essentially of from about 43 to about 48 percent aluminum, from about 1 to about 3 percent chromium, from about 1 to about 5 percent niobium, from about 0.5 to about 2.0 percent boron, balance titanium and incidental impurities.

7. A method of producing a gamma titanium aluminide alloy article, comprising the steps of:

providing a piece of a gamma titanium aluminide alloy having a composition capable of forming alpha, alpha-2, and gamma phases;

determining the alpha transus temperature of the gamma titanium aluminide alloy piece;

hot isostatic pressing the gamma titanium aluminide alloy piece at a temperature of from about 125 F. to about 225 F. below the alpha transus temperature and at a pressure of from about 20,000 to about 25,000 pounds per square inch, for a duration of from about 2 to about 8 hours;

and

heat treating the piece at a temperature of from about 50 F. to about 100 F. below the alpha transus temperature for a time sufficient to refine the microstructure and generate a microstructure comprising from about 20 to about 80 volume percent gamma phase, the step of heat treating being conducted at a temperature of from about 50 F. to about 100 F. above the temperature of the step of hot isostatic pressing.

8. The method of claim 7, wherein the gamma titanium aluminide piece has a composition, in atomic percent, comprising from about 46 to about 50 percent aluminum.

9. The method of claim 7, wherein the gamma titanium aluminide piece has a composition, in atomic percent, consisting essentially of from about 46 to about 50 percent aluminum, from about 1 to about 3 percent chromium, from about 1 to about 5 percent niobium, balance titanium and incidental impurities.

10. The method of claim 7, wherein the gamma titanium aluminide piece has a composition, in atomic percent, consisting essentially of from about 43 to about 48 percent aluminum, from about 1 to about 3 percent chromium, from about 1 to about 5 percent niobium, from about 0.5 to about 2.0 percent boron, balance titanium and incidental impurities.

11. The method of claim 7, wherein the step of heat treating is performed immediately after the step of hot isostatic pressing, without allowing the piece to cool to an intervening lower temperature.

# Creep resistant gamma titanium aluminide
# EP1052298

- **Patent Assignee**
  **HOWMET RESEARCH**
- **Inventor**
  LARSEN DONALD E
  MCQUAY PAUL A
- **International Patent Classification**
  C22C-014/00
- **CPC Code**
  C22C-014/00

- **Publication Information**
  EP1052298 A1 2000-11-15 [EP1052298]
- **Priority Details**
  1999US-09307882 1999-05-10

- **Fampat family**

| | | | |
|---|---|---|---|
| EP1052298 | A1 | 2000-11-15 | [EP1052298] |
| JP2000345259 | A | 2000-12-12 | [JP2000345259] |


- **Abstract:**
  (EP1052298)
  A creep resistant gamma or near gamma titanium aluminide includes carbon in the composition in an amount of at least about 0.03 weight % effective to increase high temperature creep resistance as compared to similar materials devoid of carbon.

## Claims

(EP1052298)

1. Titanium aluminide comprising titanium in the range of about 53 to about 64 weight % and aluminum in the range of about 29.5 to about 38 weight % wherein carbon is included and controlled in the alloy composition in an amount of at least about 0.03 weight % effective to increase high temperature creep resistance as compared to similar alloy devoid of carbon.
2. Titanium aluminide consisting essentially of, in weight %, about 60% to about 63.5 % Ti, about 29.5% to about 33.0% Al alloyed with one or more alloying elements selected from Cr, Ga, Mo, Mn, Nb, Ni, Si, Zr, Ta, V and W each in amount of at least 0.1 weight % and strengthening dispersoids present in an amount of at least about 0.5 volume % wherein carbon is included and controlled in the composition in an amount of about 0.04 to about 0.33 weight % effective to increase high temperature creep resistance as compared to similar alloy devoid of carbon.
3. Titanium aluminide consisting essentially of, in weight %, about 31.5% to about 32.5% Al, about 4.0% to about 5.5% Nb, about 1.5% to about 3.0% Mn, about 0.2% to about 0.4% B, and about 0.04% to about 0.10% C and balance essentially Ti.
4. Titanium aluminide consisting essentially of, in weight %, about 29.8% to about 31.2% Al, about 4.0% to about 5.2% Nb, about 1.5% to about 3.0% Mn, about 0.25% to about 0.37% B, and about 0.04% to about 0.10% C and balance essentially Ti.