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## Number of documents: 15

CN103572082	A high Nb-TiAl alloy and its preparation method UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN102825259	Method for preparing TiAl inter-metallic compound powder by using titanium hydride powder UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN1752265	Heating technology for refining TiAl alloy ingot microscopic texture UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN101020983	Heat treatment process for large size as-cast high-Nb TiAl-base alloy to obtain complete lamellar structure UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN1462816	Method for preparing TiAl alloy plate with high niobium UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN1425788	Gamma TiAl induction phase gamma 1 base high temperature structure material UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN104388733	Preparation method of TiAl/alpha-Al <sub>2</sub> O <sub>3</sub> nano-composite material UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN104357701	Preparation method of TiAl/TiC nanocomposite UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN104313373	Preparation method of TiAl / TiO <sub>2</sub> nanocomposite UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN102672150	Direction control method of TiAl-Nb alloys lamellar structure UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN102011195	Preparation method of directional solidification high-Nb TiAl alloy single crystal UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN1352315	Process for preparing high niobium Ti Al alloy large size cake material UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN101994043	High Nb containing TiAl porous intermetallic compound gradient material and preparation method thereof UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN101875106	One kind of directional freeze Gao Nitai the preparation method of aluminum alloy UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING
CN102303117	Method for preparing porous heat exchange surface of TiAl-based intermetallic compound UNIVERSITY OF SCIENCE & TECHNOLOGY BEIJING

## A high Nb-TiAl alloy and its preparation method CN103572082

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> LIN JUNPIN ZHANG ZHIYONG ZHANG LAIQI LIANG YONGFENG HAO GUOJIAN</li> <li>• <b>International Patent Classification</b> C22C-001/03 C22C-030/00</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN103572082 A</a> 2014-02-12 [CN103572082]    </li> <li>• <b>Priority Details</b> 2013CN-0582389 2013-11-18</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Family</b> <table style="width: 100%; border-collapse: collapse; margin-top: 5px;"> <tr> <td style="width: 30%;"><a href="#">CN103572082</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 20%;">2014-02-12</td> <td style="width: 30%;">[CN103572082]</td> </tr> <tr> <td><a href="#">CN103572082</a></td> <td style="text-align: center;">B</td> <td>2015-08-05</td> <td>[CN103572082B]</td> </tr> </table> </li> </ul>		<a href="#">CN103572082</a>	A	2014-02-12	[CN103572082]	<a href="#">CN103572082</a>	B	2015-08-05	[CN103572082B]
<a href="#">CN103572082</a>	A	2014-02-12	[CN103572082]						
<a href="#">CN103572082</a>	B	2015-08-05	[CN103572082B]						

- **Abstract:**

(CN103572082)

The invention relates to a high Nb-TiAl alloy and a preparation method thereof, and belongs to the field of smelting of nonferrous metals. The preparation method of the alloy is two times of vacuum magnetic suspension smelting; different processes are adopted in the two times of smelting to charge high-purity Ar gas. In the first time of smelting, materials are put in a crucible for vacuumizing; the high-purity Ar gas is charged after preheating smelting with 15-40 kw of lower power; the power is increased to 35-45 kw to totally melt A1 block materials; after the power is increased to 85-110 kw for smelting, the heating is stopped, and the alloy is cooled along with a water cooling copper crucible; in the second time of smelting, the vacuumizing is implemented; after the materials are baked with low power, the power is increased to 85-110 kw; after the materials are molten, the high-purity Ar gas is charged; after the power is increased to 110-125 kw for smelting, then the power is decreased to 85-110 kw for casting. Through the reasonable design of the smelting process, the oxygen content of the high Nb-TiAl alloy can be reduced to 300 ppm; compared with the existing smelting process, the oxygen content is reduced to 40-70%. The organization uniformity is prominently improved when components are accurately controlled; the alloy has no crack and nonmetallic inclusion defects, so that the processing performance is improved.





**Claims**

(CN103572082)

1. A high-Nb-TiAl alloy preparation method, characterized in, can be produced by double vacuum smelting this magnetic levitation, and the two secondary smelting take different process regime.
2. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, smelting divided twice, 1st-order, first the material is placed in a crucible is evacuated, filled with high purity Ar gas preheated in a low power, and then the power was adjusted to 35-45 kw of the Al block completely melted, the power is adjusted to 85-110 kw, smelting 15-25 minutes later, water-cooled copper crucible heating is stopped the alloy vary depending on cooling; 2nd time, evacuated, from low power 35-45 kw after drying material, a power boost to 85-110 kw, melted to form hump after the subject material, filled with high purity Ar gas, then the power was increased to 110-125 kw smelting 8-15 minutes, then the power was reduced to 85-110 kw casting.
3. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, smelting process either 1st time, the water-cooled copper crucible placed within sponge titanium, a high-purity Al block, will AlNb74 (wt. %) master alloy was placed in a cloth bucket, when the vacuum degree reached  $5.5 \times 10^{-3}$ pa rear, by a power of 15-3025 kw, 15-25 minutes after Ar gas to the heat of the smelting chamber filled with high purity pre-melting 450450Pa or more up to, and the power added to 35-45 kw, Al block complete melting of the material gas after complete release, the power applied to the 9085-12010 kw smelting 15-25 minutes, melt hump added after formation of the funnel AlNb74 cloth (wt. %) master alloy, the alloy melt water-cooled copper crucible with the final resting power cooling; 2nd secondary smelting process either, evacuated to  $5.5 \times 10^{-3}$ pa rear, by a power of 35-45 kw, 5-15 minutes after warm-up of the drying material, the power was increased to 9085-12010 kw smelting, is formed to be long enough to melt in the crucible after humps, high-purity Ar gas and supplying the oven body closed off, so that the chamber vacuum reaches 400360-400Pa, power is applied to the molten 115-125 kw smelting 8-15 minutes, then the power was reduced to 9085-12010 kw casting, the present invention to obtain a high-Nb-TiAl alloy.
4. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, smelting process either 1st time, the water-cooled copper crucible is in turn placed within sponge titanium, a high-purity Al block, will AlNb74 (wt. %) master alloy was placed in a cloth bucket, when the vacuum degree reached  $5.5 \times 10^{-3}$ pa rear, power is 20 kw is performed, high-purity Ar gas charged minute warm-up 204 after refining of the melt chamber for 500Pa, and the power applied to a 40 kw, causes the Al block completely melted material gas after complete release, 20 minutes was quickly added to the melter 100 kw power, the funnel was added after melt hump formed cloth AlNb74 (wt. %) master alloy, the alloy melt with water-cooled copper crucible stopped after cooling power; smelting process for 2nd time, by applying vacuum to  $5.5 \times 10^{-3}$ pa rear, by a power of 40 kw, 10 minutes after drying material, 100 kw power rises rapidly reduce the smelting, is formed to be long enough to melt in the crucible after humps, high-purity Ar gas and supplying the oven body closed off, so that the chamber vacuum reaches 400Pa, 10 minutes after power is applied to the molten smelt 120kKw, the power was reduced to 100 kw casting, the present invention to obtain a high-Nb-TiAl alloy.
5. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, material is pretreated before melting it, to its treatment process, a purity greater than 99.7% in absolute ethanol washing with the material, air-dried at room temperature for 2 hours and allowed to spread above.
6. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, respectively 99.99% purity higher than for high purity Al block material, industrial zero-order titanium sponge, AlNb74 (wt. %) master alloy having a granular form.
7. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, minor alloying materials include raw material is Cr, V, W, Mo, Mn, Si, B, Y, before melting it, with the micro alloy AlNb74 (wt. %) was added together with the master alloy cloth bucket.
8. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, order placement of the material, the water-cooled copper crucible placed in this order from bottom up to drain liquid from sponge titanium, a high-purity Al block.
9. A high-Nb-TiAl alloy preparation method according to claim 1, characterized in, 2nd time prior to smelting, after smelting ingot having upper and lower surfaces of the 1st time of the water-cooled crucible placed in upside down, followed by smelting 2nd time.
10. 1 produced by the method as claimed high Nb-TiAl alloy, characterized in, Ti alloy as a main component (45-48) at.% Al (7-10) at.% Nb, oxygen content of the alloy containing less than 300 ppm.

## Method for preparing TiAl inter-metallic compound powder by using titanium hydride powder

CN102825259

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> SHAO HUIPING WANG ZHI LIN TAO GUO ZHIMENG YE QING WANG JUN SUN SEN LYU SHAOYUAN</li> <li>• <b>International Patent Classification</b> B22F-009/20</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN102825259 A</a> 2012-12-19 [CN102825259]    </li> <li>• <b>Priority Details</b> 2012CN-0354102 2012-09-21</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b>  <table style="width: 100%; border: none;"> <tr> <td style="width: 30%;"><a href="#">CN102825259</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 30%;">2012-12-19</td> <td style="width: 30%;">[CN102825259]</td> </tr> <tr> <td><a href="#">CN102825259</a></td> <td style="text-align: center;">B</td> <td>2015-03-11</td> <td>[CN102825259B]</td> </tr> </table> </li> </ul>		<a href="#">CN102825259</a>	A	2012-12-19	[CN102825259]	<a href="#">CN102825259</a>	B	2015-03-11	[CN102825259B]
<a href="#">CN102825259</a>	A	2012-12-19	[CN102825259]						
<a href="#">CN102825259</a>	B	2015-03-11	[CN102825259B]						

- **Abstract:**

(CN102825259)

The invention belongs to the technical field of powder metallurgy, and relates to a method for preparing TiAl inter-metallic compound powder by using titanium hydride powder. The method comprises the following preparation steps of: weighing titanium hydride powder and aluminum powder according to an atom ratio of Ti to Al being 1: 1, and uniformly mixing the powders through ball milling of a high-energy ball milling machine, wherein toluene is added as a controlling agent in a ball milling process, so as to prevent oxidation; then sintering the powders by using a certain process in a rapid warming tube type electric furnace with a vacuum degree of  $4.0 \times 10^{-2}$  to  $4.0 \times 10^{-3}$  Pa, and cooling along with the furnace to obtain the TiAl inter-metallic compound. The method provided by the invention is simple in technique process; the cheap titanium hydride powder is used as a raw material, and is simply milled after diffusing and sintering in a low temperature condition, so as to obtain the TiAl inter-metallic compound powder with very high purity; and the TiAl inter-metallic compound is subjected to follow-up machining, such as molding, through a powder metallurgy normal method.

**Claims**

(CN102825259)

1. TiAl intermetallic compound powder titanium hydride powder A method of preparation, characterized in:

(1) in accordance with Ti, Al atomic ratio of 1:1 was weighed titanium hydride powder and aluminum powder, in a high energy ball mill for milling 1-24 hours for homogenization; which toluene was added as a control agent to prevent oxidation process;


(2) the well-mixed mass is then placed in a vacuum degree of  $4.0 \times 10^{-2}$  Pa rapid rise in tube type furnace, at 100-650 °C for calcination process, a heating rate of 2-4 °C/min, temperature holding time of 10min-4 hours; then directly heated to high temperatures, at 750-1000 °C for warming 1-5 hours for alloying; low rate was increased diffusion response is directed to aluminum powder and titanium hydride powder diffusion reaction of a dehydrogenization, for titanium and aluminum are subjected to a temperature higher alloying between;

(3) at the end of cooling followed by furnace, TiAl intermetallic compound powder to give after the milling step.

2. TiAl intermetallic compound powder with one method of preparing the titanium hydride powder according to claim 1, characterized in: the starting materials of titanium hydride powder having an average particle size of 20-65 m, aluminum powder has an average particle size of 5-20 m.

3. TiAl intermetallic compound powder prepared by one method of titanium hydride powder according to claim 1, characterized in: step (3) TiAl intermetallic compound powder has an average particle size after grinding was 10-50 m.

## Heating technology for refining TiAl alloy ingot microscopic texture CN1752265

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> SONG XIPING ZHANG</li> <li>• <b>International Patent Classification</b> C22F-001/04</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN1752265</a> A 2006-03-29 [CN1752265]</li> <li>• <b>Priority Details</b> 2005CN-0086726 2005-10-26</li> </ul> <div style="text-align: right;">  </div>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <table style="margin-left: 20px; border-collapse: collapse;"> <tr> <td style="padding-right: 10px;"><a href="#">CN1752265</a></td> <td style="padding-right: 10px;">A</td> <td style="padding-right: 10px;">2006-03-29</td> <td>[CN1752265]</td> </tr> <tr> <td><a href="#">CN1329549</a></td> <td>C</td> <td>2007-08-01</td> <td>[CN1329549C]</td> </tr> </table> </li> </ul>		<a href="#">CN1752265</a>	A	2006-03-29	[CN1752265]	<a href="#">CN1329549</a>	C	2007-08-01	[CN1329549C]
<a href="#">CN1752265</a>	A	2006-03-29	[CN1752265]						
<a href="#">CN1329549</a>	C	2007-08-01	[CN1329549C]						

- **Abstract:**

(CN1752265)

A heat treating technology for fining microscopic structure of cast TiAl alloy ingot containing A (45-48 at%) and Nb (6-8 at%) includes such steps as quenching in salt bath plus ageing one or more times, and high-temp forging.





**Claims**

(CN1752265)

1. TiAl alloy ingot microstructure thermal processing of a refinement process, characterized in this process the basic process is as follows: first subjected to salt bath hardening heat treatment + aging one or more passes of the process, and then subjected to a high temperature forging.
2. TiAl alloy ingot having a refined microstructure of the hot-working process according to claim 1, characterized in salt bath hardening process is: the temperature at T temperature not less than 10 °C -15 °C rapidly quenched into molten salt bath of the ingot, the ingot from the heating furnace is transferred to the salt bath at a time of 5-10 seconds, the quenching at a cooling rate greater than 100 °C/sec salt bath, so that phase can be completely converted into the bulk phase; ingot in a salt bath heat insulation 10-20 minutes; salt bath is operated at 800 °C -820 °C; salt bath by weight of the component 80%-82% BaCl<sub>2</sub> + 18%-20% NaCl.
3. TiAl alloy ingot having a refined microstructure of the hot-working process according to claim 1, characterized in aging treatment procedure is to: aging temperature at T temperature below 20 °C -40 °C for, i.e. 1300 °C -1320 °C; time was 1-2 hours; followed by furnace cooling to 1250 °C, incubated for 4 hours, cooled to room temperature.
4. TiAl alloy ingot having a refined microstructure of the hot-working process according to claim 1, characterized in a high temperature forging process either: at 1230 °C -1250 °C temperature range, performing envelope forging or isothermal forging, forging deformation amount is not more than 50%, strain rate is from 1x10<sup>-2</sup>-1x10<sup>-3</sup>/ seconds; forging after deformation, immediately placed in an air oven furnace cooling to room temperature to 900 °C.
5. TiAl alloy ingot having a refined microstructure of the hot-working process according to claim 1, characterized in first two-mild heat treatment, at T and the T<sub>e</sub> between temperature, phase and phase by phase transfer between tissue to refine the ingot, hot forging is carried out once again.
6. TiAl alloy ingot having a refined microstructure of the hot-working process according to claim 1, characterized in cycles through the heat treatment is carried out first, oil-cooled or water cooled by repeating, and of the phase transition block shape using phase to phase to refine the ingot texture decomposition of block shape, to be used with high-temperature forging.
7. Claim 1 or 2 or 3 or 4 or 5 as 6 TiAl alloy ingot having a refined microstructure or the hot-working process, characterized in which the TiAl alloy composition of the Al content is not only suitable for use 48at.% TiAl alloy to 45at.%, but also to a niobium content of the TiAl alloy ranges from 6at.% to 8at. %.
8. Claim 1 or 2 or 3 or 4 or 5 as or hot working the alloy ingot microstructure of the TiAl 6 refinement process, characterized in TiAl alloy ingot which is adaptable to conventional induction melting of the TiAl alloy not only of the molding, and is useful for ion beam melting TiAl alloy of the consumable melting and molding.

## Heat treatment process for large size as-cast high-Nb TiAl-base alloy to obtain complete lamellar structure

### CN101020983

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> JUNPIN LIN ZHENG FANG XU XIANGJUN XU YANLI WANG YONG ZHANG ZHI LIN GUOLIANG CHEN</li> <li>• <b>International Patent Classification</b> C22C-030/00</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN101020983 A</a> 2007-08-22 [CN101020983]    </li> <li>• <b>Priority Details</b> 2007CN-0065071 2007-04-02</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b>  <table style="width: 100%; border: none;"> <tr> <td style="width: 30%;"><a href="#">CN101020983</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 20%;">2007-08-22</td> <td style="width: 30%;">[CN101020983]</td> </tr> <tr> <td><a href="#">CN100500907</a></td> <td style="text-align: center;">C</td> <td>2009-06-17</td> <td>[CN100500907C]</td> </tr> </table> </li> </ul>		<a href="#">CN101020983</a>	A	2007-08-22	[CN101020983]	<a href="#">CN100500907</a>	C	2009-06-17	[CN100500907C]
<a href="#">CN101020983</a>	A	2007-08-22	[CN101020983]						
<a href="#">CN100500907</a>	C	2009-06-17	[CN100500907C]						

- **Abstract:**

(CN101020983)

The present invention belongs to the field of intermetallic compound technology and is especially heat treatment process for optimizing the structure of large size as-cast high-Nb TiAl-base alloy to obtain fine and homogeneous complete lamellar structure. The present invention features that alloy samples of sizes 10x10x10 mm to 60x60x60 mm are cut off from as-cast high-Nb TiAl-base alloy ingot, set into crucible, maintained inside a heat treatment furnace at 1350-1400 deg.c for 6-36 hr, maintained inside one other heat treatment furnace at 900-1050 deg.c for 30-60 min, and finally air cooled outside the furnace to room temperature. Thus treated alloy has fine and homogeneous complete lamellar structure, greatly increased available sizes and low treating cost.




**Claims**

(CN101020983)

1. TiAl-base alloy large-size full-ply tissue obtained as-cast high-niobium a heat treatment method, characterized in from 100-200x200-500 mm in the center of the TiAl-based alloy ingot as-cast high-niobium wire-cut size of 10x10x10-60x60x60 mm range of the alloy sample, without any additional process, after put in a crucible, at 1350-1400 °C range places it into the heat treatment furnace insulation 6-36 hours, after it was removed immediately placed in the furnace temperature to 900-1050 °C incubated in a heat treatment furnace 30-60 minutes, and finally removed from the furnace to cool in air to room temperature; TiAl-based alloy ingot having the chemical composition of the as-cast high-niobium was at.% atomic percent: Al: 45-46%, Nb: 5-10%, W: 8.5-1%, B: 8.5-1%, Y: 0.01-0.1%, the balance being Ti; sample was subjected to high temperature annealing process, to obtain tablets layer group average grain size between 120-250 micron meters in a uniform full-ply tissue.

## Method for preparing TiAl alloy plate with high niobium CN1462816

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> PINLIN JUN MIAO JIASHI WANG YANLI</li> <li>• <b>International Patent Classification</b> C22C-014/00 C22F-001/18</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN1462816</a> A 2003-12-24 [CN1462816]</li> </ul> <div style="text-align: right;">  </div> <ul style="list-style-type: none"> <li>• <b>Priority Details</b> 2003CN-0137516 2003-06-11</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><a href="#">CN1462816</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 20%; text-align: center;">2003-12-24</td> <td style="width: 40%; text-align: center;">[CN1462816]</td> </tr> <tr> <td><a href="#">CN1207423</a></td> <td style="text-align: center;">C</td> <td style="text-align: center;">2005-06-22</td> <td style="text-align: center;">[CN1207423C]</td> </tr> </table> </li> </ul>		<a href="#">CN1462816</a>	A	2003-12-24	[CN1462816]	<a href="#">CN1207423</a>	C	2005-06-22	[CN1207423C]
<a href="#">CN1462816</a>	A	2003-12-24	[CN1462816]						
<a href="#">CN1207423</a>	C	2005-06-22	[CN1207423C]						

- **Abstract:**

(CN1462816)

A technology for preparing high-Nb TiAl alloy plate includes cladding the raw alloy twice, forging, cutting the forged cake to obtain rectangular blank, heat treating under a certain parameters, turning surface to remove oxidized surface layer, cladding, heating, high-temp rolling, and decladding. Its advantages are use of ordinary rolling mill, and high surface quality and uniform structure of product.

**Claims**

(CN1462816)

1. TiAl alloy sheet production method according to one high-niobium, process flow is: the alloy ingot was subjected to annealing heat treatment after turning, the envelope after the turning process, and then high-temperature hot-rolled sheath, the sheath was removed after hot rolling, high niobium titanium aluminum-based alloy plate material was obtained; characterized in: TiAl alloy panel making specific process parameters are as follows high-niobium:

A, alloy billet: alloy billet forging steel strip produced by the secondary sheath, forging cake has been sliced from a rectangular blank;

B, annealing heat treatment process: at 1300 °C -1320, 20min FC + 1250 °C -1270 ° C2-2.5 hours furnace cooling + 900 °C -950 ° C4-4.5 hours air-cooling the heat treatment is performed;

C, turning: cutting the annealed alloy blank after the heat treatment of the surface of the oxide scale is removed by a turning process, surface finish attains \*\*\*6, blank to the rounded corner;


D, sheath: 304 stainless steel sheet prepared using lathing goes through a sheath, the alloy ingot disposed in a central, upper and lower plus stainless-steel plate of the same material, with the upper and lower steel plates welded argon-arc welding envelope.

E, alloy heat: heating of the oven to the open rolling temperature, incubated for 30-40 minutes, rolled out from a furnace;

F, high temperature capsule rolling: rolling mill for rolling on the steel will be transferred to, open rolling temperature of 1250 °C - 1290 °C, deformation rate 0.1/seconds-0.5/sec, alloy pass deformation of 10%-15%; the base of the fire using a rolling method, rolling is complete and the workpiece is placed in the oven, the oven was cooled to 1000 °C, and then remove empty cold;

G, peeling off the sheath: adopts tangent bed cut-away sheath.

## Gamma TiAl induction phase gamma 1 base high temperature structure material CN1425788

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> CHEN GUOLIANG WANG YANLI NI XIAODONG</li> <li>• <b>International Patent Classification</b> C22C-021/00 C22C-030/00</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN1425788</a> A 2003-06-25 [CN1425788]</li> </ul> <div style="text-align: right;">  </div> <ul style="list-style-type: none"> <li>• <b>Priority Details</b> 2002CN-0131106 2002-10-09</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><a href="#">CN1425788</a></td> <td style="width: 10%;">A</td> <td style="width: 20%;">2003-06-25</td> <td style="width: 30%;">[CN1425788]</td> </tr> <tr> <td><a href="#">CN1189581</a></td> <td>C</td> <td>2005-02-16</td> <td>[CN1189581C]</td> </tr> </table> </li> </ul>		<a href="#">CN1425788</a>	A	2003-06-25	[CN1425788]	<a href="#">CN1189581</a>	C	2005-02-16	[CN1189581C]
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<a href="#">CN1189581</a>	C	2005-02-16	[CN1189581C]						

- **Abstract:**

(CN1425788)


The gamma-1 base high temperature structural material with gamma TiAl inducing phase is a kind of TiAl base intermetallic compound as high temperature alloy. The alloy has intermetallic compound TiAl with simple crystal structure and light specific weight as base for the alloy system and includes the alloy compounds of Al 30-50 wt%, Nb 25-45 wt%, Ti 20-35 wt% and small amount of micro alloy elements. REfractory metal element is used to raise smelting point, reduce diffusion, reinforce solid solution and thus to form high-Nb TiAl alloy and derivative gamma-1 intermetallic compound base alloy. The TiAl base intermetallic compound has high use temperature, tensile strength at 1100 deg.c up to 450 MPa, two times that of common TiAl alloy.

**Claims**

(CN1425788)

1. One -TiAl-induced phase 1-based high-temperature structural material, characterized in, alloy components in percent by weight to 30-50% Al, 25-45% Nb, 20-35% Ti, alloys containing small amounts of alloying elements, including C, B, Y, Ce or the like element, is less than 0.2-0.3 atomic percent; include W, Si, Hf or the like is less than 0.5 atomic percent of the element.

## Preparation method of TiAl/ $\alpha$ -Al<sub>2</sub>O<sub>3</sub> nano-composite material CN104388733

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> LIN JUNPIN ZHANG ZHIYONG LIANG YONGFENG ZHANG LAIQI</li> <li>• <b>International Patent Classification</b> C22C-001/10 C22C-014/00 C22C-021/00 C22C-030/00 C22C-032/00</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN104388733 A 2015-03-04 [CN104388733]</a> </li> <li>• <b>Priority Details</b> 2014CN-0539040 2014-10-13</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <a href="#">CN104388733</a>                          A      2015-03-04                          [CN104388733]</li> </ul>	

- **Abstract:**

(CN104388733)

The invention relates to a preparation method of a nanometer  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> reinforced TiAl-based composite material. The method includes process control of the form and the temperature of TiAl melt before addition of nanometer  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> particles, process control of uniform rolling of nano-particles in the TiAl melt without adsorption to the wall of a crucible in the addition process, and electromagnetic stirring process. The method comprises the following steps: preparing nano-particles, putting TiAl mother alloy in a crucible, carrying out vacuum pumping, and filling high purity argon for protection; improving the electromagnetic induction power to completely melt the mother alloy, and reducing the power to make the surface of the molten alloy planar; pouring the nano-particles into the surface of the molten alloy, improving the power after 90% of the nano-particles are completely rolled in the molten alloy until no nano-particles float on the surface of the molten alloy, improving the power, stirring, shutting the power, and carrying out furnace cooling; and overturning cast ingots, putting the ingots into the crucible, carrying out vacuum pumping, introducing highly pure argon, fast improving the power to 105-115kw, electromagnetically stirring for 8-10min, stopping the power, and carrying out furnace cooling. The nanometer  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> uniformly dispersed and distributed TiAl-based composite material is prepared through the above process design.

**Claims**

(CN104388733)

1. A TiAl / -Al<sub>2</sub>O<sub>3</sub> nano composite preparation, characterized in, TiAl / -Al<sub>2</sub>O<sub>3</sub> nano composite methods of preparation include nano -Al<sub>2</sub>O<sub>3</sub> before addition, in, after respectively take different processing steps:

Step 1, adding the nano -Al<sub>2</sub>O<sub>3</sub> before, the weighed ratio nanoparticles, and the package, the mother alloy ingot into water-cooled crucible TiAl, cloth bucket placed in the encapsulated nanoparticles, evacuated and filled with high purity argon;

Step 2, adding the nano -Al<sub>2</sub>O<sub>3</sub> during, completely melting the master alloy is first raised, then down power to the alloy level substantially planar, nanoparticles are added, the addition of alloy to about 90% of the particles entrained, power increasing level float until the alloy is not present to the nanoparticles;

Step 3, the liquid alloy to be not present on the floating nanoparticles after post, the lifting power of the electromagnetic induction, using an electromagnetic stirring stopped and then furnace cooled power; the cooled ingot is reversed again placed in the crucible, evacuated and filled with high purity argon; again quickly raising the electromagnetic induction power and electromagnetically stirred, to cool the oil was stopping power.

2. TiAl / -Al<sub>2</sub>O<sub>3</sub> nanocomposite production method according to claim 1, characterized in, in step 1, the proportion of the 1 wt. %-weighed 10 wt.% nano -Al<sub>2</sub>O<sub>3</sub> suspended encapsulated particles placed in a vacuum induction furnace with aluminum in the cloth bucket and then, a vacuum 5.5x10<sup>-3</sup> Pa -6.0x10<sup>-2</sup>Pa, charge high purity argon to 400Pa-500Pa.

3. TiAl / -Al<sub>2</sub>O<sub>3</sub> nanocomposite production method according to claim 1, characterized in, in step 2, 95-105 kw power to first up, then down power to 35-45 kw; addition of alloy to be about 90% of the particles involved, up until no headspace alloy 65-75 kW power to the floating particles.

4. TiAl / -Al<sub>2</sub>O<sub>3</sub> nanocomposite production method according to claim 1, characterized in, in step 3, adding the nano -Al<sub>2</sub>O<sub>3</sub> liquid to be floating particles after the alloy is not present, increase 105-115 kw power to, electromagnetic stirrer 8-10 min; reversed again after cooling the ingot after placed in the crucible, a vacuum 5.5x10<sup>-3</sup> Pa -6.0x10<sup>-2</sup>Pa, charge high purity argon to 400Pa-500Pa; again raised 105-115 kw power to, electromagnetic stirring again 8-10 min.

5. According to claim 1-4 wherein one TiAl / -Al<sub>2</sub>O<sub>3</sub> nano composite preparation, characterized in, TiAl master alloy component is Ti (43-47) at.% Al (0-10) at.% Nb, nano -Al<sub>2</sub>O<sub>3</sub> in an amount of 1 wt. %-15 wt. %.

6. TiAl / -Al<sub>2</sub>O<sub>3</sub> nanocomposite production method according to claim 5, characterized in,

Step 1, the -Al<sub>2</sub>O<sub>3</sub> 1 wt.% ratio nano-particles are weighed, a previously prepared master alloy component is placed in the crucible Ti43at % Al ingot within, evacuated to a vacuum in the furnace was 6.0x10<sup>-2</sup> Pa, Ar to charge high-purity 400Pa; 95 kw to 2, dal on the electromagnetic power step, the master alloy is completely melted; power down to 35 kw, the alloy remains substantially level plane; addition of alloy nanoparticles be completely convolvement 90%, up to 65 kw power;

Step 3, the liquid alloy to be absent after floating particles, to power up 105 kw, 10min after the electromagnetic stirring, cooling the oil was stopped power; the ingot is extracted and inverted again within a crucible, evacuated to a vacuum in the furnace was 6.0x10<sup>-2</sup> Pa, charge argon to 400Pa, to 105 kw-up power rapidly, 10min electromagnetic stirring, cooling the oil was stopping power.

7. TiAl / -Al<sub>2</sub>O<sub>3</sub> nano composite material production method according to claim 5, characterized in,

Step 1, the -Al<sub>2</sub>O<sub>3</sub> 8 wt.% ratio particles are nano-scale, a previously prepared master alloy ingot into the crucible Ti45at.% Al10at.% Nb content, to draw a vacuum in the furnace was 8.0x10<sup>-3</sup> Pa, charge high purity Ar to 450Pa;

In step 2, dal electromagnetic power to 100 kw, completely melting the master alloy; power down to 40 kw, the alloy remains substantially level plane; addition of alloy nanoparticles be completely convolvement 90%, up to 70 kw power;

Step 3, after the liquid alloy to no floating particles, power increasing to 110 kw, after 9min electromagnetic stirring, cooling the oil was stopped power; the ingot in a crucible and inverted again in, evacuated to a vacuum in the furnace was 8.0x10<sup>-3</sup> Pa, charge argon to 450Pa, to 110 kw-up power rapidly, 9min electromagnetic stirring, cooling the oil was stopping power.

8. TiAl / -Al<sub>2</sub>O<sub>3</sub> nanocomposite production method according to claim 5, characterized in,

Step 1, the -Al<sub>2</sub>O<sub>3</sub> 15 wt.% ratio particles are nano-scale, a previously prepared master alloy ingot into the crucible is component Ti47at % Al; evacuated to a vacuum in the furnace was 5.5x10<sup>-3</sup> Pa, charge high purity Ar to 500Pa;

Step electromagnetic power 105 kw to 2, dal, completely melting the master alloy; power down to 45 kw, the alloy remains substantially level plane; 90% to complete the addition of alloy nanoparticles convolvement, power up to 75 kw;

Step 3, the liquid alloy to be absent after floating particles, to power up 115 kw, 8min after the electromagnetic stirring, cooling the oil was stopped power; the ingot is extracted and inverted again within a crucible, evacuated to a vacuum in the furnace was 5.5x10<sup>-3</sup> Pa, charge argon to 500Pa, to 115 kw-up power rapidly, 8min electromagnetic stirring, cooling the oil was stopping power.





**Claims**

(CN104357701)

1. A method of preparing a nanocomposite TiAl/TiC, characterized in, the method comprising the addition of the nano TiC, in, after respectively take different processing steps:

Step 1, adding the nano TiC before, the encapsulated nanoparticles, the master alloy ingot into a crucible TiAl water, highly purified argon is evacuated and filled with;

Step 2, adding the nano TiC during, first up power to the master alloy is completely melted, then down power level substantially planar to the alloy, adding the encapsulated nano-particles, to about 90% of the addition of the alloy particles convolvement, I power level until the alloy without floating nanoparticles;

Step 3, the liquid alloy to be not present on the floating particles after, power increasing, with magnetic stirring, and then stopping power and then furnace cooled; the cooled ingot placed in the crucible is turned, evacuated and filled with high purity argon; power rise again and then, cooling the oil was stopped power electromagnetic stirring, where carbon, nanocomposites TiAl/TiC prepared.

2. Nanocomposites TiAl/TiC preparation method according to claim 1, characterized in, step 1 to the aluminum foil is encapsulated nanoparticles with encapsulated nanoparticles TiC, and then encapsulated into the cloth bucket TiC.

3. Nanocomposite TiAl/TiC a manufacturing method according to claim 1, characterized in, in step 1, a vacuum  $5.5 \times 10^{-3}$  Pa -  $6.0 \times 10^{-2}$  Pa, charge high purity argon to 400Pa-500Pa.

4. Nanocomposite TiAl/TiC a manufacturing method according to claim 1, characterized in, in step 2 the master alloy TiAl 95-105 kw power to first up completely melted; then drop level planar 35-45 kw power to the alloy.

5. Nanocomposite TiAl/TiC a manufacturing method according to claim 1, characterized in, step 2, the addition of the alloy particles of about 90% convolvement, liter 55-65 kw power to, the liquid alloy until the floating particles is not present.

6. A manufacturing method that TiAl/TiC nanocomposite according to claim 1, characterized in, step 3, to be not present on the floating particles after the liquid alloy, liter 95-105 kw power to, electromagnetic stirrer 5-7 min; inverted again placed in the crucible after cooling the ingot, again raised 95-105 kw power to, electromagnetic stirring again 5-7 min, and then stopping power oil was cooled.

7. 1 according to claim-TiAl/TiC one nano composite material as defined in 6, characterized in, in step 1, into water-cooled crucible TiAl master alloy component is Ti (43-47) at.% Al (0-10) at.% Nb, nano TiC in an amount of 1 wt. %-5 wt. %.

8. Nanocomposite TiAl/TiC a manufacturing method according to claim 7, characterized in:

In step 1, as nanoparticles TiC 1 wt.% weighed ratio, the master alloy ingot into the crucible Ti43at % Al, the furnace evacuated to vacuum  $6.0 \times 10^{-2}$  Pa, charge high purity Ar to 400Pa;

In step 95 kw to 2, dal on the electromagnetic power, reduced power to 35 kw after completely melted master alloy; to the addition of alloy nanoparticles completely convolvement 90%, up to 55 kw power;

In step 3, the liquid alloy to be floating particles after the absence, increase power to 95 kw, 7min electromagnetic stirring; and inverted again within the ingot is extracted in a crucible, the furnace evacuated to vacuum  $6.0 \times 10^{-2}$  Pa, charge argon to 400Pa; rapidly increasing power to 95 kw, 7min electromagnetic stirring, cooling the oil was stopping power.

9. Nanocomposite TiAl/TiC a manufacturing method according to claim 7, characterized in,

In step 1, the proportion of the weighed nanoparticles TiC 5 wt.% by weight, of the alloy ingot into the crucible Ti45at.% Al10at.% Nb, the furnace evacuated to vacuum  $8.0 \times 10^{-3}$  Pa, Ar charge high purity to 450Pa;

In step 100 kw to 2, dal on the electromagnetic power, reduced power to 40 kw after completely melted master alloy; to the addition of alloy nanoparticles completely convolvement 90%, up to 60 kw power;

In step 3, to be floating particles after the liquid alloy is not present, up to 100 kw power, 6min electromagnetic stirring; the ingot is extracted and inverted again into the crucible, the furnace evacuated to vacuum  $8.0 \times 10^{-3}$  Pa, charge argon to 450Pa ;-up power rapidly to 100 kw, 6min electromagnetic stirring, cooling the oil was stopping power.





10. Nanocomposite TiAl/TiC a manufacturing method according to claim 7, characterized in,

In step 1, as nanoparticles TiC 10 wt.% weighed ratio, the master alloy ingot into the crucible Ti47at % Al, evacuated to a vacuum in the furnace was  $5.5 \times 10^{-3}$  Pa, charge high purity Ar to 500Pa;

In step 105 kw to 2, dal of electromagnetic power, master alloy is completely melted and reduced power to 45 kw; addition of alloy nanoparticles be completely convolvement 90%, up to 75 kw power;

In step 3, liquid alloy to be floating not present after the particles, power increasing to 105 kw, 5min electromagnetic stirring; the ingot is extracted and inverted again into the crucible, the furnace evacuated to vacuum  $5.5 \times 10^{-3}$  Pa, charge argon to 500Pa ;-up power rapidly to 105 kw, 5min electromagnetic stirring, cooling the oil was stopping power.

## Preparation method of TiAl / TiO<sub>2</sub> nanocomposite CN104313373

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> LIN JUNPIN ZHANG ZHIYONG LIANG YONGFENG ZHANG LAIQI</li> <li>• <b>International Patent Classification</b> C22C-001/03 C22C-001/10 C22C-014/00 C22C-030/00</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN104313373 A 2015-01-28 [CN104313373]</a>    </li> <li>• <b>Priority Details</b> 2014CN-0539071 2014-10-13</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <a href="#">CN104313373</a>                          A        2015-01-28                          [CN104313373]</li> </ul>	

- **Abstract:**

(CN104313373)

The invention relates to a preparation method of a nano-TiO<sub>2</sub> reinforced TiAl-based composite. The method comprises TiAl melt form and temperature process control before nano-TiO<sub>2</sub> particles are added, process control that nano-TiO<sub>2</sub> particles are evenly drawn into by a TiAl melt and are not adsorbed by a crucible wall in the addition process, and an electromagnetic stirring process. Nanoparticles are encapsulated by aluminum foil and put into a distribution hopper; a TiAl master alloy is put into a crucible, the crucible is vacuumized and is filled with an argon gas for protection and the electromagnetic induction power is increased until the master alloy in the crucible is completely melted; the liquid surface of the alloy is in a plane by decreasing the power, the nanoparticles are poured onto the liquid surface of the alloy, the power is increased and the stirring is carried out after 90% of particles are drawn into the alloy liquid and floating particles do not exist on the liquid surface, and the power is stopped and the furnace cooling is carried out; the prepared ingot castings are overturned and put into the crucible again, the crucible is vacuumized and filled with the argon gas, the power is rapidly increased and the electromagnetic stirring is carried out, and then the power is stopped and the furnace cooling is carried out. Through the design of the process, the TiAl-based nanocomposite with evenly dispersed and distributed nano-TiO<sub>2</sub> particles is realized.

## Claims

(CN104313373)

1. A TiAl/TiO<sub>2</sub> producing nanocomposites, characterized in, the preparation comprising the steps of:

Step 1, adding the nano TiO<sub>2</sub> prior to, preparation of nanoparticles, and the mother alloy ingot into water-cooled crucible TiAl, evacuated and filled with high purity argon;

Step 2, adding the nano TiO<sub>2</sub> procedure in, first raising the power, the master alloy is completely melted, then the alloy down power level substantially planar, nanoparticles are added, addition of alloy to be about 90% of the particles involved, to boost the power to the liquid alloy until floating nanoparticles not present;

Step 3, adding the nano TiO<sub>2</sub> after, to boost the power, power and then furnace cooled electromagnetic stirring stopped; the cooled ingot reversed again placed in the crucible, evacuated and filled with high purity argon; again up power, power electromagnetic stirring is stopped the oil was cooled.

2. TiAl/TiO<sub>2</sub> nano composite material production method according to claim 1, characterized in, in step 1, TiO<sub>2</sub> preparation of nanoparticles comprising a magnetic nanoparticle with aluminum foil placed in a vacuum furnace is encapsulated and suspended within the cloth bucket; TiAl after evacuation to a water-cooled crucible the alloy ingot into a female  $5.5 \times 10^{-3}$  Pa -  $6.0 \times 10^{-2}$  Pa, charge high purity argon to 400Pa-500Pa.

3. TiAl/TiO<sub>2</sub> nanocomposite production method according to claim 1, characterized in, in step 2, adding the nano TiO<sub>2</sub> during, the master alloy is completely melted 95-105 kw power to first up, and then lowering the liquid level substantially planar 35-45 kw power to the alloy, the extract to about 90% of the alloy particles convolvement, up floating to the power level until there is no 45-55 kw alloy nanoparticles.

4. TiAl/TiO<sub>2</sub> method for producing composite nanoparticles according to claim 1, characterized in, in step 3, adding the nano TiO<sub>2</sub> thereafter, raised 85-95 kW power, stopping power and then furnace cooled after electromagnetic stirring 1-3 min; reversed again after cooling the ingot in a crucible, a vacuum  $5.5 \times 10^{-3}$  Pa -  $6.0 \times 10^{-2}$  Pa, charge high purity argon to 400Pa-500Pa; Does not exist on the liquid alloy to be floating particles after, to power increasing again 85-95 kw, electromagnetic stirring power cooling the oil was stopped 1-3 min.

5. 1 according to claim-TiAl/TiO<sub>2</sub> one nanocomposite material as defined in 4, characterized in, the mother composition of the alloy is TiAl Ti (43-47) at.% Al (0-10) at.% Nb, in an amount of 1 wt.% nano TiO<sub>2</sub>-5 wt. %.

6. Nanocomposites TiAl/TiO<sub>2</sub> preparation method according to claim 5, characterized in,

In step 1, the TiO<sub>2</sub> 1 wt.% ratio nanoparticles by weighing, the previously prepared mother alloy ingot is placed in the crucible Ti43at % Al within the component, the furnace evacuated to vacuum  $6.0 \times 10^{-2}$  Pa, charge high purity Ar to 400Pa;

In step 2, up to 95 kw of electromagnetic power, the master alloy is completely melted; reduced power to 35 kw, the alloy remains substantially level plane; addition of alloy nanoparticles be completely convolvement 90%, up to 45 kw power;

In step 3, the liquid alloy to be floating particles after the absence, power increasing to 85 kw, after 3min electromagnetic stirring, cooling the oil was stopped power; the ingot is extracted and inverted again in a crucible, the furnace evacuated to vacuum  $6.0 \times 10^{-2}$  Pa, 400Pa to charge argon, -up power rapidly to 85 kw, 3min electromagnetic stirring, cooling the oil was stopping power.

7. TiAl/TiO<sub>2</sub> nanocomposite production method according to claim 5, characterized in,

In step 1, the TiO<sub>2</sub> 5 wt.% ratio in the nanoparticle is weighed, a previously prepared mother ingot Ti45at.% Al10at.% Nb component is placed in the crucible, the furnace evacuated to vacuum  $8.0 \times 10^{-3}$  Pa, charge high purity Ar to 450Pa;

In step 2, dal electromagnetic power to 100 kw, and the mother alloy is completely melted; power down to 40 kw, the alloy remains substantially level plane, to the addition of alloy nanoparticles completely convolvement 90%, up to 50 kw power;

In step 3, the liquid alloy to be floating particles after the absence, power increasing to 90 kw, after 2min electromagnetic stirring, cooling the oil was stopped power; the ingot is extracted and inverted again within a crucible, the furnace evacuated to vacuum  $8.0 \times 10^{-3}$  Pa, 450Pa to charge argon, -up power rapidly to 90 kw, 2min electromagnetic stirring, cooling the oil was stopping power.





8. TiAl/TiO<sub>2</sub> nano composite material preparation method according to claim 5, characterized in,

In step 1, the TiO<sub>2</sub> in proportion 10 wt.% weighed nanoparticles, a previously prepared master alloy ingot in a crucible Ti47at % Al content of, the furnace evacuated to vacuum  $5.5 \times 10^{-3}$  Pa, charge high purity Ar to 500Pa;

105 kw to 2, dal of electromagnetic power in step, the master alloy is completely melted; power down to 45 kw, the alloy remains substantially level plane, the addition of alloy nanoparticles be completely convolvement 90%, up to 55 kw power;

In step 3, the liquid alloy to be floating particles after the absence, power increasing to 95 kw, after 1min electromagnetic stirring, cooling the oil was stopped power; the ingot is extracted and inverted again into the crucible, the furnace evacuated to vacuum  $5.5 \times 10^{-3}$  Pa, 500Pa to charge argon, -up power rapidly to 95 kw, 1min electromagnetic stirring, cooling the oil was stopping power.

## Direction control method of tial-nb alloys lamellar structure CN102672150

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> DING XIANFEI LIN PINJUN ZHANG LIWEI WANG YONGSHENG CHENG FANG YE FENG</li> <li>• <b>International Patent Classification</b> B22D-027/20 C30B-029/52</li> <li>• <b>CPC Code</b> B22D-027/04; B22D-027/20; C30B-011/00/6; C30B-029/52; C30B-029/60/5</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN102672150 A</a> 2012-09-19 [CN102672150]    </li> <li>• <b>Priority Details</b> 2012CN-0148454 2012-05-14</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b>  <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><a href="#">CN102672150</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 20%;">2012-09-19</td> <td style="width: 30%;">[CN102672150]</td> </tr> <tr> <td><a href="#">WO2013170585</a></td> <td style="text-align: center;">A1</td> <td>2013-11-21</td> <td>[WO2013170585]</td> </tr> </table> </li> </ul>		<a href="#">CN102672150</a>	A	2012-09-19	[CN102672150]	<a href="#">WO2013170585</a>	A1	2013-11-21	[WO2013170585]
<a href="#">CN102672150</a>	A	2012-09-19	[CN102672150]						
<a href="#">WO2013170585</a>	A1	2013-11-21	[WO2013170585]						

- **Abstract:**

(WO2013170585)

A direction control method of TIAI-Nb alloy lamellar structure can control the direction of the alloy lamellar structure based of a full peritectic reaction of alloy by changing solidification condition including temperature gradient (G) and drawing speed (V) to full dissolved the primary betadendritic crystals in a solidification process using common directionally solidification technology so as to e liminate the potential bad effect on the alloy structure. The method is simple, which can improve the performance of the TIAI-Nb alloy and promote the industrial application of the directionally solidified TIAI-Nb alloy.

**Claims**

(WO2013170585)

Claims machine translated from Chinese

Claim of right book

1. One titanium aluminum niobium alloy laminar organization directional control method, its characteristic lies in: Uses titanium aluminum niobium alloy atom percentage is (46-53) Ti- (45-46) Al- (2-8) Nb, is the series carries on the titanium aluminum niobium alloy laminar organization directional control with the ordinary Bridgman directional freeze, and pulls out including gradient of temperature G through the change coagulation condition pulls the speed V to urge the titanium aluminum niobium alloy to have the complete peritectoid reaction, causes Beta the arborescent crystal to be dissolved in the solidification process newborn completely, eliminates it to the adverse impact that the alloy organization probably brings, thus achieved has controlled the alloy laminar took to the goal.

2. The method that according to claim 1 station, its characteristic lies in: Stated the titanium aluminum niobium alloy laminar organization direction to control the system method including the following step:

(1) regarding stated the ingredient scope the titanium aluminum niobium alloy good test specimen to carry on the directional freeze, gradient of temperature G was 10(3) K/m- 10(4) K/m, the soaking time is 5 15min, pulled out pulls the speed V in 5 Mu m/s 200 Mu m/s;

Continues to pull out, when the test specimen directional freeze growth achieves the total length 1/2 positions, the start quenches the installment to the test specimen quickly quenches processing quickly;

(2) carries on line cutting and analyzes to the organization with the correlation technique method the alloy stick that the above step obtains;

Observation analysis step (1) in various test specimens newborn Beta arborescent crystal growth rule and appearance as well as size and volume fraction along with directional freeze parameter rules of changes, as well as the Nb contents of various test specimens condition and characteristic the effect on newborn Beta arborescent crystal growth shape;

Finally the summary obtains various test specimens to have the degree of peritectoid reaction.

3. The method that according to claim 2 stations, its characteristic lies in: Stated the step (1) after the vacuum degree achieved 10<sup>-3</sup>Pa-10<sup>-4</sup>Pa, passes over the inert controlled atmosphere to enable the vacuum degree to achieve -0.07 -0.05MPa, the power transmission heating, caused temperature increment to the titanium aluminum alloy melting point above condition under afterward, tests the gradient of temperature G scope that controlled is 10(3) K/m- 10(4) K/m, pulled out pulls the speed V scopes is 5 Mu m/s 200 Mu m/s.





4. In the claim 1-3 any item of institute according to method that stated that its characteristic lay in: When regarding the specific ingredient's titanium aluminum niobium alloy, namely some titanium aluminum niobium Cheng Fen definite the alloy in (46-53) Ti- (45-46) Al- (2-8) Nb this scope, adjustment coagulation condition gradient of temperature G and pulls out pulls the speed V to a A1 equivalent close phase diagram package crystal ingredient, the alloy can have the complete peritectoid reaction.

5. The method that according to claim 1 or 2 stations, its characteristic lies in: In the gradient of temperature and pulls out pulls speed is under the true definite value condition, when regarding (46-53) Ti- (45-46) Al- (2-8) Nb alloy through the adjustment the content of aluminum and niobium, makes alloying constituent close peritectic point, is easier to obtain the complete peritectoid reaction.

6. The method that according to claim 1 or 2 stations, its characteristic lies in: Stated the step 1), continued to pull out, grew when until the test specimen directional freeze to the 45mm length position, carried on to the test specimen quenches processing quickly.

7. The method that according to claim 3 stations, its characteristic lies in: Stated the step (1) after the vacuum degree achieved 5x10<sup>-3</sup>Pa, passes over the controlled atmosphere high pure argon to enable the vacuum degree to achieve -0.07 -0.05MPa, the power transmission added the heat afterward, caused temperature increment to the titanium aluminum alloy melting point above condition under.

## Preparation method of directional solidification high-Nb TiAl alloy single crystal CN102011195

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> JUNPIN LIN XIANFEI DING GUOJIAN HAO HAOLIANG WANG JIANBO TONG GUOLIANG CHEN</li> <li>• <b>International Patent Classification</b> B22D-027/04 C22C-001/02 C22C-014/00 C30B-011/00 C30B-029/52</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN102011195 A</a> 2011-04-13 [CN102011195]    </li> <li>• <b>Priority Details</b> 2010CN-0562550 2010-11-23</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b>  <table style="width: 100%; border: none;"> <tr> <td style="width: 30%;"><a href="#">CN102011195</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 20%;">2011-04-13</td> <td style="width: 30%;">[CN102011195]</td> </tr> <tr> <td><a href="#">CN102011195</a></td> <td style="text-align: center;">B</td> <td>2012-06-06</td> <td>[CN102011195B]</td> </tr> </table> </li> </ul>		<a href="#">CN102011195</a>	A	2011-04-13	[CN102011195]	<a href="#">CN102011195</a>	B	2012-06-06	[CN102011195B]
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<a href="#">CN102011195</a>	B	2012-06-06	[CN102011195B]						

- **Abstract:**

(CN102011195)

The invention discloses a preparation method of a directional solidification high-Nb (niobium) TiAl (titanium aluminum) alloy single crystal, which belongs to the field of metal material preparation. The high-Nb TiAl alloy mainly comprises the elements such as Ti, Al, Nb and the like; and the atomic percentage of the components of the master alloy generally is: Ti: Al: Nb= (44-49);(45-46);(6-10).The directional solidification high-Nb TiAl alloy single crystal is successfully prepared by using a Bridgman directional solidification system through a two -step directional solidification process in which a bar subject to primary Bridgman directional solidification is inverted by 180 degrees and then loaded into the Bridgman system once again, and performing secondary directional solidification under the same directional solidification conditions. The processing technique is simple and reliable, does not need a seed crystal, has high applicability and is suitable for practical engineering. The high-Nb TiAl alloy single crystal prepared by the directional solidification method has high temperature performance and room temperature plasticity in good combination and has broad application prospect in high-temperature structure material, particularly the booster turbine blades of aircraft engines and the like.

**Claims**

(CN102011195)

1 . High niobium titanium aluminum alloy single crystal production method of a directional solidification, characterized in: directional solidification single crystal aluminum alloy the atomic percentage of high niobium titanium: (44-49) Ti-(45-46) Al-(6-10) Nb, preparation process comprises the following steps:

(1) . Master alloy melting: with the plasma arc or vacuum induction skull to atomic ratio (44-49) Ti-(45-46) Al-(6-10) Nb component of the raw material alloy for melting, and cast into a mother alloy ingot ;

(2) . As-cast master alloy ingot was cut into a sparker (3-50) x (50-1000) mm cylinder rods, and a Bridgman directional solidification of the high-purity argon with a built-in systems for first directional solidification, directional solidification process controlling the growth rate was 5-200 m/s, the temperature gradient of 1-10 K/mm ;

(3) . For the first time after completion of directional solidification, removal rods, and the initial surface is subjected to polishing processing, and then the primary directional solidification alloy rod flipped 180°, Bridgman directional solidification of the high-purity argon with threaded again subjected to unidirectional solidification in the system, the secondary directional solidification process of growth rate and temperature gradient are the same as the first directional solidification ;

(4) . After taking out the secondary directional solidification of the high niobium titanium aluminum alloy, a rubbing treatment is carried out again at a surface, it is possible to obtain high niobium titanium aluminum alloy single crystal .

2 . One directional solidification process for preparing high niobium titanium aluminum alloy single crystal according to claim 1, characterized in:

Step (2) are, or are above the cylinder rods of the high-purity argon with a built-380Pa 380Pa Bridgman directional solidification system to perform a first directional solidification ;


Step (2) must be oriented in the as-cast master alloy prior to solidification of the ingot is cut into 6x100mm sparker cylinder rods .

3 . A directional solidification process for preparing high niobium titanium aluminum alloy single crystal according to claim 1, characterized in: step (2) withdrawing the Bridgman directional solidification system consists mainly of a motion system, heating system and re-melting metal is cooled system composed, heating mode as resistance heating or high frequency induction heating, the heating temperature may be adjusted between a range from room temperature to 2000 °C, liquid coolant is a gallium-indium alloy, the bottom part of the moving speed of the system adjustable in the range of 1-1000 m/s .

4 . A directional solidification process for preparing high niobium titanium aluminum alloy single crystal according to claim 1, characterized in: step (3) was, is a directional solidification of the alloy rod again an inverted 380Pa or more high-purity argon 380Pa or by incorporating the Bridgman directional solidification of the system .

5 . A directional solidified aluminum alloy high niobium titanium method for producing a single crystal according to claim 1, characterized in: step (3) was, the growth rate of the secondary directional solidification process with both step and the temperature gradient (2) in the same.

## Process for preparing high niobium Ti Al alloy large size cake material CN1352315

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> LIN JUNPIN WANG YANLI CHEN GUOLIANG</li> <li>• <b>International Patent Classification</b> C22C-001/00 C22C-014/00 C22F-001/18</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN1352315 A</a> 2002-06-05 [CN1352315]</li> </ul> <div style="text-align: right;">  </div> <ul style="list-style-type: none"> <li>• <b>Priority Details</b> 2001CN-0134630 2001-11-08</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><a href="#">CN1352315</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 20%;">2002-06-05</td> <td style="width: 40%;">[CN1352315]</td> </tr> <tr> <td><a href="#">CN1132953</a></td> <td style="text-align: center;">C</td> <td>2003-12-31</td> <td>[CN1132953C]</td> </tr> </table> </li> </ul>		<a href="#">CN1352315</a>	A	2002-06-05	[CN1352315]	<a href="#">CN1132953</a>	C	2003-12-31	[CN1132953C]
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<a href="#">CN1132953</a>	C	2003-12-31	[CN1132953C]						

- **Abstract:**

(CN1352315)

The preparation of large high-Nb TiAl alloy cake includes the technological process of smelting, soakage treatment, turning, canning, forging and slow cooling. The preparation process features the smelting including the first self-consuming, the self-consuming kish and the second self-consuming steps; the soakage treatment at 1100-1300 deg.c for 24-48 hr; turning to eliminate surface scale; canning with stainless steel pipe, titanium pipe and stainless steel plate; forging in a 3000-5000 oil press at deformation temperature of 1200-1350 deg.c after heating at 1250-1300 deg.c for 40-60 min in the furnace and preheating for 6-10 hr to produce deformatino amount of 60-80 % at the rate of 0.001-0.1/s; and tempering at low temperature. The present ivention has the advantages of fine crystal grains and excellent comprehensive mechanical performance.



**Claims**

(CN1352315)

TiAl alloy large-size cake timber production method of a high-niobium, process flow is:

Smelting soaking treatment turning envelope forging slow cooling, characterized in:

A, smelting: 1st + 2nd time consumable times + consumable shells consumable;

B, soaking annealing: 1100-1300 °C insulation 24-48 hours, furnace cooling of tapping;

C, turning: turning the annealed surface of the ingot oxide scale removal, the surface roughness reaches Ra6.3-1.6;

The envelope d: outer diameter by 150-300 mm wall thickness 2-6 mm pure stainless steel pipe as a sheath, the ingot was placed central titanium tube, and using tig with 2-6 mm thick stainless steel tube capped at both ends, and further a stainless steel tube whose outer 1-3 mm thick stainless steel plate coated with, a stainless steel tube and stainless steel sheet is disposed between the high-temperature celloidine and cyriot real;


E, canning a heating: of the oven was heated to 1250-1300 °C insulation 40-60 minutes, immediately out of the furnace;

F, forging: will go through 6-10 hours preheated forging is transferred quickly to 3000-5000 ton hydraulic press forging is performed on, deformation temperature of 1200-1350 °C, deformation rate of  $1 \times 10^{-3}$ - $10^{-1}$ /s, deformation is 60-80%;

G, has been forged the forgings placed within 600-800 °C low-temperature furnace of the inner, low-temperature tempering is carried out, to prevent forging cracks caused by residual stress due to internal high forging.

## High Nb containing TiAl porous intermetallic compound gradient material and preparation method thereof

CN101994043

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> JUNPIN LIN FAN YANG HUI WANG ZHAOPING LU GUOJIAN HAO JINGCHUN LIU GUOLIANG CHEN</li> <li>• <b>International Patent Classification</b> C22C-001/08 C22C-021/00</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> CN101994043 A 2011-03-30 [CN101994043]</li> <li style="text-align: right;"></li> <li>• <b>Priority Details</b> 2010CN-0578428 2010-12-08</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Family</b> CN101994043                                      A                                      2011-03-30                                      [CN101994043]</li> </ul>	

- **Abstract:**

(CN101994043)

The invention provides a high Nb containing TiAl porous intermetallic compound gradient material and a preparation method thereof, belongs to the technical field of intermetallic compounds, and relates to a method for preparing the intermetallic compound porous material. The method comprises four parts, namely (1) preparing a high Nb containing TiAl (Ti-48Al-(5-10)N bat. percent) porous intermetallic compound by adopting a powder metallurgical vacuum sintering process, wherein the porosity is between 30 and 60 percent; (2) mixing Ti powder, Al powder and Nb powder for 8 hours according to the atomic percentage (Ti-48Al-(5-10)N bat. percent), and drying the mixed powder to prepare a cold-spraying powder; (3) cleaning the high Nb containing TiAl coarse porous substrate material prepared in the step (1), and depositing the cold-spraying powder which is prepared in the step (2) onto the coarse porous substrate at one time; and (4) performing vacuum insulation sintering by adopting a three-stage sintering process to obtain a fine pore-coarse pore composite gradient porous material. The method has the advantages that the mixed powder of the Ti powder, the Al powder and the Nb powder is directly sprayed on the outer surface of the high Nb-TiAl porous material, and the process is simple and efficient.

**Claims**

(CN101994043)

1 . One high niobium titanium intermetallic compound porous aluminum gradient material, characterized in: material thickness of the porous metal body along the flat plate-shaped cross-section, from one side to another side of the mass density and a gradient distribution pores, the pores are near full open-cell structure, the matrix having a porosity of 30%-60%, the coating having a porosity of 20%-40%, the coating thickness is 0.5 mm -20 mm .

2 . One high niobium titanium intermetallic compound porous aluminum gradient a manufacturing method according to claim 1, characterized in, particular process flow of the method are as follows:


Ti powder will be 2.1 (100-500 mesh), Al (100-500 mesh) powder and Nb powder (-500 mesh) in terms of atomic percentage (Ti - 48Al-(5-10) Nb at. %) 8 hours mixedly, uniaxial compaction is carried out in a mold, followed by two stage vacuum sintering process by the powder metallurgical preparation of a high-Titanium aluminum porous intermetallic compounds, porosity of 30%-60% ;

Ti powder will be 2.2 (300-500 mesh), Al (300-500 mesh) powder and Nb powder (-500 mesh) in terms of atomic percentage (Ti - 48Al-(5-10) Nb at. %) mixed powder, mixed 8 hours, sufficient drying process is carried out, cold spray powder made ;

The step 2.3 2.1 high niobium titanium aluminum porous intermetallic compound produced by performing the cleaning process, cold spray powder obtained in the step 2.2 with the cold-spray deposited onto high niobium titanium aluminum intermetallic compound on the disposable porous, cold spray operating temperature of 400 °C, sprayed with a nitrogen atmosphere ;

Three-stage sintering process is performed again using the 2.4 vacuum thermos sintering, to obtain high niobium titanium aluminum porous intermetallic compound graded material.

## One kind of directional freeze Gao Nitai the preparation method of aluminum alloy CN101875106

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> JUNPIN LIN XIANFEI DING HAOLIANG WANG LAIQI ZHANG YANLI WANG FENG YE GUOLIANG CHEN</li> <li>• <b>International Patent Classification</b> B22D-027/20</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN101875106 A</a> 2010-11-03 [CN101875106] </li> <li>• <b>Priority Details</b> 2009CN-0238430 2009-11-20</li> </ul>								
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <table style="width: 100%; border: none;"> <tr> <td style="width: 30%;"><a href="#">CN101875106</a></td> <td style="width: 10%; text-align: center;">A</td> <td style="width: 20%;">2010-11-03</td> <td style="width: 30%;">[CN101875106]</td> </tr> <tr> <td><a href="#">CN101875106</a></td> <td style="text-align: center;">B</td> <td>2011-12-28</td> <td>[CN101875106B]</td> </tr> </table> </li> </ul>		<a href="#">CN101875106</a>	A	2010-11-03	[CN101875106]	<a href="#">CN101875106</a>	B	2011-12-28	[CN101875106B]
<a href="#">CN101875106</a>	A	2010-11-03	[CN101875106]						
<a href="#">CN101875106</a>	B	2011-12-28	[CN101875106B]						

- **Abstract:**

(CN101875106)

The invention discloses a preparation method of a directional solidification high-niobium TiAl-base alloy, which belongs to the field of metal material preparation. The high-niobium TiAl-base alloy contains Ti, Al, Nb, W, Mn, C, B and Y, and the atomic percentage is: (43-49) Ti-(45-46) Al-(6-9) Nb-(0-0.5) (W and Mn)-(0-0.5) (C and B)-(0-0.5) Y, an as-cast master alloy rod which is smelted by plasma arc or vacuum suspension is taken as a raw material, a high-purity alumina ceramic tube with a coating layer of which the main component is yttrium oxide is used as a crucible, Ga-In-Sn alloy liquid is cooling liquid, and the directional solidification high-niobium TiAl-base alloy is successfully prepared by using an improved zone-melting and directional solidification system. The processing technology is simple and reliable, the directional solidification effect is obvious, and the method has universal applicability. The directional solidification high-niobium TiAl-base alloy which is prepared by the directional solidification method has comprehensive and good high temperature performance and room temperature ductility and has wide application prospect in terms of high temperature structural materials.

**Claims**

(CN101875106)

1. A directional solidification process for preparing high niobium titanium aluminum-based alloy, characterized in alloy composition are atomic percent:(43-49)Ti-(45-46)Al-(6-9)Nb-(0-0.5)(W,Mn)-(0-0.5)(C,B)-(0-0.5)Y, production process is:

(1) mother alloy melting: a plasma arc or vacuum induction levitation furnace for melting, and cast into ingots;

(2) preparing high purity alumina ceramic crucible inner wall of the coating, an alumina crucible size of: (7-25) x120mm, a volume percentage of the ingredients of the coating composition: (87-93) +% yttria (2-3) +% phosphate (5-10)% bentonite;

(3) cutting the wire into a cylinder of the as-cast master alloy ( (6-20) x100mm) sample, placed in the crucible to the float zone and introduced into the modified directional solidification system, by applying vacuum to 3x10<sup>-3</sup>Pa, recharged to the system is filled with the highly purified argon to 380Pa, turns on system power is heated, and overcomes the alloy melting point 20-500K is reached, i.e. 1930K-2410K, a heating rate of 15-20K/min, after warm-retaining 15-30 minutes to uniformize sufficiently melted alloy;

(3) start a directional solidification, by directional solidification PLC control panel on the system area with directional solidification rate is 1-100 m/s;

(4) after completion of directional solidification, vented to atmosphere, the crucibles were removed with gentle an outer layer is ceramic scraping, grinding and polishing the surface thereof was removed and high niobium titanium aluminum-based alloy to give a directional solidification.

2. High niobium titanium aluminum-based alloy directional solidification process according to claim 1, characterized in that if necessary, the sample is introduced into the bottom seed, the seed titanium aluminum alloy single crystal claim is rod-shaped, cross-sectional diameter is the same as with the master alloy, high 5-25 mm, with the mother alloy is carried out after welding assembly argon-arc welding bottom ends, followed by a directional solidification process, cut-away after completion of the seed crystal portion where directional solidification.

3. A directional solidification process high niobium titanium aluminum-based alloy according to claim 1, wherein the modified directional solidification after melting into the area of the tungsten-rhenium thermocouple system comprised with (1), the insulating panel (2), high-niobium titanium aluminum alloy (3), a graphite sleeve (4), a high-purity alumina crucible (5), the crucible coating (6), a thermocouple protective sleeve (7), the induction coil (8), a thermally conductive base (9), the heat radiation shield (10), a liquid metal cooled liquid (11), a water cooling system (12) composition; tungsten-rhenium thermocouple and a thermocouple outer protective sleeve, and inserted in the high niobium titanium aluminum alloy stick heart ministry, measuring a high internal temperature Niobium-Titanium aluminum alloy; high purity alumina crucible inner wall coated with an inert coating material body to block the alloy at a high temperature chemically react with the crucible; high purity alumina crucible having a graphite sleeve mounted inside concentric with the inner and maintain position; insulation panel provided on the graphite outer liner, constant-temperature environment within the system ensure that coagulates, causing the columnar crystal along the axial growth; induction coil being positioned in a peripheral thermal insulation board, and the graphite sleeve for inductively heating the interior of the insulation panels; located in the lower portion of the graphite sleeve to prevent the escape of heat radiation radiating heat barrier, retaining the system within a constant-temperature environment and increasing the temperature of the coagulation system and the cooling system to increase the temperature gradient difference; makes contact with the alloy in a directional solidification process of the thermally conductive base bottom ends serve to keep the crucible and the single action of conducting heat, the alloy is solidified in the axial direction; liquid metal coolant to directly cool the heat-conducting base of the crucible, water-cooling system for the coolant to cool the liquid metal.


4. With the directional solidification after melting into the area of the changed system according to claim 3, wherein the single-turn induction coil is changed to the original float zone system multi-turn coil, the induction coil is disposed between the crucible and the graphite sleeve, the effect of shielding magnetic fields on the coagulation process, and through induction coil heating graphite sleeve, provide a stable high-temperature heat source to a high-Titanium aluminum alloy; crucible with a graphite sleeve inner wall from the outer wall 2-3 mm.

5. After melting into the area of the change to the directional solidification system according to claim 3, is characterized in that under conditions of a graphite sleeve shield magnetic field interference, using a tungsten-rhenium thermocouple pair alloy and the melt temperature measurements, controlling the heating rate and the directional solidification front melt superheat.

6. After melting into the area of the change to the directional solidification system according to claim 3, wherein the liquid metal coolant with Ga-In-Sn alloy slurry.

## Method for preparing porous heat exchange surface of TiAl-based intermetallic compound

CN102303117

<ul style="list-style-type: none"> <li>• <b>Patent Assignee</b> UNIVERSITY OF SCIENCE &amp; TECHNOLOGY BEIJING</li> <li>• <b>Inventor</b> JUNPIN LIN FAN YANG LAIQI ZHANG GUOJIAN HAO</li> <li>• <b>International Patent Classification</b> B22F-007/04 C23C-024/00</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Publication Information</b> <a href="#">CN102303117</a> A 2012-01-04 [CN102303117] </li> <li>• <b>Priority Details</b> 2011CN-0249709 2011-08-27</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Fampat family</b> <a href="#">CN102303117</a>                      A                      2012-01-04                      [CN102303117]</li> </ul>	

- **Abstract:**

(CN102303117)

The invention relates to a method for preparing a porous heat exchange surface of a TiAl-based intermetallic compound, and belongs to the technical field of intermetallic compounds. The method comprises the following steps of: (1), mixing 43 to 50 atom percent of Ti powder, 0 to 10 atom percent of Al powder and the balance of Nb powder, and drying the powder to prepare cold spraying powder; (2), polishing and cleaning a metal substrate, and depositing the cold spraying powder on the metal substrate at one time; and (3), performing vacuum heat preservation and sintering by using a three-step sintering process again, and thus preparing a TiAl-based alloy porous layer on the metal substrate. The invention has the advantages that: mixed metal powder can be directly sprayed on the outer surface of a metal plate (pipe), and the method is simple, high in efficiency and suitable for mass production of heat exchange plates (pipes); the prepared TiAl-based porous coating layer has a uniform thickness and uniform pores, and is firm, difficult to fall off, and applicable for plate-type or pipe-type heat exchanges of the fields such as chemical industry, petroleum, metallurgy, sea water desalinization, high-temperature heat exchange and the like.

**Claims**

(CN102303117)

1. One or titanium-based intermetallic compound method for producing a porous heat exchange surface, characterized in, preparing step comprises:
  - 1) Ti powder will be, Al powder and Nb powder in an atomic percent Ti-(43-50) Al-(0-10) Nb at.% ingredients, and then placed in a V-type blender mixed powders were each 5-8 hours, powders were taken out as cold spray powder after drying;
  - 2) Step 1) placed in the prepared mixed cold spray powder dusting device of the injection molding machine, the pure Ti or TiAl alloy matrix is subjected to polishing, followed by ultrasonic cleaning treatment, and then the cold spray deposited onto the Cold Spray powder pure Ti or TiAl alloy disposable manner on the substrate, cold spray the working temperature was 300-500 °C, sprayed with a nitrogen or argon atmosphere;
  - 3) Step 2) the sample is placed in a vacuum sintering furnace, sintering process using three-stage: 1st stage at 120-150 °C insulation 30-60min, 2nd step was heated to 550-600 °C insulation 120-180min, 3rd step was heated to 1300-1400 °C insulation 180-300min, a sintering process in a vacuum heat insulation, cooling of the oven, in pure Ti, TiAl based intermetallic compound TiAl alloy substrates with a layer of porous coating.
2. Preparation method according to claim 1, characterized in, Ti particles having a particle size of 25 m -150 m, Al powder having a size of 25 m -150 m, particles having a particle size of less than Nb 25 m.
3. Preparation method according to claim 1, characterized in, pure Ti, TiAl alloy substrate 1500# sandpaper to the sanding.
4. Claim 1 or 3 as production method, characterized in, pure Ti or TiAl alloy substrate is a sheet or tubing.