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

(11) Publication number: **0 174 393**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **84114127.8**

(22) Date of filing: **22.11.84**

(51) Int. Cl.⁴: **C 23 C 4/18**
C 22 C 1/04, H 01 J 35/08

(30) Priority: **02.12.83 US 557508**

(43) Date of publication of application:
19.03.86 Bulletin 86/12

(84) Designated Contracting States:
AT DE FR GB

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(54) **Method for producing high density tungsten-rhenium alloys.**

(57) A method for forming dense bodies of tungsten-rhenium alloys is provided. A semi-dense body is formed by low pressure plasma deposition and the body is rendered fully dense by heat treatment for one hour at at least 1800°C.

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METHOD FOR PRODUCING HIGH DENSITY TUNGSTEN-RHENIUM ALLOYS

BACKGROUND OF THE INVENTION

The present invention relates to a method of forming a dense article of tungsten-rhenium alloy. More particularly it relates to a method for forming articles containing tungsten-rhenium alloys with full density and in a great variety of configurations.

The tungsten-rhenium alloys are refractory alloy materials which have numerous uses at elevated temperatures. A principal use is in the targets of X-ray machines where an incident beam or burst of high velocity electrons are made to impinge to induce emission of X-rays. The rhenium has been a beneficial additive to the tungsten in limiting thermal damage from the impinging high energy electrons. To limit thermal damage to such targets they are rotated at about 10,000 rpm in conventional X-ray apparatus to spread the location on which the high energy electrons impinge.

These materials have been formed into articles such as the targets from the powder by sintering the cold pressed powders at elevated temperatures. For example, it has been found possible to form such articles by cold pressing the tungsten-rhenium alloy particles and by then sintering them at about 2400°C for about 5 hours. Articles having densities of about 91-93% are formed by this process.

It has long been desired to make articles which have higher densities and to do so without excessive heating of the articles to be formed.

Surprisingly it has now been found possible to form such articles and to raise their density from about 90 to about 100% of the theoretical by relatively short time

heat treatments at temperatures in the range of 1800 to 2100°C.

BRIEF SUMMARY OF THE INVENTION

It is accordingly one object of the present invention to provide a method for forming articles with tungsten-rhenium alloys in a wide variety of configurations and at high density.

Another object of the present invention is to provide a method which permits articles containing tungsten-rhenium alloys to be formed at approximately 100% of theoretical density from a powdered form.

Another object is to provide a method for rapid and efficient densification of tungsten-rhenium alloys formed from the powder.

Other objects and advantages of the invention will be in part apparent and in part pointed out in the description which follows.

In one of its broader aspects the object of the present invention may be achieved by plasma spraying a tungsten-rhenium alloy onto a receiving surface and then by heat treating the deposited body at a temperature of between about 1800 and 2100°C for 1 hour.

DETAILED DESCRIPTION OF THE INVENTION

Example 1. A fine powder of an alloy of tungsten and rhenium preferably one containing 90% tungsten and 10% rhenium is provided. This powder is employed in a low pressure plasma deposition apparatus to deposit a body of the alloy on a receiving surface. The grain size of the material as it is deposited on the receiving surface is of the order of 1 to 2 microns.

Example 2. The deposit of Example 1 was subjected to a heat treatment at 1500°C for 1 hour and it was observed that there was no increase in the grain size nor was there any increase in the density of the spray deposited body.

Example 3. A body as prepared in Example 1 was deposited as described above and was subjected to a heat treatment at 1800°C for 1 hour. It was found that the composition was substantially densified by this treatment.

Example 4. A sample of plasma spray deposited body prepared as described above in Example 1 was subjected to a heat treatment at 2100°C for 1 hour and it was observed that the density of the deposit was raised from a value of about 90% to the value of about 100% of the theoretical density.

With regard to the 1800°C treatment and the 2100°C treatment it was observed that the grain size of the deposited body was increased from the original as-deposited grain size of about 1 to 2 microns to a grain size of about 15 microns following the heat treatment.

The finding of the densification of the tungsten-rhenium plasma spray deposited alloy at the temperature of 1800°C and 2100°C for the short period of 1 hour is quite surprising and unexpected. This observation is particularly true inasmuch as the sintering of cold pressed tungsten-rhenium powder at 2400°C for 5 hours did not result in a densification to the 100% figure and in fact the product had relatively low density in the range of 91 to 93% of theoretical density.

The percentage of rhenium included in the tungsten-rhenium samples of the above examples was about 10%. However values of between 2% and 37% rhenium may be included in samples which may be successfully densified by the method of this invention.

A rhenium concentration of between 2 and 25% is preferred.

It has been determined that the densified compositions of this invention may be employed successfully for targets of X-ray machines based on production of X-rays with the alloys in a simulator apparatus.

CLAIMS

1. A method for forming fully dense tungsten-rhenium articles which comprises providing the finely divided powder having the desired concentrations of tungsten and rhenium, subjecting the powder to low pressure plasma deposition to form a body on a receiving surface, concentrating and densifying the body at a temperature of at least 1800°C for approximately 1 hour.

2. The method of claim 1 in which the temperature of densification is between 1800 and 2400°C.

3. The method of claim 1 wherein the rhenium concentration is greater than 2%.

4. The method of claim 1 wherein the shown concentration is between 2 and 37%.

5. The method of claim 1 wherein the rhenium concentration is between 2 and 25%.

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EUROPEAN SEARCH REPORT

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EP 84 11 4127

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
Y	US-A-3 146 134 (T. PACALA et al.) * Column 2, line 5 - column 3, line 12; claim 1 *	1-5	C 23 C 4/18 C 22 C 1/04 H 01 J 35/08
Y	US-A-4 390 368 (D.L. HOUCK) * Claim 1; column 1, lines 55-61 *	1-5	
Y	US-A-3 577 227 (G.F. DAVIES) * Claim 1 *	1-5	
Y	US-A-4 332 617 (V.M. HOVIS et al.) * Claim 1 *	1-5	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

B 22 F
C 23 C
C 22 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11-11-1985	SCHRUERS H.J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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