

Powder Metallurgy of Tungsten Alloy

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Abstract

Preparation of tungsten powder, sorts of tungsten alloys and their application in economy are made a summary in this paper.

Keywords : tungsten, preparation, sorts, application, summary

1. Introduction

Purity and size of raw material powder are very important to prepare high properties material. So it is critical to prepare superpure, superhomogeneous and superfine powder. Now there are many methods to prepare tungsten powder, such as Reduction method, Carbonyl process, Mechanical Alloying [1], Spray Drying, Chemical Vapor Deposition, Reaction Spray Process and Vacuum Plasma Spray Consolidation Process etc.

2. Preparation of tungsten powder

2.1 Carbonyl process

Carbonyl process is a kind of chemical compound of metal and CO. Its production mechanism as follows: some metal (Fe, Co or Ni etc.) could form carbonyl compound under CO, while carbonyl compound could also dissociate and become metal powder under some condition. Now carbonyl powder of Fe and Ni has been made.

2.2 Mechanical Alloying

Benjamin et al invents Mechanical Alloying (MA) in 1970'. It needs to put all kinds of metal powder of alloy into agitated ball mill, planetary-type mill or rotor high-energy mill to mill, and it needs argon to protect them in case of being oxygenized.

2.3 Spray Drying

Spray Drying is a kind of physical and chemical technique, which makes liquid atomize through physical methods to obtain superfine particles. It includes preparation of liquid and mixture, atomization and dryness, and fluid-bed conversion.

3. Tungsten alloys

Tungsten is characteristic of high melting point, good electrical conductivity, low coefficient of thermal

expansion, and so on. So it is widely applied for aviation, space flight, military and electronic industry. But high ductile-to-brittle transition temperature (DBTT) and poor oxidation resistance are great disadvantages to tungsten. To increase strength and plasticity of tungsten and widen its application, tungsten alloy, such as W-Cu, W-Ni-Fe and W-Ni-Cu etc., is developed one after the other since 1930'. At the same time, a lot of researches in theory and application are also carried out.

3.1 W-Cu alloy

WCu alloy is characteristic of both. So it is widely used for electrical contact materials and electrode materials. However, melting points of W and Cu are quite difference and two kinds of elements don't dissolve each other. WCu alloy is a kind of classical pseudoalloy. Due to high melting point of tungsten, preparation of WCu composites is usually some ways of powder metallurgy.

3.2 W/Cu functionally graded material (FGM)

With the increase of power and harsher terms, homogeneous WCu alloy is more difficult to meet the requirements. Functionally graded material (FGM) is considered to solve this problem very good.

At present, FGM has become an effective method to increase material properties. Takahashi et al makes use of stratifying W powder of size differentness to press and sinter, and obtains porous body whose pore shows graded distribution. Subsequently, Cu powder is melted and infiltrates, then becomes W/Cu FGM. But due to different sintering shrinkage ratio, shape and size of material is difficult to control.

Professor Ge Changchun primarily puts forward making use of FGM to prepare plasma facing material to fusion device in China. His group develops a way of graded sintering under ultrahigh pressure (GSUHP), of which they possess autonomous knowledge property right, to prepare W/Cu FGM [2] (SEM pattern is showed in Fig. 1).

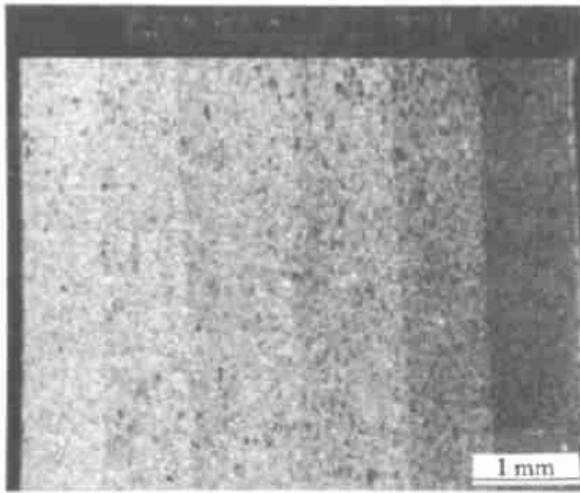


Fig. 1. SEM of W/Cu FGM.

3.3 Tungsten heavy alloy

Tungsten heavy alloy is based on tungsten (90% ~ 98%), and its bond is iron family element which is added into a little other elements. W heavy alloy is usually prepared by a way of powder metallurgy, including mixing, pressing, sintering, post processor and so on. It is characteristic of high density, high strength, good conductivity, low coefficient of thermal expansion, good erosion resistance, good oxidation resistance, excellent weldability and so on. So it is widely used to military and civil industry. Now input of tungsten heavy alloy R & D increases in order to reduce its cost and develop its property.

4. Applications [3]

Refractory metal W alloy is characteristic of a series of good properties. So there are good prospects of it being used to military industry, aerospace industry, nuclear industry, electronic information, energy, metallurgy, machining industry and so on. For example, W alloy is substituted for plumbum as shielding material in nuclear industry. And it is suitable for nuclear fuel container and shielding material of radiation-resistant. W-Ni-Fe and W-Ni-Cu high-density alloy are widely used for shielding material in medical industry, communication industry and electric industry. W-Cu alloy is used for electrical contact material, micro-electronic packaging material and heat-sink material. So tungsten alloy attaches importance to many countries, now it becomes one of the most active fields in material science community.

5. References

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