Study on Spheroidizing Technology of Spherical Cast Tungsten Carbide

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Abstract

This paper introduces a special spheroidizing technology at ultra-high temperature. The conventional cast tungsten carbide (YZ) is melted at high temperature, rapidly cooled and spheroidized on a new ultra-high temperature spheroidizing equipment to prepare various grades WSC powders.

Keywords : spherical cast tungsten carbide (WSC), spheroidizing, rapid cooling, microhardness

1. Introduction

The WSC powder has stable chemical compositions, high hardness, uniform, dense, fine, equiaxed, dendritic, non hypereutectic and hypoeutectic structures; no stress concentration and microcracks, higher toughness than crushing powder when using [1] and high densification which is beneficial to built-up welding and thermal spray coating so that coating material has high wear resistance and toughness when it is subjected to friction and impact [2,3].

At present, the study on preparation of the YZ powder focus on two aspects, that is, the YZ powder with regular shape, fine, equiaxed and dendritic microstructure is attained by improving of the conventional process. Another spherical powder produced by special technology like plasma process is studied in order to obtain the WSC powder.

2. Experimental Procedures

Process flow: The YZ is melted at high temperature, rapidly cooled and spheroidized on a new ultra-high temperature spheroidizing equipment to prepare various grades WSC powders by sieving etc.

Analyzer: microhardness tester, SEM, ASTM examination, metallographic microscope.

3. Results and Discussion

3.1 Effect of spheroidizing temperature on product quality

It can be concluded from experimental results that the trend of coarsening of the particle size increase with rising temperature. The higher degree of overheat of particles is, but the viscosity decreases, and so the possible and chance of particle bonding and growth due to collisions among particles.

The SEM analytical results show that with increasing of the temperature the sphericity of surface is improved. The spheroidizing rate is also increased with temperature. Therefore, under certain temperature conditions, the spheroidizing rate and sphericity of particles both can be in an ideal condition.

3.2 Effect of cooling rate on product quality

In rapid cooling grains required can be achieved by controlling the cooling rate. With increasing of the cooling rate, as a result obtain fine-grained and even nano-grained YZ [4]. For the WSC, the finer microstructure and higher microhardness can be attained by controlling higher cooling rate.

It can be seen from experimental results that under the temperature enough to melt product, the morphology of the WSC particle is restricted by different cooling methods or cooling rates. Because of guaranteeing sufficient holding time at high temperature zone, the cooling rate of materials is reduced, surface shrinkage time is increased and its surface sphericity is better.

One of methods to control the grain size is to control the cooling rate. The faster the cooling rate is, the finer the grain is.

It can be concluded from experimental results that effect of the cooling rate on microhardness. The microhardness increases with decreasing the particle size. Meanwhile, under the same conditions the coarser particles are, the slower the cooling rate is, thereby the microhardness decreases.

3.3 Effect of material dispersion method on product quality

YZ is melted at high temperature and will shrink to spherical shape under surface tension of molten liquid drops. Therefore, certain distances are required between liquid drops after melting, otherwise these liquid drops can bind each other to lead to growth of particles. Hence, controlling proper particle dispersion is one of importance parameters to control the WSC product quality.

The particle size and particle size distribution of the product conform to that of raw material on the whole. The better material dispersion is, the closer the particle size and particle size dispersion of resulted product is to that of raw material. But the worse dispersion can lead to the particle size of the product much higher than that of raw material.

The material dispersion methods have great effects on the sphericity and spheroidizing rate of the product. The material dispersion method is better, the sphericity and spheroidizing rate is relatively ideal, whereas there exist defects for other processes. Particles can bond together after spheroidizing and form the so-called dumbbell particles and ideal spherical shape under better dispersion conditions. The wider the particle size of raw material is, the greater the possible of fine particles adhering to coarse particles is, in such a case material dispersion degree is not good, the greater the chance of particle contact in falling is, the higher the frequency of particle bonding is, thereby producing the dumbbell particles.

4. Conclusions

1) The WSC powder which can meet the requirements is prepared by controlling the feed rate, feed method, melting temperature and cooling rate of the YZ and properties of raw material.

2) The cooling method and cooling rate have great influences on the microstructure and microhardness of the product. The WSC powder with higher microhardness and finer grain has been produced by using better cooling method.

3) Raw material dispersion has great effect on the particle size, particle size distribution, sphericity, spheroidizing rate of the product.

4) The higher the melting temperature is, the better the sphericity of the product is, the higher its spheroidizing rate is as well, but its particle size tends to coarsen.

5. References

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