A Study of the Effect of Tungsten Oxide on W, WC Powder and Alloy Properties

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Abstract

This is about the effects deoxidization, carbonization and alloying preparation on fine grain W, WC, and grade YG8 powder reduced by "yellow tungsten oxide" and "blue tungsten oxide". The result indicates that yellow tungsten has single composition and blue tungsten oxide has complex composition. With this feature, yellow tungsten oxide got better uniformity and concentration distribution on fine particle size W and WC powder than blue tungsten oxide's. The grade alloy YG8 that made of this W or WC powder has uniform alloy construction, concentrated WC grain distribution and better alloy properties.

Keywords : tungsten oxide, tungsten powder, tungsten carbide powder agglomeration particle, alloy property

1. Introduction

The evidence[1,2] of extent research shows that blue tungsten has advantages in producing fine size tungsten powder and tungsten carbide powder. However, it is reported[3,4,5] that tungsten oxide material has simplex phase which become the key factor in manufacturing tungsten and tungsten carbide powder with uniformed particle size and low agglomeration. But no further study had been done for this effect on cemented carbide properties. So that this paper studies on the effects of two kind materials (yellow tungsten oxide and blue tungsten oxide) on W and WC powder properties and corresponded alloy properties.

2. Experiment and results

2.1 Experiment

Commercial yellow tungsten oxide and blue tungsten oxide are used, and then proceed through X-ray quantitative analysis, and SCT, Fisher detection. To get W20 and WC20, reduce above yellow oxide and blue oxide in the fifteen gas heating reduction furnace respectively, W20's Fsss as control criterion. Test and analyze reduced W20 with Fsss, particle size distribution, SEM etc. Also processes by the same carbon mixing, carbonization and ball milling to get WC20. Also test and analyze it with Fsss, particle size distribution SEM etc. Now, we get WC20 by different materials. Pass them by the same alloying process to prepare YG8 alloy. Test and analyze them with normal physical characteristics, coercivity, magnetic saturation and metallographic structure detections, meanwhile test WC grain size and distribution by metallurgical analyzer.

2.2 Trial results

Random sampling volume produced batches of different tungsten oxide to X-ray quantitative analysis and SEM analysis. The result shows in table 1 and fig 1. Reduce the above tungsten oxides in recyclable H_2 atmosphere. Water content is controlled within 100ppm. The corresponded W20 result is showed as table 2 and fig.1. Carbonize every batches of W20 in molybdenum wire carbonization furnace. Pass through other processes of ball milling, sieving and then test. The results show in table 3 and fig.2. Take two samples of WC produced by two kinds of materials respectively. Process them to YG8 alloy. Test them, the results are showed in table 4 and fig.2, WC particle size and distribution are showed in table 5.

Table 1. XRD quantitative analysis about composite of tungsten oxide and other testing data

Tungsten Oxide	WO_3(%)	$WO_{2.90}$(%)	$WO_{2.83}$(%)	SCT ($g.cm^{-3}$)	Fsss.(μm)
Yellow Tungsten Oxide	100	0	0	2.76	25
Blue Tungsten Oxide	35.8	0	64.2	2.51	28

Table 2. Fsss. and distribution of W20 in various group (G/M: original state/milling state unit: um)

Sample	Fsss(G/M)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
Blue -1	2.22/1.97	9.4	35.2	31.4	17.3	5.1	0.9	0.2	0.1	0.4	0
Blue -2	2.22/2.1	10.7	32.3	27.4	14.7	5.7	2.4	2.8	0.2	3.8	0
Yellow-1	2.22/1.96	11.6	43.3	30.4	10.5	2.3	0.5	0.5	0.6	0.3	0
Yellow-2	2.12/1.95	7.9	34.3	30.8	13.5	5.1	3.1	1.9	2	1	0.4

Table 3. Fsss. and distribution of WC20 in various groups (G/M: original /milling state) (unit: um)

Sample	Fsss(G/M)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
WC-1-1Blue	2.3/1.85	15	33.2	24.5	16.8	6.2	1.5	1.2	0.7	0.8	0.1
WC-2-1Blue	2.2/1.82	12.8	35	25.7	13.1	6.2	3.6	3.5	0.1	0	0
WC-1-1Yellow	2.48/2.00	15.1	31.9	31.2	16.5	5.2	0.1	0			
WC-2-1Yellow	2.43/2.12	10.3	31.9	34.6	20.2	3	0	0	0	0	0

Table 4. properties of alloy YG8 made with different raw material of tungsten oxide

Sample	Coercivity (KA/m)	Hardness (HRA)	Density ($g/cm^{3)}$	Magnetic Saturation (%)	Transverse rupture intensity（MPa）
Blue-1-2	15.5/14.0	91.2/90.9	14.77	82	2230
Yellow-1-2	15.7/15.8	91.1/91.1	14.77	88	2450

Table 5. WC particle size and average particle-size of alloy YG8 in various test groups (Unit: um)

Sample	<0.3	0.3-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-5.0	5.0-7.0	7.0-10	Total (pcs)	WC average
Blue-1-2	17	75	362	191	14	4	3	1	667	0.90 um
Yellow-1-2	49	194	579	156	7	0	0	0	985	0.73 um

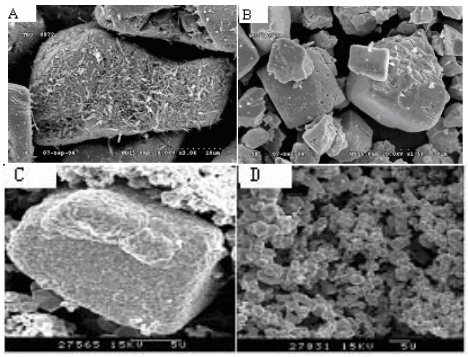

Fig. 1. SEM of blue tungsten oxide (A) .yellow tungsten oxide(B)and SEM of W20 produced by blue tungsten oxide (C) and yellow tungsten oxide (D).

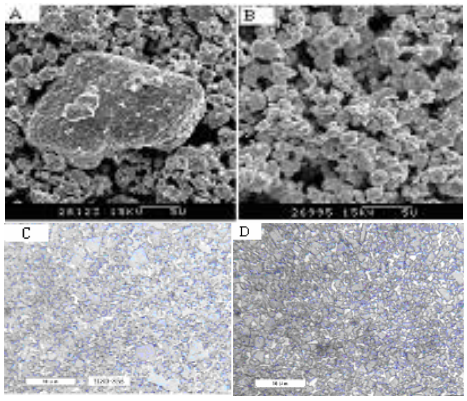

Fig. 2. SEM of WC20 produced by blue tungsten (A). yellow tungsten (B) and microstructures of alloy produced by blue tungsten oxide-1-2(C) yellow tungsten oxide-1-2 (D).

3. Summary

3.1 yellow tungsten oxide (WO_3) has simpler phase than blue tungsten oxide. Blue tungsten oxide is a combination of WO_3, $WO_{2.90}$ and $WO_{2.83}$. This character affects correspond final product a lot.

3.2 Compared with that of blue tungsten oxide, W (W20) and WC (WC20) powder made of yellow tungsten oxide has better uniform structure and no big agglomeration, and more concentrative particle size distribution by means of Poisson distribution method.

3.3 Compared with blue tungsten oxide, alloy made of yellow tungsten oxide has better uniform structure and more concentrative WC particle size distribution and better synthesis properties.

4. Reference

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