

A Study of Reduced and Carburized Reaction in Dry-milled $WO_3+Co_3O_4+C$ Mixed Powders with Different Carbon Content

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1. Introduction

Recently, many researchers were interested in the synthesis of nano-sized WC powder by the method of reduced and carburized reaction of WO_3 with carbon. The carbon content in WC-Co cemented carbide was known to be a very important factor for the mechanical properties.[1] When the alloy has more carbon, the free carbon is appeared, and when less carbon, intermediate η phase in the microstructure. These phases make worse to the mechanical properties. Thus, the carbon control in the synthesis of WC/Co mixed powders is very important through the processes. This study is how to control the carbon content during the synthesis of nano-crystalline and uniform WC-Co composite powders with the different carbon content by the direct reduced and carburized reaction.

2. Experiment

The powders of WO_3 (Taegu Tec Ltd, $1.5\mu m$), Co_3O_4 (Kojundo Chemical Laboratory Co. Ltd, $1\mu m$), C(CANcard Co., $0.6\mu m$), VC(H. C. Stark, $1.4\mu m$), and Cr_3C_2 (H. C. Stark, $2.9\mu m$) were used in this study. These powders were mixed with the compositions of WC-10 and 20 wt%Co, respectively. The content of carbon in the powder was varied from 1.0 to 1.2 times to the stoichiometric amount of reduction and carburization. The dry-milling was carried in planetary mill (Fritsch, P-5) under the conditions of ball-to-powder ratio 30 : 1, charging Ar gas(99.999%), 150 rpm for 20 hours. Dry-milled powders were reduced and carburized at the temperatures of 900~950°C for 3 hours with Ar gas. Producted gases were CO and CO_2 .

Reduced and carburized powders were observed the shape and size of the particles using FE-SEM (JEOL Co., JSM-6330F), and measured the particle size of WC with Image Analyzer. The phases of WC, Co and other were analyzed by XRD(Rigaku Co., DMAX-2500.). Using Scheerer's Formula($B = 0.9\lambda/t\cos\theta$: $\lambda_{K\alpha} = 1.54056\text{\AA}$), WC size was calculated, in order to compare with the measured particle size of WC by Image Analyzer. The chemical compositions of C, W and Co in the powders were analyzed by using Carbon/Sulfur Analyzer(CS-300) and ICP-AES (SPECTRO-FLAME).

3. Results and Discussion

The dry-milled powder showed more broaden in the peaks of XRD than the wet-milled powder. The carbon content was less in the dry-milled powder.

4. Reference

[1] J. Gurland : Trans. AIME., Feb.(1954) p285