Characteristics of nanostructured WC/Co powders produced by chemical vapor condensation process

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Introduction

WC/Co hard alloys are widely used for wear resistance machine parts or tools material. If the composition of alloys is fixed, the important factors which affecting the mechanical characteristics of WC/Co cemented carbide are the size of particles. The reduction of the WC particle size provides a marked improvement in the mechanical properties such as hardness, wear resistance and even transverse rupture strength of WC/Co cemented carbide. Thus, in order to increase mechanical properties of the WC/Co material, it is necessary to make the WC particle size as small as possible. CVC process has been adapted to produce the nano-sized clusters by homogeneous condensation from decomposed metal-organic precursor of gas phase. A high purity powder with relatively less agglomeration can be obtained. It is a much more direct route for making WC powders than the traditional processing methods and offers the potential for the production of novel materials with homogeneous nanophase powders. On the other hand, it is known that the coalescence of WC particles occurs during the sintering of WC/Co. In the case of nanophase powder, this phenomenon is accompanied by rapid grain growth. Such grain growth is an import feature of nanophase WC/Co powders. In this study, we will describe the results of the nanophase WC powder synthesis and consolidation of nanophase WC/Co powder.

Experimental

For powder preparation the metal-organic precursor which contained W components was used as starting materials. Solid tungsten hexa-carbonyle($W(CO)_6$) were used as precursor and it was vaporized from the precursor evaporator and feed into the reaction zone. The evaporated precursor was directly injected into the reaction furnace by He gas and carburized with CH_4, H_2 gas to form the nanophase WC particles. The conditions of reactor were 400~1300℃ and 1 atmosphere. The synthesized WC particles were collected at cooling zone. In order to examine the vaporization temperature the precursor was measured using a thermal gravity analyzer(TGA). The powder morphologies and powder size were observed by field emission scanning electron microscope and transmission electron microscope.

Results and Discussion

The metallic precursor were vaporized in the inert gas and the vaporized precursor was directly injected into the reaction furnace with carrier gas. The flow of the carrier gas containing the vaporized precursor condensed at reaction furnace, and formed the nanophase WC particles. The size of as-synthesized powder was about 10~20nm in diameter with less agglomeration, and it had uniform particle size distribution. The synthesis yield of WC powders was promoted with increasing the reaction temperature. And the size of the WC powder was increased but agglomeration of powders was decreased with increasing temperature. The specific surface of area reached maximum value at 800℃ and then decreased due to the size increasing.