Study on the preparation of WC/Co powder from WC/Co scrap by direct-carburization process

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Introduction

Cemented carbide is well-known engineering material widely used for wear resistance machine parts or tools material because of their high hardness, strength and wear resistance. It is the mixture of the tungsten carbide and cobalt, which are expensive and worth recycling materials. In order to obtain the WC/Co powder from the waste WC/Co bulk scrap, a new recycling process was developed. It is the combined process of the thermal oxidation and reaction/carburization process.

During oxidation of WC/Co, the hard WC/Co scrap was significantly expanded and became a sponge-like mass that can be easily crushed by mechanical milling. After oxidation and mechanical milling, the WC/Co hard metal alloy was fully transformed into the oxide powders, and it was direct-carburized to WC/Co by the solid carbon. It is possible to produce highly homogeneous ultrafine WC/Co composite powder with uniform distribution of WC in the Co matrix from the waste WC/Co scrap by the new process. The present study was focused on the synthesis of an ultrafine WC/Co composite powder from the WC/Co scrap by the new thermal reaction process.

Experimental

The WC/Co scrap with a cylindrical shape was oxidized at 1073K for 24 hours in the air. During the oxidation, the WC/Co scrap was continuously expanded to form porous structure that can be easily broken by mechanically milling. The oxide of the hard metal was crushed, and then mixed with solid carbon. The crushing and mixing were carried out using a ball mill with a stainless steel jar and WC/Co balls under dry conditions. Finally, this mixture of the oxide powder and solid carbon powder was direct-carburized under the Ar or H_2 atmosphere at the temperature of 750℃~1100℃ to produced the WC/Co powder. The phase, morphology and chemical composition of the powder were analyzed by XRD and SEM.

Results and Discussion

The WC/Co hard metal alloy was fully transformed into the oxide mixtures of $CoWO_4$ and WO_3 by the oxidation and mechanical milling processes. The tungsten component in the WC/Co hard metal transformed into a single oxide form (WO_3) and the complex oxide form ($CoWO_4$), however, the cobalt (Co) component transformed into the complex oxide form ($CoWO_4$). This oxide powder with a mixed phase of $CoWO_4$ and WO_3 was direct-carburized to WC/Co by the solid carbon in a flowing stream of Ar or H_2. After the

reduction and carburization, the synthesized powder has a loosely agglomerated structure with an average particle size of 0.3㎛ and has the same chemical composition as the used raw material(figure 1). It was concluded that the waste WC/Co hard metal can be recycled into the WC/Co composite powder without changing its chemical composition by the combination process of the oxidation, mechanical milling and direct-carburization processes.

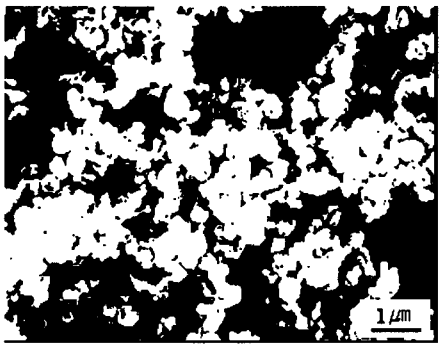

Figure 1. SEM micrograph of WC/Co powder synthesized from WC/Co scrap