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Thermodynamic calculation designed compositions, microstructure and mechanical property of ultra-fine WC-10Co- Cr_3C_2-TaC cemented carbides

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Abstract

The grain size of WC and the content of inhibitors are two critical factors responsible for mechanical properties of cemented carbides. Cr_3C_2 and TaC grain-growth inhibitors are added simultaneously to control the grain growth of ultra-fine WC-Co cemented carbides. The content of doping inhibitors should be controlled strictly, below the maximum solubility in the binder phase, to avoid the appearance of free carbides, which cause brittleness and thus have a negative influence on mechanical properties. In this work, several ultra-fine WC-10 wt.%Co cemented carbides with various contents of Cr and Ta were designed and fabricated via combining thermodynamic calculations and key experiments. With the addition of Cr_3C_2 and TaC to a certain extent, the density, transverse rupture strength, hardness and fracture toughness of WC-Co cemented carbides are improved significantly. However, excessive Cr_3C_2 and TaC lead to the formation of M_7C_3 as well as coarse (Ta,W)C grains, which deteriorates the mechanical properties. Based on thermodynamic calculations, a favorable addition of inhibitors can be established, which enables an effective control of microstructure and mechanical properties.

Keywords

Cemented carbides; Grain-growth inhibitor; Thermodynamic calculations; Maximum solubility; Mechanical property

1. Introduction

Ultra-fine WC-Co cemented carbides possess good hardness and toughness as well as a better wear resistance than traditional cemented carbides. Consequently, they are