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Effect of Al₂O₃ ceramic binder on mechanical and microstructure properties of spark plasma sintered WC-Co cermets

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Abstract

This study investigates how the partial replacement of Co with Al₂O₃ ceramic binder has an effect on the sintering behaviour, microstructure, and final mechanical properties of WC-Co cermets via spark plasma sintering. To examine this, three batches (WC-6wt%Co, WC-3wt%Co-3wt%Al₂O₃, and WC-6wt%Al₂O₃) were mixed through high energy ball mill, and sintering was carried out at temperatures of 1350 °C and 1600 °C. The results showed nearly full dense WC-Co cermets at different temperatures. It was shown that WC-6wt%Al₂O₃, in comparison to reference WC-6wt%Co cermet, not only led to the rise in sintering temperature from 1350 °C to 1600 °C, but also reduced its strength and toughness. But replacing some part of Co with alumina (WC-3wt%Co-3wt%Al₂O₃) exhibited the combination of high strength (1095 MPa), hardness (17.62 GPa), and fracture toughness (19.46 MPa. m^{1/2}).

Keywords: Tungsten carbide, Alumina, Cobalt, SPS, Mechanical properties.

1. Introduction

WC-based cermets are used widely in cutting tools, dies, mining tools, and wear-resistant parts due to its properties which include high hardness, wear-resistance, chemical stability, and proper mechanical capabilities in high temperatures [1-5]. One of the most important binders used in WC-based cermets is Co. Although Co binder improves the sintering process and increases strength and toughness considerably, there are some problems too. These include the toxic nature

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