
Study of the effect of chromium doping on the grain boundary character and toughness of WC-Co

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Abstract

Cemented carbides tools are used in applications demanding high hardness and toughness. However, fracture during operation of WC-Co tools is deleterious for tool performance and lifetimes. Interfaces in WC-Co, especially the WC grain boundary network are crucial, as crack path is mostly intergranular. Therefore, it is beneficial to gain knowledge about the WC boundaries. This will in turn allow for grain boundary engineering (GBE) of WC-Co tools with superior performance and lifetimes.

To achieve this, first WC grain boundaries have been examined using wedge loaded double cantilever beam (DCB) fracture tests. Since the literature review of WC-Co revealed that $\Sigma 2$ twist boundaries are the most abundant boundary type, these have been studied with DCB tests. Ideal $\Sigma 2$ twist boundaries (perpendicular to the surface) for fracture testing have been identified from electron backscatter diffraction (EBSD) data via a custom MATLAB script working in MTEX. The fracture energy of $\Sigma 2$ twist boundaries on a WC-10wt%Co sample have been compared to cleaving the lowest energy plane (type II) in a WC single crystal. Fracture energies of $3.59 \pm 0.30 \text{ Jm}^{-2}$ and $7.04 \pm 0.36 \text{ Jm}^{-2}$ were measured for cleaving $\Sigma 2$ twist boundaries and type II planes respectively.

As a complementary study, grain boundary character distribution (GBCD) analysis for the most abundant boundaries ($\Sigma 2$ boundaries and $\Sigma 13$ boundaries) in WC-Co was performed. This analysis is based on Rohrer et al.'s five parameter grain boundary character distribution (GBCD) analysis where relative areas of different grain boundary types are specified as a function of lattice misorientation and boundary habit plane normal (2). Boundary populations are inversely correlated with boundary energy. Hence, GBCD analysis will provide an indication of grain boundary energy. Furthermore, the effect of chromium doping on WC boundary populations of a chromium doped sample (WC-10wt%Co-1wt%Cr) was examined and compared with an undoped WC-Co (WC-10wt%Co) sample. boundaries compared to all WC boundaries.

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