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Spark Plasma Sintering of tungsten carbide nanopowders obtained through DC arc plasma synthesis

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Abstract

The paper dwells on the research conducted into high-rate consolidation of pure tungsten carbide (WC) nanopowders using the Spark Plasma Sintering technology. Studies included the effect that the original size of WC nanoparticles and their preparation modes have on density, structure parameters, and mechanical properties of tungsten carbide. Samples of high-density nanostructured tungsten carbide characterized by high hardness (up to 31-34 GPa) and improved fracture toughness (4.3-5.2 MPa·$m^{1/2}$) were obtained. It has been found that materials that show abnormal grain growth during sintering have lower values of sintering activation energy as compared to materials the structure of which is more stable during high-rate heating. A qualitative model is proposed that explains this effect through the dependence of the grain boundary diffusion coefficient on the grain boundary migration rate.

Keywords: tungsten carbide, nanopowders, spark plasma sintering, DC arc thermal plasma synthesis, grain growth

1. Introduction

Pure tungsten carbide is of interest for a variety of applications (cutting tools, drawing dies, etc.) due to a good combination of physical and mechanical properties (high melting temperature,

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