Understanding of the growth mechanisms of boron carbide (B_4C) structures and nano/micro fibers under non-catalytic conditions

Cengiz KAYA, Suna AVCIOĞLU, and Figen KAYA

Yıldız Technical University, Faculty of Chemical and Metallurgical Engineering, Department of Metallurgical and Materials Engineering, Davutpaşa Campus, 34210, İstanbul/TURKEY

Over the last decade, the interest in the non-catalytic synthesis of high purity boron carbide nanoparticles increases rapidly because of its outstanding properties, such as low density, high hardness, high melting point, and high neutron absorption cross-section for thermal neutrons. In addition to its conventional applications high aspect ratio boron carbide (B_4C) nanoparticles are strong candidates for energy applications, such as batteries, supercapacitors, and fuel cells. For the synthesis of anisotropic boron carbide nanostructures, various strategies have been developed. Even though these synthesis approaches were successful on a laboratory scale, a feasible catalyst-free synthetic route for the mass production of boron carbide anisotropic structures needs to be developed.

The fundamental understanding of the growth mechanisms of anisotropic boron carbide particles is critically important for developing a feasible, low-cost synthesis route that can yield boron carbide particles with desired morphologies for specific applications. In the present study, a low-temperature non-catalytic synthesis route is introduced to yield boron carbide belts and fibers from the sol-gel synthesized polymeric precursors. The influence of the processing conditions, such as starting composition, thermal decomposition holding time, and heat treatment temperature on the morphology of boron carbide particles was investigated and optimized to increase the yield of fiber formation. Given the obtained results, the formation and growth mechanisms of boron carbide particles were speculated and comprehensively discussed.

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