Synthesis of Tungsten Carbide Nanoparticles in Triple Thermal Plasma Jet System

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The metal carbidematerials are widely used in industries dueto excellent physical and mechanical properties, such as high melting point,high hardness, low coefficient of friction, and good electrical conductivity withchemical stability. The tungsten carbide is difficult to be synthesized as nano-sizedparticle due to extreme high melting and vaporization temperature of tungstenas 3,695 and 6,230 K, respectively.

Triple thermalplasma jet system was newly developed for synthesis of promising nanomaterialby refractory material vaporization with efficient thermal transfer in ourlaboratory. In the traditional singular thermal plasma jet system, injection ofstarting material into the central plasma jet region of highest temperature isdisturbed by rapid and strong turbulent flow. Therefore, although thermalplasma jet could generate high thermal environment above 10,000 K, thevaporization of refractory material was incomplete. In the triple thermal plasma jet system, on the otherhand, the triple thermal plasma jet system generated from the three torches areencountered at the center axis of the reactor. The injected starting materialfrom the top of thermal plasma jet system goes through the wider hightemperature region for a longer residence time compared with singular torchsystem.

In this work, tungsten carbide (WC)nanoparticles were synthesized from refractory tungsten powder and variouscarbon sources including amorphous carbon, carbon nanotubes and methane (CH_4)gas. In order to evaporate tungsten powder, the thermal plasma characteristicswere controlled by the flow rates of reactive CH_4 and thermallyconductive gases such as He, N_2, and H_2. Micro-sizedtungsten powder was fed into the triple plasma jets, than feeding rate was200~400 mg/min with argon carrier gas of 5 L/min. The input power provided bythe triple DC power supply was controlled at total 20~30 kW. As a result,tungsten carbide nanoparticles were synthesized at tens of nanometer and then, characteristicof produced tungsten carbide was analyzed according to various carbon sourcesuch as powder and gas. The produced particles were analyzed for theircharacteristics by X-ray diffraction (XRD) and scanning electron microscope(SEM).