Synthesis of Metal-Boride Nanoparticles using Triple Thermal Plasma Jet System

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Metal-boride nanomaterials are promising material with a high melting point, chemical stability, hardness, thermal and electric conductivities. The chemical reaction to bonding of metal-boride requires high thermal environment over 4,000 K from the refractory materials. Titanium, Nickel, and Tungsten borides nanoparticles were synthesized in triple thermal plasma jet system in this study. The coalesced high-enthalpy of triple thermal plasma jet generates an extensive high temperature region. Therefore, it was greatly improved to be vaporized for starting material as micro-sized Ti, Ni, W, and B powders which have high vaporization temperature above 3,000 K and borides synthesis reaction was dominated. The triple thermal plasma jet was generated by 14 L/min of Ar and 16 L/min of N2 gases. The current of each torch was about 100 A and then the voltage of them was about 10 V. Three kinds of starting material were respectively injected as mixture of (1) Ti and B powder, (2) Ni and B powder, and (3) W and B powder in the experiment with argon carrier gas at 5 L/min. The mixing ratio of metals and B powders was controlled to investigate the chemical interaction to boride reaction. As a result, from the mixed metals and boron powder as starting material (1) Ti:B, (2) Ni:B, (3) W:B as 2 to 1 of molar ratio, several mixed phases of metal-boride nanoparticles were synthesized as (1) TiB and TiB2, (2) NiB, Ni2B and Ni4B3, and (3) WB, W2B and WB4 based on X-ray diffraction analysis. Additionally, the synthesized metal-boride nanoparticles were observed as 30 to 100 nm by Scanning Electron Microscope analysis.