The Triple DC Plasma Torch System for Nanoparticle Synthesis

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Thermal plasma has been received a great attention for the synthesis of functional nanoparticles because any kind of material can be used as a feedstock. They are typically generated by direct current (DC), radio frequency (RF), or microwave (MW) power sources. Among them, RF inductively coupled plasma (RF-ICP) torches are widely used for the production of nanoparticles due to a relatively high power and an electrodeless system to avoid the contamination issue raised by the electrode erosion. In addition,the direct injection of the feedstock into the hot plasma core is achievable in the RF-ICP system. The RF-ICP system, however, has disadvantages of a low economic feasibility due to a high construction and running cost. On the otherhand, DC arc plasmas have advantages of a low construction and running cost and a high flexibility in operating conditions including power level, working gasspecies and flow rate, processing pressure, etc. The difficulties of DC plasma utilization in the nanoparticle synthesis process are the electrode erosion ina high power and the loss of starting material through the peripheral region of thermal plasma jet. In order to overcome such disadvantages, the triple DC plasma torch system was used in the present work. In the triple DC plasma torch system, three thermal plasma jets are ejected from each plasma torch and they are merged into a strong single plasma plume. Therefore, the electrode erosion is limited for each plasma torch while the total power level is sufficient for the evaporation of starting material. In addition, the feedstock is injected into the jet merging area. In the present work, thermal flow characteristics of the triple DC plasma jet was numerically simulated. In addition, oxide, carbide, and boride nanoparticles which are difficult to be prepared by conventional methods were successfully synthesized in the triple DC plasma torch system.

This research wasfunded by the Nuclear Research Base Expanding Program (NRF-2015M2B2A9030393) and the Priority Research Centers Program (2010-0020077) throughthe National Research Foundation of Republic of Korea.