235 Numerical studies on synthesis of nanoparticles by DC plasma torch

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Plasma torches, which produce stable plasma jet have vast applications in different types of industries. Plasma jets have been used in cutting thick plates of metal, welding, metallurgy, surface hardening, various functional metallic and ceramic coatings, synthesis of novel materials, as well as fabrication of high temperature ceramic nanoparticles. The non-transferred DC plasma torch is one of the most suitable configurations to generate a thermal plasma jet and produced nanoparticles [1-4].

A key issue in the field of thermal plasma aided synthesis of nanoparticles is the size distribution of the product particles. Due to the uncontrolled quenching of the precursor-laden plasma, as it happens during the turbulent mixing with ambient gases, the sizes of the nucleated particles have wide size distribution. The quenching can be controlled by supersonically expanding the plasma in to a low pressure chamber through a conversing nozzle by maintaining a pressure difference across the plasma torch and the chamber [5-7]. The high rate of cooling produced in the adiabatic supersonic expansion ensure the homogeneous condensation of particles with a narrower size distribution.

In this work, we have studied the evolution of particle size distribution during the supersonic thermal plasma expansion method and investigate the effects of experimental variables like reactant injection rate, sample collection chamber pressure etc. by using numerical modelling known as nodal general dynamic equations (NGDE) solver [5, 8]. The numerical results suggest that the decreases of chamber pressure to 10 mbar reduce the average particle size with better particle size distribution. Consistent with the experimental results [7], the numerical results also suggest the formation of smaller nanoparticles (around 10 nm) with lower reactant injection rate of 0.7 gm/min.

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