Seminar

Institute for Plasma Research

Title : Thermal plasma synthesis of nanoparticles: simulation and experimental based study

Speaker: Dr. Gayatri Dhamale
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Date : 15th November 2019 (Friday)

Time : 03.30 PM

Venue : Seminar Hall, IPR

Abstract:

Nanoparticles, a connecting link between the bulk materials and structures at atomic or molecular levels, are of great interest due to broad range of applications offered by them. Reduction in size leads to increased surface to volume ratio and quantum confinement, which results in interesting and different physico-chemical properties of the material compared to its bulk counterpart. Those changed properties are not only found to be interesting but also successfully moulded into design and development of different devices.

Thermal plasmas operated in high power (~tens of kW) close to atmospheric pressure are established as a reliable and most effective route for engineering the particles in nano scale like nanoparticle fabrication, spheroidization, 2D structure formation like nano-walls, sheets, films, etc. Thermal plasmas not only melt materials but also evaporate and open up a new avenue for formation of different structures at nano scale via the mechanism of vapor phase nucleation. It is feasible due to the presence of high temperature (~10,000K), high enthalpy, flexibility in chemical environment and precursor selection (solid, liquid or in gaseous form) as well as a sharp quenching rate. The process of nanoparticle synthesis in thermal plasma highly relies on modeling techniques due to the experimental limitations of investigating the basic physical mechanism. Taking into account the features offered by this route and necessity of modeling study, a radio frequency inductively coupled thermal plasma reactor (RF-ICTP) has been used to synthesize nanoparticles of different ceramic materials viz., Al2O3, Y2O3 and Nd2O3 in sync with simulation study.

In the talk the experimental techniques as well as theoretical modeling used for synthesis of different refractory ceramics would be presented. Talk would include plasma diagnosis and optimization of the operating parameters for nanoparticle production with high throughput. To understand physics behind the formation of particles in thermal plasma, numerical modeling of homogenous nucleation and growth of particles was used by coupling the results obtained from CFD simulation of the plasma torch. The shortcomings in the study were faced while carrying out the CFD simulation and numerical modeling. The plasma dynamics is greatly affected during synthesis due to the presence of precursor vapor species. However, lacking of transport properties of the same constrained us for getting accurate plasma flow fields. Thus there is a scope for further study in generating such database along with carrying out the numerical modeling of particle formation especially for multi-atomic systems.