NUMERICAL APPROACH IN THE DESIGN OF A PLASMA REACTOR FOR NANOPARTICLE PRODUCTION

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In recent years, inductively coupled plasma torch (ICPT) have played and increasing important role in many technological process, as a clean and effective mean to produce plasma jet with high enthalpy content that can be usefully employed in a wide range of application, such as chemical synthesis of nanoparticle, plasma processing of fine powders and others.

The purpose of this project is to design an inductively coupled plasma reactor for synthesis of nanoparticles. The design aim is to obtain an optimal injection of the solid particle precursors resulting in a perfect evaporation.

The theoretical models are implemented in the computational fluid dynamic (CFD) commercial package Fluent, customized with User Define Functions (UDF). The first step consists in the implementation (UDF) of the adequate plasma thermodynamic and transport properties under the assumption of local thermodynamic equilibrium (LTE). The coupling between the electromagnetic field induced by the coil inductor and flow field is added in the energy equation as a source term (UDF) to generated the plasma flow.

After defining, comparing and validating the plasma flow against VKI ICP code, the injections of particles are investigated. The trajectory of those particles, as well as the heat and mass transfer between the particles and the plasma are analyzed and computed. The simulations results obtained by means of 3D model are presented, for the injection of silicon and titanium particles in different torch configuration.

Finally, a parametric investigation is done on the different operating conditions. Advantage and inconvenient of the approach are underlined to clarify and discuss the effect of several parameters on the heating, melting, evaporation and mixing of the injected particles, and suggestions for future work are performed.

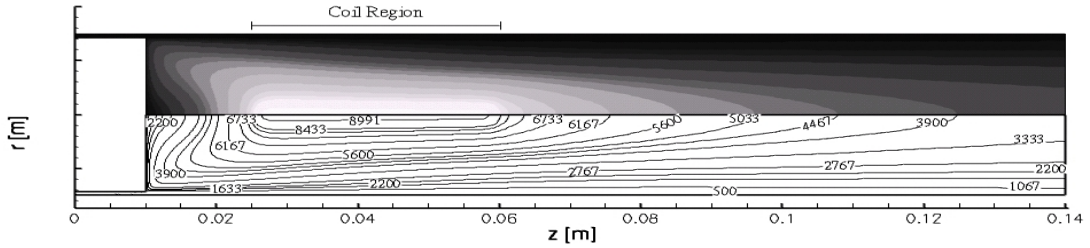

Figure 1: Temperature contours and isolines of air, Pt=5KW, Q=0.96g/s

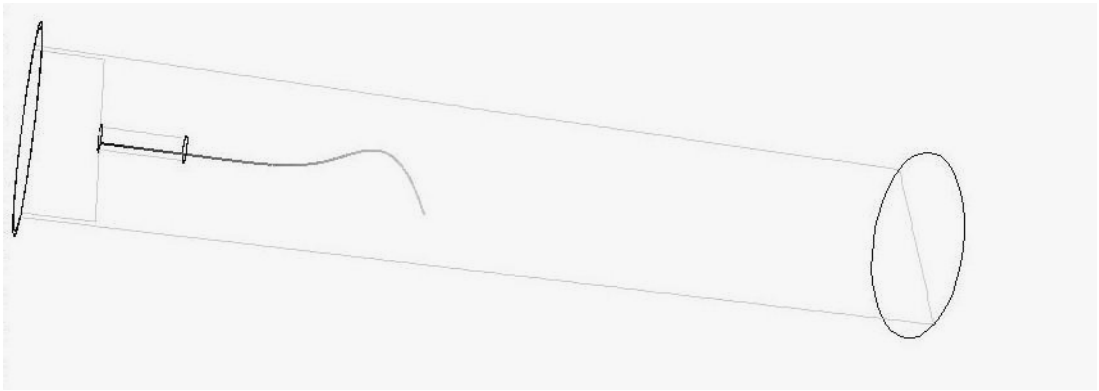

Figure 2: Residence time of 75µm silicon particle injected in the plasma flow