Contribution ID: **1215** Type: **Poster**

3P09 - TWO TEMPERATURE SIMULATION OF SUBATMOSPHERIC ARC DISCHARGE*

Wednesday 26 June 2019 13:30 (1h 30m)

Arc discharges that fall into low-temperature plasmas have several industrial applications including nanoparticle synthesis, plasma thrusters, and thin film deposition. The complexities associated with the simulation are dealing with large gradients of densities, temperatures, material evaporation, deposition, and species transport. Most widely used model for simulating the arc discharges is a single temperature fluid transport coupled to ionization equilibrium. The model could estimate the plasma properties to a satisfactory level in the arc column alone. Outside the arc, any charged species, that escape from the arc-core, will be chemically and thermally in a non-equilibrium state. These non-equilibria become more and more prominent with the decrease of the background pressure. At low background pressures (<100 Torr), due to fewer collisions between the electrons and heavy species, the electrons may not attain thermal equilibrium with the rest of the species. Thermal non-equilibrium influences the reactions in a significant way, particularly the electron impact ionization. In order to predict the species densities accurately, the reactions must take into account the differences in the species temperatures.

In the present work, we have attempted the two temperature simulations of arcs, used in the synthesis of nanoparticles. The simulations were performed in USim fluid-plasma software.[1] USim has a wide variety of fluid equation systems that could be customized for modeling the two temperature multi-species plasma system. The recently updated reaction solver in USim could be used for calculating the rate s of the species reactions, occurring at electron and heavy species temperatures.

1. Kundrapu, M., Loverich, J., Beckwith, K., Stoltz, P., Shashurin, A., and Keidar, M., "Modeling Radio Communication Blackout and Blackout Mitigation in Hypersonic Vehicles,"Journal of Spacecraft and Rockets, Vol. 52, No. 3 (2015).

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* Work supported by DOE SBIR Phase II Award No. DE-SC0015767. Dr. Curtis W. Bolton is the program manager.

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Session Classification: Poster - Industrial/Commercial/Medical Applications and Plasma and Pulse Power Diagnostics

Track Classification: 6.1 Nonequilibrium Plasma Applications