Development of a 30Kw inductively-coupled plasma torch for high temperature aerospace material testing at UVM.

Walten Owens

Mechanical Engineering, University of Vermont

A 30 kW inductively coupled plasma (ICP) torch facility was developed at the University of Vermont. The facility will test advanced aerospace materials for thermal protection of hyper velocity vehicles. An ICP torch is a device designed to heat gases to very high temperatures through electron excitation and heavy particle collisions. The inductively coupled discharge is attractive to applications where a clean and stable source of plasma is essential. This facility will further our understanding of gas/surface interactions and provide quasi steady-state conditions for ablation analysis.

Although inductive discharges have been studied for over a century, ICP Torch facilities have not been extensively developed in the U.S. to simulate the aero-thermal environments needed for the development of thermal protection materials. Currently, most facilities designed with aerospace applications use arc-jet heaters which are typically more expensive to operate and because its direct discharge attaches to the electrodes, electrode material enters the stream as a contaminant.

The effective design of the ICP torch depends on the integration of the power supply, gas supply and the pressure control systems. Test conditions for materials are based on duplicating total enthalpy, post shock total pressure and velocity gradients from the flight environment. Specially designed probes were built to withstand long-duration exposure to high temperature plasmas and to hold test materials in a stagnation-point configuration, normal to the main axis of the plasma flow. Calorimeters and pressure probes will be installed to measure stagnation-point heat flux and pitot pressure. Laser spectroscopic diagnostic measurements of the reacting boundary layer over the test material surface will also be performed.

The presentation will cover the basic operating principles and the main features of the 30kw ICP torch facility at the University of Vermont. It will also cover the challenges faced during the design process. The poster will include spectacular photos of the plasma discharge and test facility.