DEVELOPMENT OF A SENSING & CONTROL TECHNIQUE FOR AN INNOVATIVE ATMOSPHERIC PLASMA CVD PROCESS

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ABSTRACT

The electric hybrid vehicle is an advanced transportation concept using a combination of the solid oxide fuel cell (SOFC), batteries, and supercapacitors. The solid oxide fuel cell serves as the main power plant while the batteries and supercapacitors act as energy storage devices. The batteries provide the initial power (first 5 to 10 min. of operation) during the SOFC start-up phase and the supercapacitor serves as a load leveling device. After the SOFC becomes operational, the batteries switch to standby mode. The SOFC provides power for vehicle operation and to recharge the energy storage devices.

Atmospheric plasma chemical vapor deposition (CVD) has been identified as an enabling technology for the hybrid electric vechile. This technique is used to deposit thin, dense electrolyte layers, electronic conducting ceramic seal layers, and porous electrodes for the SOFC. This process is also an enabling technology to deposit ultra-high surface ceramic electrodes for supercapacitors. Consistent deposition of high quality coatings on an industrial scale requires the development of real-time process control of the substrate temperature. The main objective of this work was to develop a real-time, non-obtrusive technique to measure plasma temperatures just above the substrate surface.

Plasma gas temperatures and velocities in the boundary layer between the plasma jet and the substrate were measured using a Fabry-Perot interferometer. Using a pure argon plasma to initially obtain baseline values, confirmation of plasma temperatures and velocities as a function of amperage were obtained to allow implementation of a simpler frequency integrated laser scattering technique. The effects of plasma temperatures in the boundary layer of the substrate on the quality and microstructure of deposited coatings were evaluated as a function of material loading. The feasibility of using the frequency integrated scattering technique as a real-time sensor was also investigated.