Abstract Submitted
for the GEC06 Meeting of
The American Physical Society

3D Finite Element Modeling of Arc and Jet Dynamics in a DC Plasma Torch JUAN TRELLES, EMIL PFENDER, JOACHIM HEBERLEIN, University of Minnesota — The unstable behavior of the plasma jet in direct current plasma torches has been well documented experimentally, but the nature of the instabilities is not well understood. This is in part due to our lack of understanding of the forcing effect on the plasma jet caused by the arc dynamics, mainly because the confinement of the arc inside the torch limits its direct observation. In this research, the dynamics of the electric arc and the plasma jet in a plasma torch are modeled using a 3D, time-dependent, LTE model. The fluid and electromagnetic equations are solved in a fully coupled manner by a variational multiscale finite element method, which implicitly accounts for the multiscale nature of the flow. Simulations of a commercial torch operating with Ar-He under typical operating conditions used for plasma spraying are presented. The simulation results reveal the highly unsteady and quasi-periodic behavior of the arc as well as the undulating nature of the plasma jet. Furthermore, our simulations indicate a clear correlation between the arc and jet dynamics, furthering our understanding of the interactions between thermal plasmas and cold gases, as typically found in plasma processing systems.

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Date submitted: 12 Jun 2006 Electronic form version 1.4