2007 Morton Antler Lecture Outline

Characterization of the dynamic arc-anode interaction and using plasma deposition of nanocomposites to tailor materials properties

- ✓ The first part of this lecture is concerned with characterizing the instabilities which are observed with an arc attachment to its anode under the conditions of a superimposed gas flow. A three dimensional, time dependent model has been formulated and used to simulate the movement of the anode attachment on the wall of a Cu nozzle. A good correlation has been obtained between calculated and experimental voltage traces. The results show the importance of the non-equilibrium in the anode boundary layer region. Conclusions from these simulations were compared with results from experiments where the arc attachment on a cold Cu anode was exposed to cold gas flow parallel to the anode surface. Langmuir probe and Thomson scattering measurements allowed determination of 3-D distributions of electron densities and temperatures. Distributions of electric fields could be derived from these measurements using the law of charge continuity. This allowed us to see how the anode instabilities are initiated through electric field inhomogeneities caused by asymmetric cooling of the arc.
- ✓ In the second part, the use of arc plasmas is described for depositing nanophase coatings with specific properties. Film properties can be tailored to a certain degree by having nanocrystallites imbedded in an amorphous matrix. As an example for a process of creating such nanocomposite films, an experiment is described where nano-sized particles are formed in a supersonic nozzle and accelerated towards a substrate. Additional vapor deposition can give an amorphous matrix. The focus of these experiments has been on generating superhard materials, but the concept should be applicable to modifying other materials properties.