DC arc plasma torch in pulsed mode: Properties and application to plasma spraying of liquid feedstock

Vincent Rat, Fabrice Mavier, Fadi Zoubian, Marguerite Bienia, Martine Lejeune
University of Limoges, CNRS, SPCTS, UMR 7315, F-87000 Limoges, France

Direct current plasma spray torch are complex dynamical systems that convert electricity into enthalpy and kinetic energy. They are widely used for industrial plasma spraying applications requiring ceramic coatings with expedient properties like for instance heat flux and wear resistance. Coating properties can be improved with nanomaterials which are injected within the arcjet by means of a liquid carrier medium. Either nanoparticles are dispersed in an aqueous (or alcoholic) phase or alternatively salts containing the elements to deposit are dissolved in an appropriate liquid. In both cases, liquids containing the materials interact with the arcjet and the products of this multiphase interaction are sprayed to form the ceramic coatings. The liquid interface and nano-sized particles are highly sensitive to time-dependent plasma properties due to electric arc instabilities. Dc plasma torches free of arc instabilities are then of interest to develop so that cascaded plasma torches are often used. However, arc motion in the torch body always occurs and is even necessary to limit the electrode erosion. An alternative approach is to favor the arc fluctuations in a controlled fashion to obtain a pulsed mode. A phased injection of droplets in the pulsed arc jet should permit to improve plasma/material interaction. In this paper, we present a dc arc plasma torch working a pulsed mode and its properties. A drop-on demand piezoelectric injection head is synchronized with the plasma torch and the resulting interaction is analyzed by means of time-resolved emission spectroscopy. Properties of deposited coatings are also shown.