EuroSciCon

EuroSciCon Conference on

Advanced Nanotechnology

April 18-19, 2019
Paris, France

Nano Res Appl 2019, Volume:5
DOI: 10.21767/2471-9838-C2-034

NUMERICAL MODELLING ON NANO STRUCTURED COATING IN SUSPENSION PLASMA SPRAY

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Suspension plasma spray is a promising technique for nano-structured coatings and nano-powder synthesis where nano-particles are injected into the plasma jet with the help of liquid precursors. When the particles fly through the plasma flame, their mass, momentum and energy will dramatically change due to the interaction with the flame. A comprehensive model was developed to investigate the suspension spraying in the radio frequency inductively coupled plasma torch. The model is based on hybrid Eulerian/Lagrangian coordinate system to illustrate the suspension behavior, such as suspension droplets collision, heating and evaporation; nano or agglomerate particles heating, melting and evaporation. Special considerations are directed to the suspension droplets collision, non-continuum effects and the influence of evaporation on heat transfer. After validation with experimental data, the comprehensive particle model is used to predict the trajectory, velocity, temperature and size of the in-flight nano- or agglomerate particles. A parametric analysis has been performed to find the way of controlling the operating conditions for desirable final particle status. The parameters that have a significant influence on the spray process are identified. The relationship between the predicted height of droplet complete evaporation and the droplet initial diameter is deduced. Finally, results also calculate the critical size of an ethanol droplet suspended with zirconia particles, which will be completely vaporized under present conditions.

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