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Nanostructured porous coatings via electrospray atomization and deposition of nanoparticle suspensions

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Abstract

The controlled deposition of aerosols is shown to be a valuable tool to prepare nanostructured porous coatings as required in many applications. Experiments were conducted to prepare nanostructured materials from the electrohydrodynamic atomization of liquid suspensions. The charged droplets generated by the electrospray are driven by the electric field, the liquid evaporates along the droplet path leaving a dry residue of nanoparticles that deposit on a substrate. The range of parameters leading to a stable cone-jet was studied for two different suspensions; carbon nanoparticles in ethanol and catalytic inks formed by Pt supported on carbon nanoparticles and Nafion® in ethanol. The morphology of the deposits was examined by means of digital scanning electron microscope (SEM) images. Upper views of the deposit show a structure based on clusters of nanoparticle agglomerates formed by the attachment at the deposit of nanoparticles coming from several electrospray droplets, with the cluster size (of the order of 10 microns) increasing with the flow rate. Lateral SEM images of the deposits cross-sections were processed to calculate the deposit mean density and porosity. The porosity is rather high (always larger than 90%) decreasing as the electrospray flow rate increases. Coatings prepared from catalytic inks were tested as electrodes in a fuel cell.