Electrospraying deposition of nanoparticles

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Aerosol technologies have increased their application field ranging from environmental issues of social concern to the fabrication of new materials with specific properties. The distinctive large surface/volume (surface/mass) ratio of aerosols made them especially suitable for procedures requiring a large active surface area which is the case for catalyst applications, solvent fabrication or pharmaceutical products. Moreover, aerosol nanoparticles can be used as building blocks for preparation of new materials which still retain this large surface/volume ratio as their distinctive feature. Many practical applications make use of porous materials and suitable values of surface roughness and bulk porosity may be required. In this sense, the deposition of electrosprayed suspensions of nanoparticles leads to porous films whose morphological properties may be controlled by adjusting the electrospray parameters.

An experimental work is being carried out to perform a broad study of deposit features as a function of electrospray working conditions. A suspension of carbon nanoparticles in ethanol is steadily electrosprayed in the cone-jet mode with the resulting charged droplets driven towards a collecting surface. Ethanol evaporates during the droplet flight and the particles emitted at the electrospray tip are collected on the substrate building up a granular deposit of nanoparticles. Depending on the electrospray operating conditions, aggregates or even single catalyst particles can reach the substrate generating a dendritic-like and highly porous deposit. Changes in the liquid composition and in the electrospray working parameters (needle voltage, collector voltage and flow rate) affect the stability of the cone-jet mode and also have a strong influence on the dynamics of particle arrival to the collecting surface which indeed determine the deposit structure.

The deposit morphology has been analyzed as a function of the electrospray flow rate (Q). Carbon deposits were formed with different values of Q but the same total collected mass of nanoparticles. Image processing analysis of SEM images of these deposits allows to determine the mean deposit density. The deposit mean porosity is rather high but decreases with the flow rate showing a transition from dry deposition to wet deposition probably due to incomplete evaporation of ethanol at large enough flow rates.