Electrospray deposition of inorganic and organic nanoparticles and biological macromolecules

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Electrospray deposition is a user-friendly, cheap and fast way to spray and deposit inorganic or organic nanoparticles and biological macromolecules from liquid dispersions [1-3], although it is not known by the vast majority of the scientific community for whom it may be useful.

Electrospray deposition is based on the electrostatic atomization of a conductive liquid. The field can polarize and sharpen the surface of the liquid, generating a cone (Taylor cone) that emits a jet. This jet is broken by surface tension into drops that shrink in size if the solvent is volatile enough. Since these drops are electrically charged, when repulsive electrostatic forces in the surface overcome cohesive surface tension, Coulomb explosion occurs in order to reaccommodate surface charge. The subsequent iteration of this process can give rise to an aerosol composed of the charged solid residue. If the starting conductive sample is a dispersion of nanoparticles, this residue is the charged nanoparticles. It is very easy therefore to use this effect to deposit nanoparticles with diverse origins (inorganic, organic, biological) onto conductive or isolating substrates. Moreover, since the particles are charged, they tend not to agglomerate, avoiding typical artefacts from liquid phase methods (spin coating, dip coating) than can hidden the nanometric nature of the particles. Electrospray deposition can be used at any pressure, does not require expensive instrumentation and typical deposition times are in the order of minutes. In this communication we show several examples of deposition of inorganic, organic and biological nanoparticles.

As an example of inorganic nanoparticles, Fe_3O_4 superparamagnetic nanoparticles with a diameter below 10nm are of large interest for biosensors, medical diagnosis and NMR imaging techniques. We have studied the feasibility of using electrospray techniques to deposit magnetic nanoparticles directly from a diluted suspension in water is analyzed on to an ultraflat mica surface. Characterization is done by means of Atomic Force Microscopy

As an example of organic nanoparticles, Polystyrene latex (PSL) nanoparticles are one of the most common nanoparticle standards for calibration purposes. Commercial PSL nanoparticles were diluted in ethanol (1%) and sprayed on an Al foil for times varying between 1 minute and 1 hour. Scanning Electron Microscopy was used to characterize the deposit. In short deposition times, non-agglomerated deposits can be obtained. At longer times, typical cabbage-like patterns appear.

As an example of biological nanoparticles, DNA solution (100μM) in ethanol was electrosprayed, easily obtaining stable cone-jet operation. The DNA was deposited onto a silicon wafer. After several minutes on working, AFM images were obtained on the silicon wafer.

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