Curcumin-loaded PVP particles produced by electrospray

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Electrospray, also known as electrohydrodynamic atomization (EHDA), is a robust technique for producing uniform polymeric particles with controlled morphology and size. In this technique, a liquid pumped through a nozzle is electrically charged by applying high voltage. The electrified liquid adopts a conical shape (called Taylor cone) with a thin jet at its end. This jet then breaks up into highly charged droplets, which form a charged spray plume as they drift towards an oppositely charged substrate, where they are collected as solid particles after the solvent has evaporated from them. One of the advantages of EHDA over other liquid atomization methods is its ability to produce much smaller particles (in the few-microns and nano-metric size ranges) [1].

From the point of view of biomedical and pharmaceutical applications, it is desirable to produce size-monodisperse particles. Such particles are used as vehicles for drug delivery, where the release profile of an encapsulated drug is strongly influenced by the particle size; thus the importance to control particle size in the production method [2]. Whereas it is possible to produce homogeneous particles by electrospray, the droplets in the spray often undergo Coulombic instabilities, resulting in particles with non-ideal shapes, commonly elongated or pointed particles with nano-filaments attached [3].

The objective of this work is to produce homogenous polyvinylpyrrolidone (PVP) particles by electrospray. Particles with well-controlled morphologies and sizes of up to a few microns were imaged by scanning electron microscopy (SEM) (Figure 1).

We observed that the particle size is influenced strongly by the infused liquid flow rate. The initial polymer concentration and polymer molecular weight (MW) remarkably affect the morphology of the particles. With Mn 360 kDa MW, as the polymer concentration in the solution increases we observed a progression in particle morphology from filamented particles (due to Coulombic instabilities) to non-filamented particles, to filamented morphology (due to incomplete jet breakup).

The solvent system can also affects the particles morphology and size. In the case of PVP 40kDa, less spherical (more corrugated) particles with larger sizes were obtained when we used a solvent mixture of solvent (ethanol/acetone 50/50) than when we used ethanol as solvent.

References

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Figures

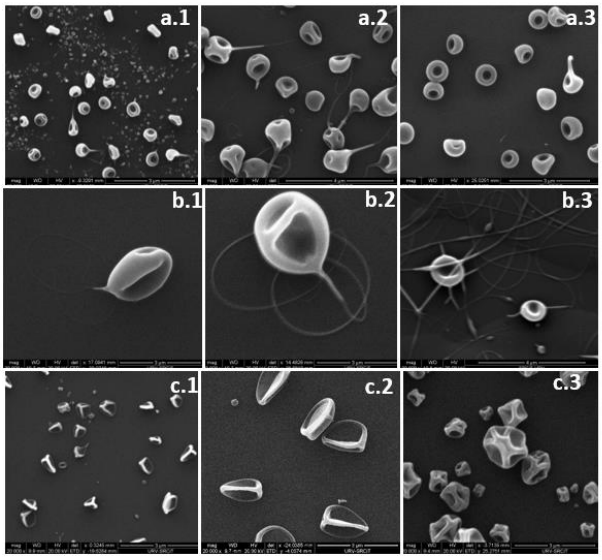

Figure 1. SEM images of PVP-curcumin microparticles of different morphologies collected on a silicon wafer.
(a) PVP 40 kDa and curcumin (0,1 %w) in EtOH at different polymer concentrations (by wt.): 1% (a.1), 5% (a.2), 10% (a.3).
(b) PVP 360 kDa and curcumin (0,1 %w) in EtOH, at polymer concentrations (by wt.): 1% (b.1), 1.5% (b.2), 3% (b.2).
(c) PVP 40 kDa and curcumin (1:1) in ethanol/acetone (50/50 v/v) at polymer concentrations (by wt.): 0.6% (c.1), 5% (c.2), 10% (c.3).