Computational Modeling of Electrospray Process for Nano Encapsulation of Food Bioactives

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Abstract

Electrospray is a well-known encapsulation method for preparing monodisperse nanoparticles from a multitude of different precursors. It has been used to produce inorganic and polymeric nanoparticles and to encapsulate bioactives having poor solubility in water. Electrospraying is a process of liquid atomization by electrical forces. The final product size depends on system parameters, solution factors, instrumental and ambient parameters. Optimization of these process parameters requires several experiments which is cumbersome. In this scenario, CFD was used to optimize process parameters like conductivity, viscosity, surface tension and density of the electrospray feed solution for proper spray of bioactives.

A finite element 3-D model was developed to predict the particle trajectory along with size of encapsulated particles using electrospray. A lab scale electrospray system contains mainly four components: (i) high voltage source (1- 30 kV), (ii) a blunt ended stainless steel needle, (iii) a syringe pump and (iv) a flat plate as collector. Similar geometry was developed for the simulation considering material property of each component. 'Particle tracing in fluid flow' module was used to study the particle trajectories in electric field. The forces acting on particles were considered to be drag force, electric force and gravitational force with electric force as dominant in electrospray process.

From the result of this study, the trajectories of electrosprayed particles reflect that the velocity of sprayed particles depends on applied forces and it increased towards the collector plate. This model would help in minimizing the experiment time to study the trajectories of electrosprayed particles. The droplet size of electrosprayed particles can also be predicted using this model.

Figures used in the abstract

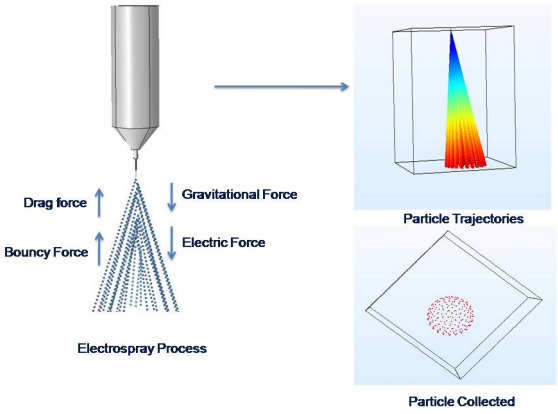

Figure 1: Trajectories of Electrosprayed Particles