Bioceramics Development and Applications

Wu Y, Bioceram Dev Appl 2014, 4:2
DOI: 10.4172/2090-5025.1000e105

Editorial Open Access

Electrohydrodynamic Atomization Processing Biologically Nanostructured Materials

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Received Date: May 28, 2014; **Accepted Date:** June 08, 2014; **Published Date:** June 10, 2014

Editorial

Electrohydrodynamic atomization phenomena has increasingly attracted the attention of researchers who are interested in pursuing this promising technique to prepare micro- or nanometer architectures such as fibers and encapsulated particles with a controllable microstructure. There are two main techniques in the electrohydrodynamic atomization processing: electrospraying and electrospinning. Electrospraying can create particles by applying a uniform electrohydrodynamic force to break up liquids into fine jets, and is an emerging method for the rapid and high throughput production of nano-meso scale particles of controlled morphology for controlled release during drug delivery. The morphology and size of electrosprayed polymer nanoparticles is strongly influenced by a host of variables that include processing parameters and the material properties of the solution such as polymer composition, molecular weight, the solvent used for polymer dissolution, and the presence and concentration of other cosolutes. In a typical electrospinning process, the precursor solution is held at the end of the nozzle in the form of a droplet by its surface tension. As is the case with electrospraying, a voltage applied to the nozzle results in the formation of a Taylor cone, from which a jet of the precursor solution will erupt. Although the jet in a Taylor-cone mode is stable near to the tip of the nozzle, it undergoes a fluid instability stage that leads to accelerated solidification of the jet and a thinning of the fibers as the jet approaches the collector [1-4] (Figures 1 and 2).

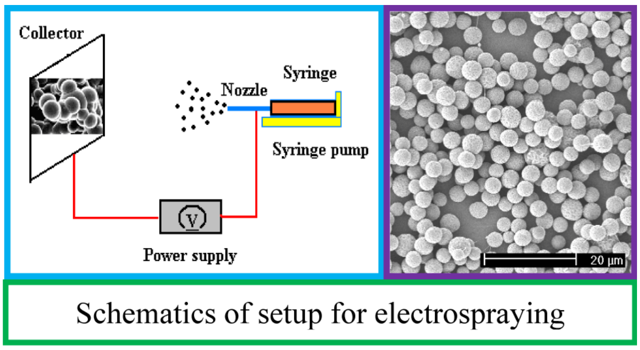

Figure 1: Schematics of setup for electrospraying

Preparation of drug carriers still remains one of the important challenges in medicine, and various fabrication techniques have been studied in the pursuit of generating size-controllable and well-dispersed (i.e. not clumped together) delivery carriers with high encapsulation efficiency. One of the significant potential advantages of the electrospraying technique is its ability to prepare micro- and nano-sized particulate drug delivery systems such as microspheres and microcapsules, in which the biological agents can be encapsulated or distributed into biodegradable polymer particles [5-8] (Figure 3).

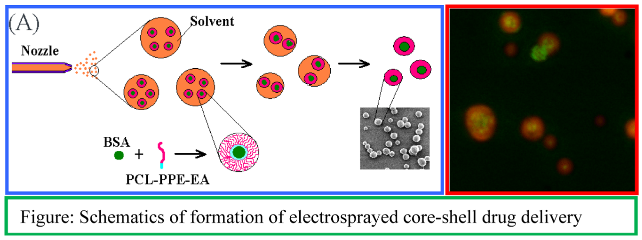

Figure 2: Schematics of formation of electrosprayed core-shell drug delivery

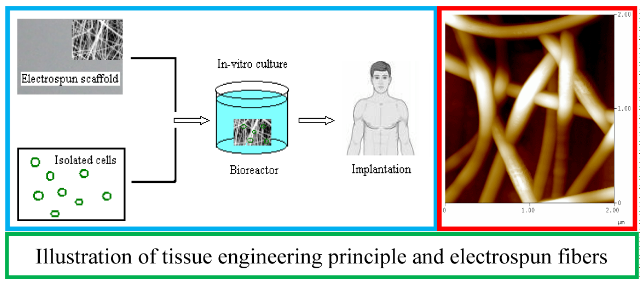

Figure 3: Illustration of tissue engineering principle and electrospun fibers

Tissue engineering is rapidly emerging as a promising therapeutic strategy to repair or reconstruct damaged tissue or organs that fail to regenerate or heal spontaneously. It has been defined by Langer and Vacanti as an interdisciplinary field that applies biological, chemical, and engineering principles towards the development of biological substitutes that restore, maintain, or improve tissue function using biomaterials, cells, and factors alone or in combination.One aspect of tissue engineering involves the fabrication of three-dimensional scaffolds with specific mechanical and biological properties similar to the native extracellular matrix (ECM).Based on the above features, electrospinning is an appropriate technique for preparing tissue scaffolds with fibers ranging from nanometer to micrometer scale that mimic a natural extracellular matrix, and has the potential for large scale production of continuous nanofibers for biomedical applications. Only recently has electrospinning been revitalized and gained popularity with the biomedical engineering community as a potential

Citation: Wu Y (2014) Electrohydrodynamic Atomization Processing Biologically Nanostructured Materials . Bioceram Dev Appl 4: e105. doi: 10.4172/2090-5025.1000e105

means of producing scaffolds for tissue engineering applications [9-12] (Figure 4).

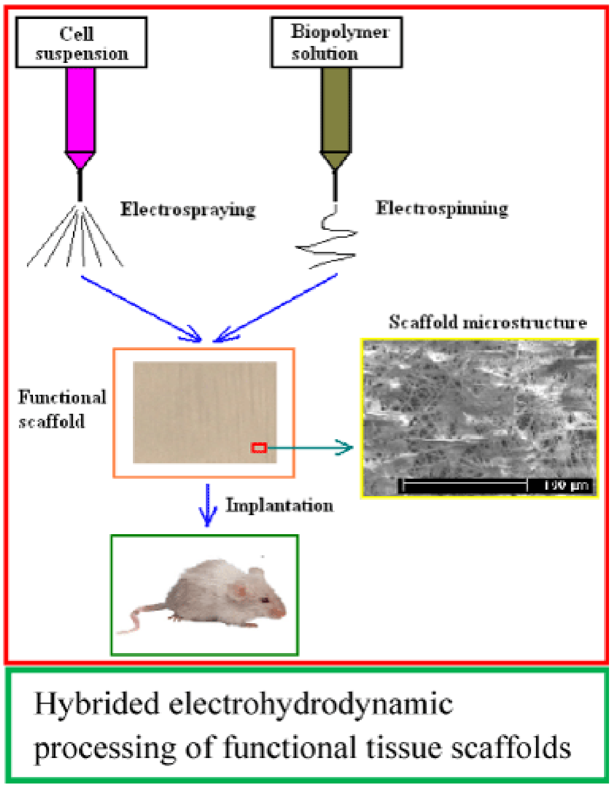

Figure 4: Hybrided eletrohydrodynamic processing of functional tissue scaffolds

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