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ELECTROSPINNING OF POLYMER NANOFIBERS - A MINI REVIEW

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Abstract:

Electrospinning is a simple, versatile and an efficient technique for the fabrication of polymer nanofibers due to the ability to produce materials with nano scale properties like high surface area to volume ratio and tuneable porosity. In electrospinning, polymer nanofibers are formed by creation and elongation of an electrified fluid jet. Various polymers have been successfully electro spun into ultrafine fibers in recent years mostly in solvent solution and some in melt form. In this paper, a comprehensive review is presented on the researchers and developments related to electrospun polymer nanofibers including processing, characterization, structure, modelling, simulations and their applications in nano-medicine. Information of those polymers together with their processing conditions has been summarized and their limitations and future trends are also discussed.

Key Words: Electrospinning, Polymer, Nano Fiber & Nano Medicine

Introduction:

When polymer fibre materials are shrunk from micro metres to nano metre, there are several characteristics that make the polymer nanofibers highly suitable for important applications. Several processing techniques such as drawing, template synthesis, phase separations self-assembly, electrospinning have been used to prepare polymer nanofibers in recent years. But, the electrospinning method seems to be the only method which can be further developed for mass production of one by one continuous nanofibers from various polymers. The term "electrospinning" is derived from electrostatic spinning describing an experimental set up for the production of polymer filaments using an electrostatic force.

Bio-Degradable Nano Fibre by Electro Spinning:

A bio-degradable nanofibre scaffold by electrospinning is a potential for bone tissue engineering. Recently, electrospinning has gained popularity with the Tissue Engineering community as a potential means of producing Scaffolds. By using electro static fibre spinning micro porous, non-woven poly-scaffolds are made. Nanofibers are formed by subjecting a fluid jet, to a high electric field. Mesenchyme stem cells (MSCs) derived from bone marrow of neonatal rats were cultured, expanded and seeded on electro spun PCL scaffolds. Nanofibers with sustainable lidocaine releases adequate efficacy and durability for pain relief in rabbits, with segmental long bone fracture (1).
In electrostatic field stretches the polymer solution into fibre at the same time when the solvent is evaporating. The diameters of the formed fibres are typically sub-micron range and they can be collected and inter connected nano fibre web onto surface of substrate (2–4). Aluminium laminated plywood panels can be made using PAN. As biocatalyst, enzymes it exhibits a number of excellent feature like high activity, high specificity and high selectivity and also catalyst many organic reactions under mild and environmentally friend condition (5,6).

Ideal Scaffolds:

The most abundant protein family in the body which has been extensively used for in vitro and in vivo tissue engineering is collagen. Type I and Type III Collagen are the principal structural elements of extra cellular matrix in many popular tissues (7).

Function of Collagen is to provide structural support to the tissue in which it is present at the same time it is also required for tissue regeneration and maintenance. Therefore, it is called as Ideal Scaffolds material into the Tissue Engineering field (8).

Nanofibers for Water Remediation and Drug Delivery:

Polymeric nano particles contain solid polymer filled coal that is better suited for water insoluble, drug pay loads. The inherity high surface to volume ratio of electro spun fibres can enhance cell attachments and drug loading properties. The drug ranging from anti-biotic agent to DNA, RNA and various growth factors have been incorporated into electro spun fibres (9). They can be formed by self-assembly of block co-polymers consisting of two or more polymer chains with different hydrophobicity (10).

Nanofibers in Textiles:

Non-oven textiles composed of electrospun fibres have large specific surface. Its small pore size makes it use in filtration and membrane applications. The two most important processing parameters viz., spinning voltage and solution concentration are correlated with the formation of bead defect in the fibres and to signal the on-set of processing voltage. It has been found that solution concentration affects fibre size. In addition, electrospinning from high concentration solution has been found to produce hinodal distribution of fibre sizes. The electro static effects influence the macro scale morphology of electro spun textiles (12).

Cellulose nanofibers are obtained from various sources by chemical treatment. Nanofibers have diameters between 5 and 60 nm. The Cellulose Nanofibers are characterized in terms of crystallinity. The ultra-structure of cellulose nanofibers is investigated by atomic force microscopy and transmission electron microscopy. Composite comprising 90% polyvinyl alcohol and 10% nanofibers are also prepared (11).

Polymer Nanofiber in Bio-Medicine and Bio-Technology:

Bio-Chemical characteristics displayed by a wide range of bio-degradable bio-polymer find application including multi-functional membrane used in artificial organ, vascular grafts, wound dressing in the field of bio-medicine and bio-technology (13).

Conclusions:

Most of the research on electrospinning of natural polymer is focussed on biopolymer nanofibers, because these are naturally occurring polymers exhibit better bio-compatibility and low toxicity than other polymers. This paper reviews different uses of polymer nanofibers in the field of biomedical, water treatment and textiles. The key applications of biopolymer nanofibers in medicine are diagnosis and target therapy, however, their wider use is still the future. Polymer nanofibers in medicine will continue to be researched because of its great potential to help the medical field.

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