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Preparation of Polymer Nanofiber and Its Application

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Today in the field of nanotechnology, polymer nanofiber have become a prominent area of research. They are widely used in wound healing, tissue engineering. Drug loaded biopolymer based nanofiber is used in wound healing. They are also used in making scaffold for tissue engineering. Electrospinning is used for generating polymer nanofiber. In this article, preparation of polymer nanofiber and application of this nanofiber is described.

Keywords: Polymer; drug delivery; electrospinning; nanofiber; tissue engineering.

1. INTRODUCTION

Nanotechnology [1] is a branch of science that deals with the materials in nanometer (10^{-9} meter) scale. Nanofiber has the diameter in the nanometer range. In this range, material shows some amazing and unusual property. Surface to volume ratio of nanofiber is very high in compared with microfiber of same material. Due to high surface to volume ratio of nanofiber, they shows significant change in mechanical, chemical, physical and biological property in compared with microfiber. Different techniques like template synthesis [2], phase separation [3],

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drawing [4], self assembly [5], electrospinning [6] have been discovered for making nanofiber. Among them electrospinning is suitable for ease of fabrication and ease of control over process parameter. An electrospinning setup consists of a voltage source, source electrode, collector electrode and syringe containing polymer solution. Nanofiber processing is dependent on voltage parameter, source to collector distance, different properties [7] of polymer solution. Researchers are doing extensive study on generating polymeric nanofiber with best mechanical, chemical and physical properties. It is widely used in biomedicine and bioengineering. They are used in developing filtration devices. Some of them are used in wound healing treatment. These nanofibre is also used as soldiers clothing and light material in space application. Some nanofiber are used for preparation in sensor, transducer, actuator.

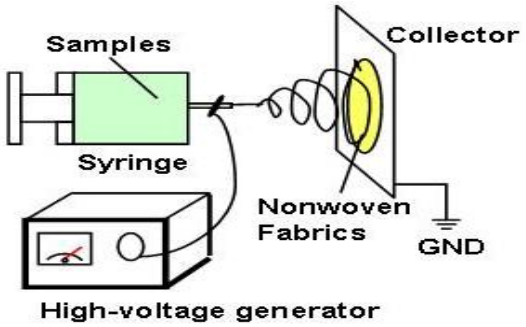

Fig. 1. Electrospinning setup for nanofiber preparation

2. PREPARATION OF NANOFIBER

It is already mentioned that different techniques have been discovered so far for making nanofiber. Electrospinning [7,8] is the best way of generating polymer nanofiber. In an electrospinning setup a high electric voltage, source electrode, collector electrode and syringe containing polymer solution are used. First a polymer solution is prepared. It is loaded in the syringe. Needle of the syringe is acting as source electrode. Now a high voltage is applied in between needle and collector. At critical value of voltage, when polymer solution overcomes the surface tension and viscoelastic force, droplet at the tip elongates into taylor cone and a jet of polymer ensues from the tip of the needle and accelerates towards the counter electrode. Due to the high surface area, polymer jet dries quickly and collected at collector in the form of nanofiber. So many polymers like poly(D,L-lactic acid), poly(L-lactic acid), collagen, collaen–PEO, polyvinylidene fluoride e.t.c.. Some of them are biomaterial and some are not biomaterial. Biomaterial based nanofiber is used in medical application and non biomaterial nanofiber is used as energy harvesting device, actuator.

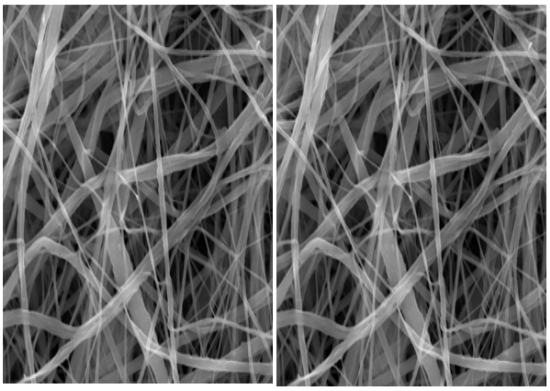

Fig. 2. FE – SEM image of nanofiber structure

3. APPLICATION OF POLYMER NANO-FIBER

Polymer nanofiber has several application in different field of science and medical. Biopolymer based nanofiber is used as drug delivery systems [9,10,11]. Different types of drug can be loaded into these nanofiber. Drug loaded nanofiber can be used for wound healing treatment. Some nanofiber features a morphologic similarity to extracellular matrix of natural tissue which is characterized by a wide range of pore diameter distribution, high porosity and effective mechanical properties. Such nanofiber meets the essential criteria for designing engineering scaffold used in tissue engineering. This scaffold can replace the natural electro cellular matrix (ECM). Some polymer material like PVDF [12], PVDF – TrFE [13] has piezoelectric property. Normally this polymer material does not show piezoelectric property. When this polymer material is electrospun into nanofiber, it becomes piezoelectric. If we apply pressure on it, it will generate voltage. Based on this properties it is used in energy harvesting technology [14]. This materials are also flexible. So it can be place anywhere in any shape for scavenging power from mechanical movement or any mechanical energy for powering the self powered nano or micro devices.

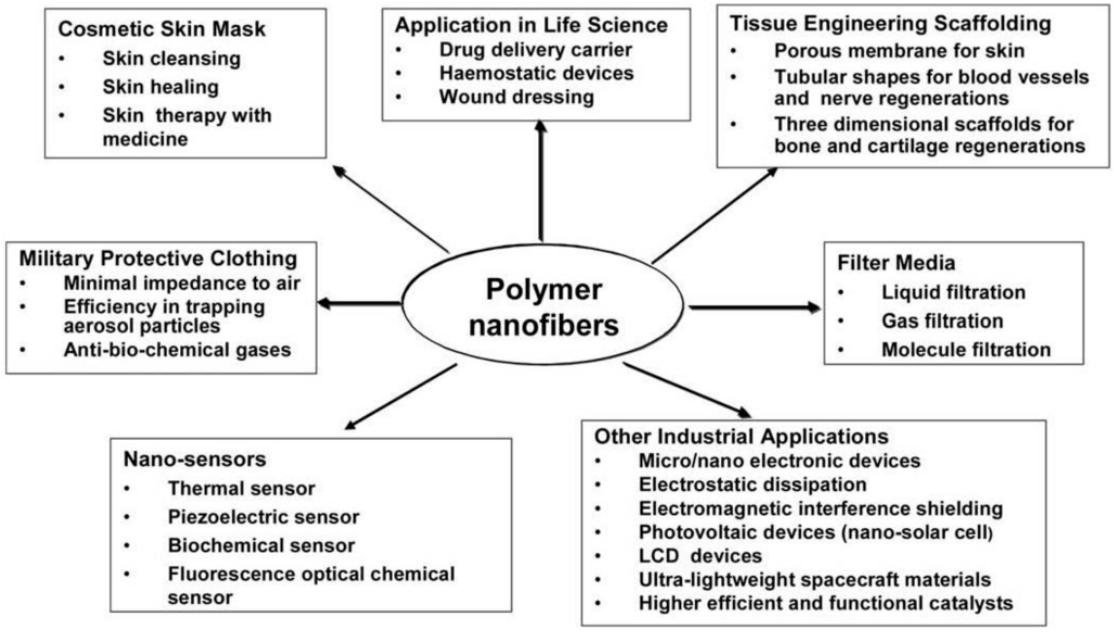

Fig. 3. Different application of polymer nanofiber

4. CONCLUSION

To use these nanofibers in biomedical application like drug delivery, tissue engineering, several important properties, such as structure, biocompatibility, biodegradability, and mechanical strength must be considered. Morphology of nanofiber is characterized by scanning electron microscope. Chemical structure of nanofiber are characterized by fourier transformed infrared spectroscopy technique. Mechanical strength can be measured from microtensile test measurement. Surface migration of the insoluble drug molecules that dispersed inside the solution causes burst release. Sustained release is a way to improve drug loading and reduce the burst release of drugs. Sustained release is possible by blending of hydrophilic and hydrophobic polymers. For example, the adding of hydrophilic polymers, such as gelatin, polyethylene glycol (PEG), and polyvinyl alcohols (PVAs) has an important effect on improving the sustained release of drugs. For time controlled drug release, layer by layer electrospinning is preferred. On the other hand, polymer nanofiber is also used in energy scavenging application. PVDF polymer has four crystalline phase(α, β, ɣ and δ) depending on the polymer chain conformation structure. It is normally present in alpha phase (non polar phase). When it is electrospun into nanofiber, it becomes piezoelectric and electroactive (β and ɣ). PVDF based nanogenerator is also used for generating power from renewable resources [15] and can be used as power source for biomedical devices [16].

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COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Kulkarni M, Mazare A, Gongadze E, Perutkova Š, Kralj-Iglič V, Milošev I, Schmuki P, Iglič A, Mozetič M. Titanium nanostructures for biomedical applications. Nanotechnology. 2015;26:6.
2. Martin CR. Membrane based synthesis of nanomaterials. Chem. Mater. 1996;8: 1739–1746.
3. Ma PX, Zhang R. Synthetic nanoscale fibrous extracellular matrix. J. Biomed. Mater. Res. 1999;46:60-72.
4. Ondarcuhu T, Joachim C. Drawing a single nanofiber over hundreds of microns. Europhys. Lett. 1998;42:215-220.

5. Whitesides GM, Grzybowski B. Self assemble at all scales. Science. 2002; 295:2418-2421.
6. Huang ZM, Zhang YZ, Kotaki M, Ramakrishna S. A review on polymer nanofibers by electrospinning and their application in nanocomposites. Compos. Sci. Tech. 2003;63:2223-2253.
7. Bera B. Literature review on electrospinning process (A fascinating fiber fabrication technique). Imperial Journal of Interdisciplinary Research (IJIR). 2016;2:8.
8. Audrey Frenot, Ioannis S. Chronakis. Polymer nanofibers assembled by electrospinning. Current Opinion in Colloid & Interface Science. 2003;8(1):64-75.
9. Stoyko Fakirov, Yue-E Miao, Tianxi Liu. Electrospun biopolymer nanofibers and their composites for drug delivery applications. DOI: 10.1002/9783527656950.ch11
10. Binoy Bera, Dipankar Mandal, Madhumita Das Sarkar. Porous silicon and its nanoparticle as biomaterial: A review. Imperial Journal of Interdisciplinary Research (IJIR). 2016;2(11):4.
11. Binoy Bera. Nanoporous silicon prepared by vapour phase strain etch and sacrificial technique. International Journal of Computer Applications (0975 – 8887), International Conference on Microelectronic Circuit and System (Micro). 2015; 42-45.
12. Binoy Bera, Madhumita Das Sarkar. Piezoelectricity in PVDF and PVDF based piezoelectric nanogenerator: A concept. IOSR Journal of Applied Physics (IOSR-JAP). 2017;9(3):95-99.
13. Hamia KE, Ribbea A, Isodab S, Matsushigea K. Structural analysis of the P (VDF/TrFE) copolymer film. Since direct J. Chemical Engineering Science. 2003;58: 397-400.
14. Binoy Bera, Madhumita Das Sarkar. Gold nanoparticle doped PVDF nanofiber preparation of concurrently harvesting light and mechanical energy. IOSR Journal of Applied Physics (IOSR-JAP). 2017;9(3): 05-12.
15. Binoy Bera, Madhumita Das Sarkar. PVDF based Piezoelectric Nanogenerator as a new kind of device for generating power from renewable resources. IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE). 2017;4(2):01-05.
16. Venugopal J, Ramakrishna S. Applications of polymer nanofibers in biomedicine and biotechnology. Appl Biochem Biotechnol. 2005;125(3):147-58.

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