Electrospinning and Piezoelectric Nanofibers

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DOI: 10.5185/vpoam.2020.0830

Graphical Abstract
Abstract
Electrospinning is a simple but efficient method to prepare polymeric nanofibers, and electrospun nanofibers have shown broad applications in diverse fields, ranging from biomedical, healthcare, and chemical engineering to electronics, environmental protection, energy, and functional textiles [1]. In the recent decade, significant progress has been made in the mass production of nanofibers using electrospinning. Various electrospinning designs are developed, and their commercialization promotes the practical applications of both electrospinning technology and electrospun nanofibers. Moreover, some unique properties have been observed on electrospun nanofibers, especially in the conversion of mechanical forces, vibrations, and sounds into electrical energy. Our team started working on electrospinning since 2004. We explored several aspects of this technology and developed unique needleless setups for making nanofiber nonwoven membranes and continuous nanofiber yarns [2]. Some of the setups are already used in commercial areas. We also uncovered that electrospun nonwoven membranes from polyvinylidene fluoride (PVDF) have a strong piezoelectric property, and no poling is required for the preparation of the piezoelectric membranes [3]. Piezoelectric nanofiber membrane could be used to convert mechanical energy, sound, and noise into electrical power [4]. The electrospun PVDF membranes have over four times higher electric outputs than their piezoelectric film counterparts. Electrospinning can realize the piezoelectric potential of polymer materials. For example, under the same conditions, the piezoelectricity of electrospun polyacrylonitrile is greater than that of electrospun PVDF [5]. This lecture will introduce the research activities of our team in the development of needleless electrospinning and piezoelectric nanofibers.

Keywords: Electrospinning, nanofibers, piezoelectric, acoustoelectric.

References
Biography of Presenting Author

Tong Lin obtained a Ph.D. in physical chemistry from the Chinese Academy of Sciences in 1998. Since 2013, he has been a Professor and Personal Chair of Deakin University. Before that, he served as a Research Academic, Senior Research Fellow, and Associate Professor at the Deakin University. Prof Lin has been an active researcher in the field of electrospinning, functional fibers, and polymers. He contributes to the development of needleless electrospinning technology for large-scale production of nanofibers and novel applications of nanofiber materials in various fields. Prof Lin has authored or co-authored over 270 peer-reviewed journal articles, 37 books/book chapters, and 90 other papers. Based on the Google Scholar database, the total citation of his publications is over 12,400, with an h-index over 61. Prof Lin has also been awarded the Australian Research Council (ARC) Future Fellow and Fellow of the Royal Society of Chemistry (RSC, UK).

Citation of Video Article


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The piezoelectric behavior of PVDF nanofibers can be improved by addition of carbon nanomaterials such as carbon allotrope fullerenes (C60) and single- and multiwalled carbon nanotubes. These additives can improve the crystalline nature and electrical conductivity thereby increasing the optimum performance of PVDF nanofibers. Electrospinning technique using PVDF is a promising tool for both aligned and random nanofibers, and the characterization techniques used for the analyses of the fabricated fibers are also discussed. A survey on the relevant applications in these fields is also done which is greatly helpful for our future experimental studies and developments. Biodegradable nanofiber-based piezoelectric transducer. Eli J. Curry, Thinh T. Le, Ritopa Das, Kai Ke, Elise M. Santorella, Debyon Paul, Meysam T. Chorsi, Khanh T. M. Tran, Jeffrey Baroody, Emily R. Borges, Brian Ko, Asiyeh Golabchi, Xiaonan Xin, David Rowe, Lixia Yue, Jianlin Feng, M. Daniela Morales-Acosta, Qian Wu, I-Ping Chen, X. Tracy Cui, Joel Pachter, and View ORCID ProfileThanh D. Nguyen. A few researchers have utilized electrospinning to create flexible PLLA piezoelectric nanofiber films (23–25), but the reported works struggle with major limitations. First, these reports lack appropriate material processing to stabilize the nanomaterial or utilize the shear-piezoelectric mode (i.e., d14) of PLLA for an optimal piezoelectric performance. Electrospinning of nanofibers and their applications. The parameters governing electrospinning process are given in Figure 9. Solution Parameters: viscosity, conductivity, molecular weight, molecular weight distribution, surface tension, polymer structure, solution properties. Process Parameters: applied electric field, tip to collector distance, feeding or flow rate, hydrostatic pressure in the capillary, plate movement. Ambient Parameters: humidity and temperature of the surroundings, solution temperature, air flow rate. Figure 9: Electrospinning process parameters. The characteristics of electrospinning and Electrospun Nanofibers (.). Lefayet Sultan Lipol, Md. Moshiur Rahman. The mixture of the cell and the salt (solution) on nanofibers surface increases attraction power of the cell because of salt and there may be some porosity as well on the cell. Salt gives away the cell in solution. Then these cells attract other cells to adjust with it [3]. Electrospinning results in nanofi-bers laid is in the form of nanofi-bers, (2) both drug and carrier down in a layer that has high porosity but very small are nanofi-ber-form, hence the end product will be the pore size, providing good resistance to the penetration two kinds of nanofi-bers interlaced together, (3) the of chemical harm agents in aerosol form [60]. For a nanofi-brous devices piezoelectric [128]. Electrospun precise measurement, two fi-bers crossing to each other polymer nanofi-bers could also be used in developing on the surface are generally chosen. The upper hor-functional sensors with the high surface area of nanofi—izontal tangent of the lower fi-ber is taken as a reference, bers facilitating the sensitivity.