Science and engineering of electrospun nanofibers for advances in clean energy, water filtration, and regenerative medicine

Ramakrishna, S.[a,b,c], *Jose, R.*[a,d], *Archana, P.S.*[a], *Nair, A.S.*[a], *Balamurugan, R.*[a], *Venugopal, J.*[a], *Teo, W.E.*[a]

[a]Healthcare and Energy Materials Laboratory, National University of Singapore, Singapore 117576, Singapore

[b]Institute of Materials Research and Engineering (IMRE), A-STAR, 3 Research Link, Singapore 117602, Singapore

[c]King Saud University, Riyadh 11451, Saudi Arabia

[d]Faculty of Industrial Science and Technology, Universiti Malaysia Pahang, Pahang 26300, Malaysia

ABSTRACT

Nanostructured materials with high aspect ratio and one-dimensional (ID) morphology are nature's choices when high degree of functional performances and flexible properties are concerned. Two examples are extracellular matrices in tissues of living organism, and light harvesting rods of the retina and chlorophyll. Electrospinning (E-spinning) is a simple processing technique that allows fabrication of high aspect ratio nanofibers (NFs) in a commercial scale. Electrospun nanofibers (E-spun NFs) combine a number of physical properties such as guided electron transport, strain-induced electronic properties, high mechanical strength, high degree of flexibility, large specific surface area, high electron and thermal diffusivity, and tailorable pore distribution. Our laboratory has been involved in fabrication of E-spun polymeric, inorganic, and polymer-nanocomposite fibers in random, aligned, crossaligned, sheaths, tubes, yarns, core/shell, and trilayer morphologies. This article focuses on application of the E-spun fibers in the areas of clean energy, water treatment, and regenerative medicine in the authors' laboratory. In addition, the article briefly reviews the progress made in these areas using E-spun NFs.

Keywords: Clean energy; Electrospun nanofibers; Regenerative medicine; Nanofibers; water filtration

ACKNOWLEDGEMENTS

Authors acknowledge fellow colleagues at the Healthcare and Energy Materials Laboratory, Nanoscience and Nanotechnology Initiative, National University of Singapore. Photovoltaic and lithium ion battery researches are supported by the National Research Foundation, Singapore through the clean energy program office (NRF-CRP4-2008-03) and Competitive Research Project (NRF2007EWT-CERP01-0531). The clean water program is supported by the Environment and Water Industry (EWI) Development Council, Government of Singapore through the funded project 'Development of low pressure, high flux UF and NF membranes based on electrospun nanofibers for water treatment (EDB (EWI)-0601-IRIS-062-04)''. The clean regenerative medicine program is supported by NRF—Technion project (R-398-001-063-281).