氏名	JATOI ABDUL WAHAB
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（エレクトロスピニングによる抗菌性・着色性機能ナノファイバーの開発に関する研究）

論文審査委員	主査　教　授　倪　慶清
	教　授　玉田　靖
	教　授　金　翼水
	教　授　後藤　康夫
	教　授　YAO JUMING　（浙江理工大学）

論　文　内　容　の　要　旨

In this research polymer/silver nanoparticle composite nanofibers and ultrasonic dyeing have been investigated for antibacterial properties and functional colored applications of electrospun nanofibers. For antibacterial activities cellulose acetate (CA) and polyvinyl alcohol (PVA) based AgNP composite nanofibers were fabricated. The CA/AgNP composite nanofibers were successfully prepared by dopamine process, heat treatment and DMF assisted process for generation of AgNPs on deacetylated electrospun CA nanofibers. The dopamine method is an environmentally green process for synthesis of AgNPs while the heat treatment and DMF methods were effective and efficient in generating well dispersed fine sized (<10nm) AgNPs having higher contents and good spatial distribution on CA surfaces. Although CA/AgNP composite nanofibers have been excellent in antibacterial activities due to surface functionalized AgNPs, however, AgNPs on the surface may induce detrimental side-effect such as carcinoma, argeria, argyrosis and allergies due to prolonged exposure and excess release of silver ions. At the same time produce comparatively limited time antibacterial activities due to rapid depletion of silver. Thus to avoid these detrimental side-effects and achieve extended time antibacterial performances research was extended to synthesize AgNPs immobilized TiO 2 , multiwall carbon nanotubes (CNTs), silica nanoparticles and ZnO nanoparticles to fabricate CA/TiO 2 /AgNP, CA/CNT/AgNP, PVA/silica/AgNP and CA/ZnO/AgNP composite nanofibers for biologically safer and extended time antibacterial applications. The antibacterial assays were conducted against E. coli and S. aureus bacterial strains. All the composite nanofibers demonstrated adequately higher antibacterial properties (halo width measured via Kirby-Bauer disk diffusion test method) and long time liquid medium bacterial growth inhibition properties for the tested times.
The CA/TiO 2 /AgNP composites were successful in antibacterial activities for upto 72 hours. The CA/CNT/AgNP was investigated for upto 48hours and found effective against both the strains. Thus the CA/TiO 2 /AgNP, CA/CNT/AgNP and PVA/silica/AgNP composite nanofibers could be used for safer and extended time antibacterial applications.

The ultrasonic dyeing method for coloration of electrospun nanofibers have been used for dying of polyurethane (PU), polyacrylonitrile (PAN) and Nylon-6 nanofibers.

Generally coloration of nanofibers has been challenging in achieving higher color strengths due to scattering of high proportion of light from nanofiber surfaces owing to their very high surface to volume ratio and nano scale diameters. The ultrasonic energy helps in ensuring higher dye-uptakes may be due to breaking of dye aggregates and high mass transfer from dye solution to into the nanofibers due to the effect of ultrasonic cavitations. Process parameters such as dyeing time, dyeing temperature and dye concentrations were optimized for PU, PAN and Nylon-6 nanofibers. The optimal process time and temperature for ultrasonic dyeing of PU were 40 minutes and 70 0 C. For ultrasonic dyeing of PAN, the optimized process time and temperatures were 80 0 C and one hour. While for Nylon-6 the optimized time and temperatures were 30minutes and 80 0 C. Furthermore, for all the three studied nanofibers, ultrasonic dyeing did not significantly affect morphology, chemical structure and crystallinity of the nanofibers. Mechanical strength of all the three nanofibers was increased by ultrasonic dyeing method. Thus due to improved dye up-take, dyed PU, PAN and Nylon-6 nanofibers could be utilized in functional colored applications.