博　士　論　文　の　内　容　の　要　旨
Abstract of Doctoral Dissertation

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This thesis covers various applications of nanomaterials and polymeric nanofibers, especially facemask filters, antibacterial wound dressing, and skincare applications. Following passages summarize the research in detail.

Shortage of face masks has been a current critical concern since the emergence of coronavirus-2 or SARS-CoV-2 (COVID 19). In our work, we compared the melt-blown (MB) filter, which is commonly used for the N95 face mask, with nanofiber (NF) filter, which is gradually used as an effective mask filter, to evaluate their reusability. Extensive characterizations were performed repeatedly to evaluate some performance parameters, which include filtration efficiency, airflow rate, and surface and morphological properties, after two types of cleaning treatments. In the first cleaning type, samples were dipped in 75% ethanol for a predetermined duration. In the second cleaning type, 75% ethanol was sprayed on samples. It was found that filtration efficiency of MB filter was significantly dropped after treatment with ethanol, while the NF filter exhibited consistent high filtration efficiency regardless of cleaning types. In addition, the NF filter showed better cytocompatibility than that of the MB filter, demonstrating its harmlessness on the human body. Regardless of ethanol treatments, surfaces of both filter types maintained hydrophobicity, which can sufficiently prevent wetting by moisture and saliva splash to prohibit not only pathogen transmission, but also bacterial growth inside. Based on these comparative evaluations, it is highly recommended the wider use of the NF filter for face mask applications, which can be reused multiple times with robust filtration efficiency. It would be greatly helpful to solve the current shortage issue of face masks and significantly improve safety for front line fighters against coronavirus disease.

In another research a novel antibacterial wound dressing was prepared and then characterized for required testing. We loaded Silver sulfadiazine (AgSD) for the first time on electrospinning. AgSD was added in zein (0.3%, 0.4%, 0.5%, and 0.6% by weight) and was electrospun to fabricate nanofiber mats for wound dressing. Nanofiber mats were characterized by Fourier transform infrared spectroscopy (FTIR) to check if there was any chemical reaction between AgSD and zein. Morphological properties were analyzed by Scanning Electron Microscope (SEM), which showed uniform nanofibers without any bead formation. Diameter of nanofibers was gradually decreased with increasing amount of AgSD, which can be associated with strong physical bonding between zein and AgSD. Thermal properties of nanofiber mats were analyzed by Thermo gravimetric Analyzer (TGA). X-Ray Diffraction (XRD) further declared crystalline structure of nanofiber mats, and X-Ray Photo spectroscopy (XPS) was performed to confirm Ag and S contents in prepared wound dressing. In order to investigate antibacterial properties, disc diffusion method was carried out. Bacillus and E-Coli bacteria strains were used as gram-positive and gram-negative respectively. The antibacterial effectiveness of AgSD released from zein nanofibers was determined from the zone inhibition of the bacteria. The antibacterial

activity of zein nanofibers loaded by drug observed with both strains of bacteria in comparison to control. Excellent antibacterial efficacy was attributed to sample with 0.6% AgSD. Excellent release properties were also associated with sample with 0.6% AgSD in zein nanofibers. Keeping in view above mentioned characteristics, prepared nanofiber mats would be effective for the application of wound dressing.

The fabrication of skin-care products with therapeutic properties has been a significant for human health trends. In our recent research, we developed an efficient hydrophilic composite nanofibers (NFs) loaded with the folic acid (FA) by electrospinning and electrospraying process for tissue engineering or wound healing cosmetic applications, as well. The morphological, chemical, thermal characteristics, in vitro release study, and cytocompatibility of the resulting composite fibers with the same amount of folic acid were analyzed. The SEM micrographs indicated that obtained nanofibers were in the nanometer range, with an average fiber diameter of 75-270 nm and a good porosity ratio (34-55%). TGA curves displayed that FA inhibits the degradation of the polymer and acts as an antioxidant at high temperatures. Unlike the electrospinning process more physical interaction between FA and matrices has been shown to occur in the electrospray process. A UV-Vis in-vitro study of FA-loaded electrospun fibers for an 8 hours in artificial acidic (pH 5.44) and alkaline (pH 8.04) sweat solutions exhibited a rapid release of FA-loaded electro-spun fibers, and showing the effect of polymer matrix-FA interactions and fabrication process on its release from the nanofibers. PVA-Chi/FA webs have the highest release value with 95.2% in alkaline media. In acidic media, the highest release (92%) was occurred on the PVA-Gel-Chi/sFA sample and followed first-order and Korsmeyer-Peppas kinetic models. Further, the L929 cyto-compatibility assay results pointed out that all NFs (with/without FA) generated have no cell toxicity, on the contrary, FA in the fibers provides cell growth. Therefore, the nanofibers are a potential candidate material in skin-care and tissue engineering applications.