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MODIFICATION OF POLYESTER FIBROUS MATERIALS

In the doctoral thesis, polylactide (PLA) nonwovens with average fiber diameters ranging from 0.9 to 7 μm were obtained using the solution electrospinning method and modified. Commercial PLA, poly(L-lactide) (PLLA) and poly(D-lactide) (PDLA) as well as synthesized in CMMS PAS star-shaped PDLA with methylated β-cyclodextrin as the core and quercetin attached by inclusion complexation, and with dipentaerythritol as the core and quercetin, were used. Additionally, PLLA covalently attached onto functionalized multi-walled carbon nanotubes (MWCNT-OH) synthesized in CMMS PAS was employed. Quercetin, multi-walled carbon nanotubes (MWCNT) and linear poly(silsesquioxane) with methoxycarbonyl side groups (LPSQ-COOMe) were used as additives to the polymer solution. A method of modifying electrospun fibers by deposition of MWCNT on fiber surfaces was also used. For the first time, poly(ethylene 2,5-furandicarboxylate) (PEF) nonwovens were produced by the solution electrospinning method, and a selected nonwoven was modified through a two-step chemical reaction with (3-mercaptopropyl)methyldimethoxysilane and silver nitrate.

The structure of nonwovens was analyzed by scanning electron microscopy (SEM), whereas their thermal properties by differential scanning calorimetry (DSC) and thermogravimetry (TGA). The mechanical properties of nonwovens during stretching and their water wettability were also examined. X-ray and spectroscopic methods were also used in the research. The electrical surface resistivity of the nonwovens was measured and also impedance spectroscopy was conducted. The antibacterial activity of nonwovens was also tested with the agar diffusion plate test, and SEM was used to analyze the surfaces of the nonwovens that were in contact with bacteria-inoculated agar.

Electrospinning nonwovens from star-shaped PDLA with quercetin, blends of star-shaped PDLA with quercetin and commercial PLA in a 1:1 weight ratio, as well as the addition of quercetin to the PLA solution allowed for the production of nonwovens containing 0.2 – 1.3 wt. % of quercetin. The presence of quercetin imparted antibacterial activity to the PLA nonwovens. Furthermore, the addition of MWCNT and LPSQ-COOMe increased the mechanical strength. PLLA nonwovens containing of 0.1 wt. % of MWCNT and 10 wt. % of LPSQ-COOMe exhibited tensile strength 2.4 times greater than that of pure PLLA nonwoven.

In addition, nonwovens of commercial PLA and a blend of PLLA and PDLA were obtained and crystallized. The blend of PLLA and PDLA crystallized in the form of stereocomplex. The modification of crystallized nonwovens by deposition of MWCNT on the fiber surfaces through padding or dip-coating in an aqueous MWCNT suspension enabled imparting electrical conductivity to the nonwovens. The electrical surface resistivity of such modified nonwovens ranged from 0.1 to 1.7 kΩ/sq and depended primarily on the method of MWCNT deposition. Fiber surface roughness was modified by etching with sodium hydroxide, and its influence on the modification and electrical properties was studied.

PEF nonwovens were obtained by solution electrospinning and characterized. The variation and optimization of electrospinning conditions allowed the production of nonwovens composed of fibers with different diameters, with average values ranging from 0.18 to 2.3 μm. Furthermore, chemical modification by a two-step reaction with (3-mercaptopropyl)methyldimethoxysilane and silver nitrate allowed the formation of silver particles on the fiber surfaces, imparting antibacterial activity to the nonwovens.