

This dissertation investigated methods for obtaining novel functional materials with antibacterial and antibiofilm properties. In this work, supercritical carbon dioxide was used as a solvent in supercritical impregnation and supercritical grafting processes.

Supercritical impregnation with carvacrol of polyamide membranes was carried out under process conditions of 40°C pressures of 10, 15, and 20 MPa for 1-6 hours. The potential use of carvacrol-loaded membranes as a filter and a source of an antibacterial agent in open surgical wounds was investigated. The release of carvacrol into carbon dioxide, which is used in surgical wound insufflation was determined. In addition, SEM-FIB studies showed that loading carvacrol up to 43 wt% had a minor effect on the functionality of the membrane. An open chest cavity model was created in which a membrane with 30-34 wt% carvacrol loading emitted the active substance into the model. Microbiological tests showed a 27% reduction in bacterial contamination compared to standard membranes. Supercritical carvacrol impregnation of cellulose acetate membranes was carried out at process conditions of 40°C, pressures of 15 and 20 MPa, and for 0.5-3 hours. Carvacrol-impregnated cellulose acetate microfiltration membranes were tested in cross-filtration to evaluate the effect of active substance loading on the membrane's filtration properties. Membranes loaded at a maximum of 25% retained their original porous structure. Flow cytometry studies of the effect of carvacrol on bacterial deposition on the membrane surface during cross-filtration showed a decrease in *S. aureus* deposition from $\sim 10^7$ to $\sim 10^5$ bacteria/(cm²·mL). Membranes containing 20% and 25% carvacrol had the highest permeate flux and the smallest number of deposited bacteria. The membrane with 25% carvacrol had the most dead bacteria (42%). Modeling showed that the pore-blocking mechanism changed with increasing carvacrol content, moving from cake filtration through intermediate to standard and total blocking models.

The second method of material modification studied was grafting in the supercritical phase. The process involves chemical attachment of the active substance to the polymer structure. For this purpose, three quaternary ammonium compounds were synthesized: N-(2-hydroxyethyl)-N,N-dimethylundecan-1-amine bromide (QAC 1), N-(11-hydroxyundecanyl)-N,N-dimethyltetradecan-1-amine bromide (QAC 2) and N-(11-hydroxyundecanyl)-N,N-dimethylundecan-1-amine bromide (QAC 3). QAC 1 and QAC 2 were grafted to cellulose acetate in a two-step reaction to cellulose acetate using hexamethylene diisocyanate linker at conditions of 30 MPa and 70 MPa. In a similar process, QAC 2 and QAC 3 were attached to the structure of starch-chitosan blends. Surface wettability studies of the materials showed an increase in hydrophobicity after the grafting process. The reaction time was investigated. Further characterization of grafted cellulose acetate showed a decrease in crystallinity, the presence of a rugged surface and preservation of the original compact polymer structure. It was also shown that modification using supercritical carbon dioxide occurred throughout the whole polymer volume. Microbiological tests showed the adhesion of *S. aureus*, MRSA, *E. coli* and *S. Enteritidis* to cellulose acetate material grafted with QAC 2 was impossible.