SYNTHESIS AND CHARACTERIZATION OF NOVEL SOY PROTEIN-NANOCELLULOSE COMPOSITE AEROGELS

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Aerogels, porous materials with low density, from cellulose nanofibrils (CNF) and soy proteins (SPs) were produced by freeze casting with the objective of optimizing the production procedure to reduce defect formation in systems with relatively large sizes, because similar previous efforts have produced materials with dimensions limited to a few millimeters. These newly developed green materials, which are based on two important and widely abundant renewable resources, are unique for their low density, high surface area and low thermal conductivity, suggesting their possible use in the design of thermal insulators, porous catalysts for chemical processes, porous filters, packaging fillers, oil spill sorbents and flotation mechanisms.

Aerogels composed of CNF and SP with different composition were produced and characterized by compression tests, morphology analysis, density measurements, surface area, moisture sorption from air and liquid sorption. It was found that precursor hydrogels with initial total solids content of 8% can be easily processed into aerogels with apparent densities on the order of 0.1 g/cm3, by slow freezing. Lower densities are expected by using more diluted precursor systems. As the SP loading is increased, the morphology of the obtained aerogels transitions from fibrillar to interconnected leaf-like elements.

It is demonstrated that replacement of the more expensive CNF with SP allows the production of aerogels with a multiplicity of chemical features resulting from the amino acid contribution that maintain a high compression modulus of 4.4 MPa even at SP loadings as high as ca. 70%. Equilibrium moisture of 4-5% of aerogels in air with 50% RH was affected to a limited extent by the composition. The physical integrity of the aerogels was maintained upon immersion in polar and non-polar solvents such as water and hexane, respectively. The liquid sorption rate was fast for hydrophobic solvents in all cases and it was modulated by the chemical composition of the aerogel in water sorption experiments, which generated swelling of the solid material after sorption. Further characterization and optimization is required to develop industrial uses of SP-CNF aerogels; nevertheless, this first approach shows promising properties for future actual uses of these environmentally friendly materials.