CONVERTING SOFTWOOD TO HARDWOOD WITH SUPERCRITICAL FLUIDS AND GAS-EXPANDED LIQUIDS

Paul Charpentier, Western University, Canada
pcharpen@uwo.ca
L. Yang, Western University, Canada
William Xu , Western University, Canada

Conversion of low-value softwood into high-value building materials is an important issue for sustainability in addition to economic growth. Impregnation of wood with polymeric materials by traditional vacuum-pressure process results in non-uniform distribution of materials in the pores of various sizes. Supercritical fluids have shown excellent diffusivity, near zero surface tension and excellent penetration which can be utilized in the process of densification of wood. In this work, we examined the ability of supercritical carbon dioxide (scCO_2) and CO_2 gas expanded liquids to transport poly(methyl methacrylate) (PMMA) polymer and methyl methacrylate (MMA) monomer, during *in-situ* polymerization into four different types of softwoods, i.e. cedar, western pine, eastern pine and costal hemlock, to make composite materials. The scCO_2 experimental conditions were investigated and optimized at temperatures of 40 and 50 °C, and pressures of 2000 and 4000 psi using AIBN as initiator. The optimum temperature and pressure were found at 50 °C and 4000 psi to obtain the maximum PMMA loadings of more than 30 wt%. The PMMA loading of more than 100 wt% was achieved by using CO_2 gas expanded MMA as the media to deliver MMA into the wood matrix at 50 °C and 200 psi. The material properties of the PMMA impregnated wood were analyzed by a variety of physico-chemical techniques including FTIR, SEM, and optical microscopy to understand the material composition and PMMA distribution within the softwood matrix. PMMA was found to be distributed throughout the porous wood matrix evenly, attributed to the transport properties of scCO_2. The material properties including heat stability, water resistance, dimensional stability and hardness were also investigated and found to be greatly improved for the PMMA impregnated wood compared to the unmodified softwood. Better improvement was achieved by more loading of PMMA. The supercritical CO_2 and CO_2 gas expanded MMA processes showed great promise as a novel and green technique for polymer impregnation of wood to achieve improved properties.