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Optical properties of freeze-dried partial delignified balsa wood

Radiative cooling (RC) is natural phenomenon in which an object passively cools itself by highly radiating mid-infrared waves to the cold outer space (temperature 3 K). The delignified wood (DW), in which light-absorbing lignin compounds in woods are removed from natural wood, shows promising performance of daytime radiative cooling (DRC). The drying of DW with hot pressing is usually considered as necessary step to return the strength to the DW. However, the hot-pressing results in the reduction of microscopic pores present in the DW. The absence of pores in DW may reduce either the solar reflection or the thermal emission of mid-infrared waves. In this study, we fabricated partial delignified woods (PDWs) from natural balsa wood. The delignification of balsa wood was performed with boiling hydrogen peroxide (H2O2) solution in renewable system. The quantities of lignin compounds in PDWs were varied via the boiling time. The PDWs were dried with freeze-drying process. We've found that the freeze-drying process can keep the shape and size of PDWs as shown in Fig. 1. We discussed the solar reflectance of PDWs by measuring the UV-Vis-NIR spectroscopy. The thermal radiation of mid-infrared waves from PDWs was also discussed by measuring the FTIR spectroscopy. Our findings give the fundamental understanding of freeze-dried partial delignified woods for the invention of novel wood composite materials for construction industry.

Keywords: daytime radiative cooling, hydrogen peroxide, freeze-drying, balsa wood

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