X-ray fluorescence microscopy as a tool to study the effects of moisture on ion transport in wood cell walls

USDA Forest Service, Forest Products Laboratory, Madison, WI, USA, 53726

S. Vogt, D. Vine, S.C. Gleber, S. Chen
X-ray Science Division, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL, USA 60439

Abstract:

Damage mechanisms in forest products such as wood decay and fastener corrosion are caused by exposure to excessive moisture. Recently we proposed that transport of ions and other chemicals through the wood cell walls controls the onset of this damage. Therefore, understanding the relationships between chemical transport, adsorbed moisture, and the cell wall structure is the key to developing the next generation of treatments and chemical modifications to enhance the durability of wood.

Here we present synchrotron X-ray fluorescence microscopy (XFM) results studying the effect of moisture on the transport of ions through wood cell walls. Two micron thick sections of wood were cut and ions (Zn, Cu, K, and/or Cl) were implanted into the wood cell walls. A custom-built relative humidity chamber was used so that the moisture content of the wood could be changed in-situ during the measurements. The XFM measurements had sub-micron resolution allowing differentiation of transport between the different cell wall layers. The results showed that for all ions there was a lower humidity threshold below which no observable ion transport occurred in the cell wall. The threshold humidity ranged between 60% and 90% and depended on the ion, type of cell wall, and cell wall orientation. This range of humidity also corresponds to the known onset humidity for wood decay and fastener corrosion, which supports the connection between the onset of these damage mechanisms and cell wall chemical transport. Naturally durable wood species and chemical modified wood (i.e. heat treatment and acetylation) were also studied to better understand relationships between cell wall molecular structure, decay resistance, and cell wall ion transport.