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Neutron/X-ray scattering studies of waterlogged archaeological wood

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Conservators tasked with preserving waterlogged archaeological wood, such as artifacts found at the bottom of lakes or seas, must use reversible treatments that impart structural soundness on the often heavily decayed objects. They must also provide historical wood with appropriate resistance against further biodeterioration. Current treatments, while reversible, do not necessarily protect wood against decay organisms. Thus, there is a need to find new conservation agents and methods that can deliver all required protection. However, detailed knowledge about the wood structure and the degree of its degradation is necessary to develop effective treatments tailored to a waterlogged wooden artifact's needs. Wood, being a hierarchical material, benefits from multi-scale studies. The nanoscale length scales are often the most difficult to access due to the inherent low contrast between the wood polymers. Small angle scattering has proven particularly useful to measure changes in the nanoscale features of wood as a function of moisture uptake or removal, chemical infiltration, and fungal exposure. Small angle neutron scattering (SANS), in particular, has revealed that water accessibility at the microfibril level plays a role in moisture durability, dimensional stability, and even the decay resistance of forest products. Wide-angle and small-angle X-ray scattering have been used to measure microfibril bundling sizes as well as microfibril alignment. Thus, here, we combine SAXS/SANS and WAXS to probe the nanostructure of archaeological wood samples in terms of microfibril aggregation/alignment and cellulose crystalline structure. These measurements have revealed that in heavily degraded samples, the characteristic microfibril alignment can be lost even when the characteristic diffraction peaks from cellulose are present. We expect these findings will help understand better the mechanisms of degradation and facilitate the development of new conservation treatments for waterlogged archaeological wood.

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