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Multiscale mechanics of bamboo

Youssefian, Sina, s.uefian@gmail.com; Rahbar, Nima, Worcester Polytechnic Institute, United States

ABSTRACT

Bamboo is a naturally occurring composite material in which cellulose fibers reinforce lignin matrix. In this research, a combination of nanoindentation experimental, theoretical model of toughening mechanism and finite element method have been used to study the physics and mechanical properties of bamboo. Because the interfacial adhesion between cellulose and lignin plays an important role in overall mechanical properties of bamboo, the nanoscale adhesion between these two materials is calculated by atomistic simulation. The results show low cellulose bridging fiber density within the interlaminar cracks in the outside crack orientation and high cellulose bridge densities in the inside crack orientation that are associated with strong resistance curve behavior. The outside layers with higher fiber density has higher modulus elasticity than the inside layers. The atomistic simulation results show high adhesion between cellulose and lignin, whereas the adhesion for crystalline cellulose was higher than amorphous cellulose. The insight obtained from this study can be used to improve cellulose-based polyvinyl alcohol composite.