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Anisotropic Thermally Conductive Composite with Wood-derived Carbon Scaffolds

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Abstract: In this study, we reported a thermally conductive composite with wood-derived 3D scaffold. The composites were easily fabricated by impregnating the polyamide-imide (PAI) into the wood scaffold and then in-situ carbonized. The well-aligned cellulose mircochannels in natural wood are maintained during the carbonization, leading to the improved anisotropic thermal conductive properties of the composite. The thermal conductivity of the composite reached 0.56 $W \cdot m^{-1} \cdot K^{-1}$ in cross-plane direction increasing by 250% and 0.22 $W \cdot m^{-1} \cdot K^{-1}$ in parallel direction, increasing by 37.5%, respectively. The unique structure of the composite also plays an important role in enhancing the mechanical performance. The Young's modulus of the composite in vertical direction reached to 451.9 MPa, 4-times higher than that of natural wood in the same orientation. The integrated performance of the composites could be attributed to the alignment of cellulose nanofibers inherited from the natural wood. This study will provide an innovative design and fabrication of composite for thermal management.

Key words: wood-polymer composite, anisotropic thermal conductivity, well-aligned structure

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