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Mechanical Behavior of Bio-inspired Model Suture Joints YANING LI, Department of Mechanical Engineering, ERICA LIN, CHRISTINE ORTIZ, Department of Materials Science and Engineering, MARY BOYCE, Department of Mechanical Engineering, BOYCE GROUP/MIT COLLABORATION, ORTIZ GROUP/MIT COLLABORATION — Suture joints of varying degrees of geometric complexity are prevalent throughout nature as a means of joining structural elements while providing locally tailored mechanical performance. Here, micromechanical models of general trapezoidal waveforms of varying hierarchy are formulated to reveal the role of geometric complexity in governing stiffness, strength, toughness and corresponding deformation and failure mechanisms. Physical constructs of model composite suture systems are fabricated via multi-material 3D printing (Object Connex500). Tensile tests are conducted on samples covering a range in geometry, thus providing quantitative measures of stiffness, strength, and failure. The experiments include direct visualization of the deformation and failure mechanisms and their progression, as well as their dependence on suture geometry, showing the interplay between shear and tension/compression of the interfacial layers and tension of the skeletal teeth and the transition in failure modes with geometry. The results provide quantitative guidelines for the design and tailoring of suture geometry to achieve the desired mechanical properties and also facilitate understanding of suture growth and fusion, and evolutionary phenotype.

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