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Lattice-Enhanced BoLattice-Enhanced Bonding: RVE-Derived Cohesive Laws for 3D-Printed Metal-Composite Jointsnding: RVE-Derived Cohesive Laws for 3D-Printed Metal-Composite Joints

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Adhesively bonded joints are a promising alternative to mechanical fastening but are prone to sudden catastrophic failure. Several methods have been developed for the toughening of bonded joints, such as surface pre-treatments, grading of the adhesive properties and structured interfaces among others.
In this work, we studied a Representative Volume Element (RVE) of a metal-composite co-molded joint with a Laser Powder Bed Fused (LPBF) printed lattice reinforcement. The RVE comprised a single lattice structure infiltrated by the composite material, namely a vinyl ester matrix Sheet Molding Compound (SMC).
The local orientation of the carbon fibers was obtained from a Computational Fluid Dynamics (CFD) simulation of the infiltration process, which was then used to map the properties of the composite adherends in the RVE. The metal-composite interfaces were modeled using cohesive elements, with traction-separation laws derived from Double Cantilever Beam (DCB) and End-Notched Flexure (ENF) tests.
The RVE was loaded in opening and shear to extract mode I and mode II homogenized traction separation laws. These laws were then used to model lattice-reinforced metal-composite joints with flat interfaces, incorporating the homogenized behavior of the lattice reinforcement.
The results showed that the homogenized laws properly capture the behavior of the reinforced joints, while significantly reducing the computational effort compared to a full-scale reinforced model.

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