

Jaan-Willem Simon

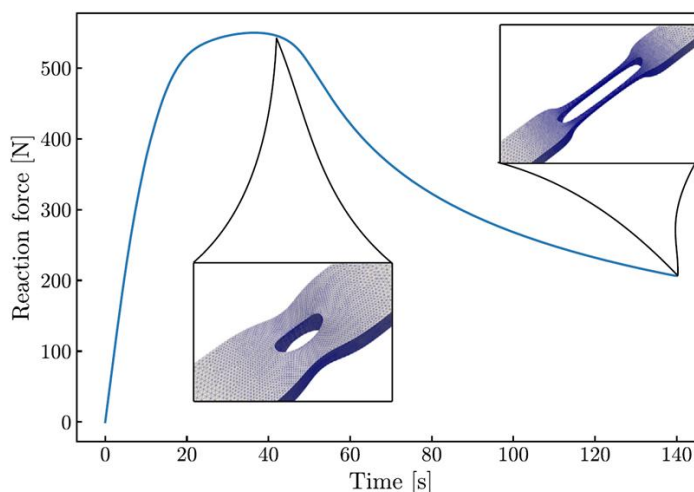
“Multiscale Analysis of Damage in Thermoplastic Fiber-Reinforced Composites”

The increasing demand for lightweight structures in transportation and related sectors has intensified the use of fiber-reinforced thermoplastic composites, driven by their short processing cycles, high toughness, and recyclability. However, their macroscopic performance is governed by complex damage-induced softening mechanisms originating in the thermoplastic matrix, which exhibits rate-dependent visco-elastoplastic behavior and large inelastic deformations. Reliable failure prediction remains challenging, particularly for woven thermoplastic composite laminates involving interacting mechanisms across multiple scales, as conventional multiscale approaches lose objectivity once softening occurs.

In this contribution, we employ a gradient-enhanced visco-hyperelastic-plastic matrix model within resolved composite microstructures. The gradient extension eliminates the pathological mesh dependence associated with softening, enabling mesh-objective microscale predictions under highly localized deformation. In computational homogenization, however, these localized responses lead to RVE-size-dependent effective behavior, a scale dependence that gradient regularization alone cannot resolve. We address this limitation using the failure zone homogenization scheme, which accounts for the finite extent of the failure zone and mitigates



Since 2022, Jaan-Willem Simon has been heading the Chair of Computational Applied Mechanics at the University of Wuppertal. Previously, he worked at RWTH Aachen University, where he led the research group Composite Materials and Structures at the Institute of Applied Mechanics. He completed his habilitation in 2018 and was appointed supernumerary Professor in 2019. He received his PhD with distinction from RWTH Aachen University in 2011, and he holds diploma degrees in Civil Engineering as well as Physical Engineering Sciences from TU Berlin, completed in 2005 and 2006, respectively, following a research stay at MIT. His research aims at optimizing materials and structures in terms of both composition and manufacturing processes to minimize material consumption. His projects involve collaborations with the NASA Glenn Research Center and numerous national and international partners from academia and industry. His current research focuses on computational material modeling of composites, particularly those based on renewable resources.



RVE-size sensitivity.

By combining mesh-objective microscale modeling with size-objective homogenization, the proposed framework establishes a physically consistent link between matrix-level damage and effective structural behavior, supporting predictive and scalable modeling of thermoplastic composite components under demanding loading conditions.