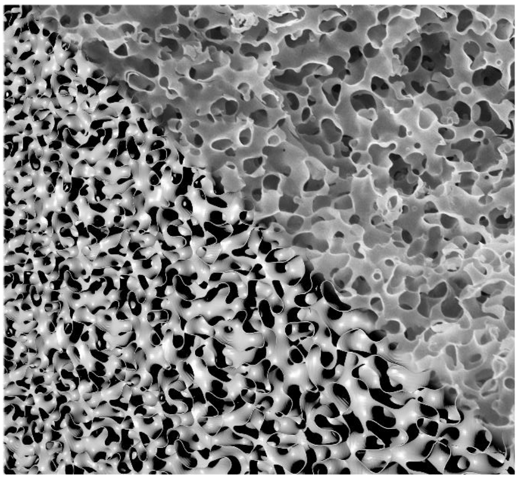
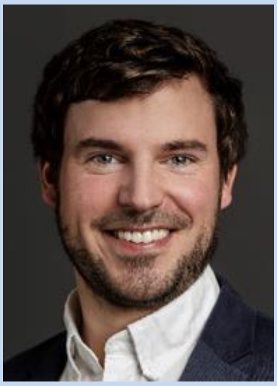
KTH SOLID MECHANICS SEMINAR; Tuesday, March 16th, 16.15; https://kth-se.zoom.us/j/64213067158

Dennis M. Kochmann's KEYNOTE seminar "Breaking with periodicity in architected cellular materials"

Tailoring the architecture of cellular materials – from random foams to periodic truss, plate and shell structures – has resulted in lightweight architected materials (or mechanical metamaterials) with beneficial properties. While periodic networks admit a simple prediction of their effective properties, they also come with significant disadvantages including the sensitivity to symmetry-breaking defects, limitations in spatially varying the unit cell design, and non-scalable fabrication. By contrast, nature is rich of non-periodic microstructures. So-called spinodal architectures are such examples, which evolve naturally during diffusion-driven self-assembly processes. Inspired by spinodal architectures, we introduce spinodoid topologies as an efficient theoretical description of "spinodal-like" structures. Following a simple mathematical parametrization, spinodoids have intriguing mechanical properties such as optimal stiffness scaling with density and a superb resilience due to their curvature distribution. They further cover an enormous property space in a seamless fashion, which enables multiscale topology optimization and spatially graded structures with locally optimized mechanical properties. To address the inverse challenge of identifying a microstructural architecture from the huge design space to achieve target effective properties, we demonstrate how a data-driven approach based on the integration of two neural networks can reliably and accurately generate foam-type cellular metamaterials with as-designed 3D anisotropy and density in a spatially uniform or functionally graded fashion. As an example, we highlight the suitability of this approach for the generation of bio-mimetic bone replacements. Finally, we present experimental prototypes of spinodoid architectures and discuss their extreme mechanical resilience at small scales.





Dennis Kochmann received his education at Ruhr-University Bochum and the University of Wisconsin-Madison. After postdoc positions at Wisconsin and Caltech, he joined the Aerospace Department at Caltech as Assistant Professor in 2011; from 2016 to 2019 he was Professor of Aerospace at Caltech. Since April 2017 he has been Professor of Mechanics and Materials at ETH Zürich, where he served as Head of the Institute of Mechanical Systems and is currently Deputy Head of the Department of Mechanical and Process Engineering. His research focuses on the link between structure and properties of a variety of (natural and architected) materials, which includes the development of theoretical, computational and experimental methods to bridge across scales from nano to macro. He was a Fulbright and Feodor-Lynen fellow, and his research has been recognized by, among others, the Bureau Prize in Solid Mechanics form IUTAM, the Richard von Mises Prize by GAMM, an NSF CAREER Award, ASME's T.J.R. Hughes Young Investigator Award, and an ERC Consolidator Grant.