Laura De Lorenzis
"Energy decompositions in variational phase-field modeling of brittle fracture"

In the past two decades, computational fracture mechanics has been revolutionized by the advent of the variational phase-field approach. This paradigm, which bears relation to Griffith's theory in classical fracture mechanics, to gradient damage models in continuum mechanics, as well as to phase-field models for phase transformations in computational material science, has opened the pathway to fracture and fatigue simulations of unprecedented flexibility, which is motivating an enormous interest from the academic and industrial worlds alike. For the simplest case of quasi-static brittle fracture in small deformations under predominant tension, the research field is by now quite mature: the available variational formulations are well understood; several groups worldwide have experimentally validated the approach in a variety of loading and geometry conditions; some open-source implementations are available online, a few of which suitable for use with commercial codes. However, for brittle fracture under multiaxial stress states, and especially in cases involving significant compression, the available formulations based on various energy decompositions are not yet satisfactory. In this talk, based on a recently submitted joint paper with F. Vicentini, C. Zolesi, P. Carrara and C. Maurini, staying within the realm of variational approaches, I will talk about the main issues with existing energy decompositions; ii. the requisites that an energy decomposition should satisfy in relation to both crack initiation and crack propagation; iii. a new energy decomposition that solves (at least partially) the issues with the existing ones.

Laura De Lorenzis received her Engineering degree and her PhD from the University of Lecce, where she first stayed as Assistant and later Associate Professor. In 2013 she moved to the TU Braunschweig as Professor and Director of the Institute of Applied Mechanics. There she was founding member and first Chair of the Center for Mechanics, Uncertainty and Simulation in Engineering. Since 2020 she is Professor of Computational Mechanics at ETH Zürich, where she currently serves as Deputy Head of the Department of Mechanical and Process Engineering. She was awarded a Fulbright Scholarship at Massachusetts Institute of Technology, an Alexander von Humboldt Fellowship at the Leibniz University of Hannover, the RILEM L'Hermite Medal, the AIMETA Junior Prize, the IIFC Young Investigator Award, an ERC Consolidator Grant, two best paper awards and two student teaching prizes at the TU Braunschweig. In 2022 she was elected EUROMECH Solid Mechanics Fellow. She authored or co-authored more than 130 papers on international journals on different topics of computational and applied mechanics.