Efficient computational methods to model non-linear material failure over multiple length scales will be presented. The first part of the presentation will focus on partition of unity methods for fracture on the macro-scale. In this context, the cracking particles method (CPM), the extended element-free Galerkin (XEFG) method and the phantom node method for cracks and shear bands in continua and structures will be explained.

The key idea of those methods is to introduce additional degrees of freedom into the variational formulation in order to account for the kinematics of cracks and shear bands. These methods will be extended to thermomechanical problems and fracture problems due to fluid-structure interaction in thin shells.

The second part of the presentation deals with multi-scale methods for fracture. Due to the ill-posedness of the underlying (initial) boundary value problem and the associated lack of scale separation, a concurrent multiscale approach will be discussed in order to couple a fine-scale model with a coarse-scale model. The coarse-scale model is based on continuum mechanics while an atomistic or continuum approach is employed at the fine-scale. Two different approaches based of the extension of the Arlequin-method and Bridging-Scale method will be presented. A simple and efficient algorithm to upscale cracks from an atomistic model to a continuum model will be proposed as well.
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Prof. Rabczuk obtained his PhD from the University of Karlsruhe. He worked at the Fraunhofer-Institute (Ernst Mach) in Freiburg before joining the Computational Mechanics Group of Prof. Ted Belytschko at Northwestern University in Evanston, USA, where he was working for 4 years as Post-Doctoral Fellow. For 1.5 years, Prof. Rabczuk was a member of the Computational Mechanics group of Prof. W.A. Wall at the Technical University of Munich. In February 2007, he was appointed Senior Lecturer at the Department of Mechanical Engineering at Canterbury University, Christchurch, New Zealand. In 2009, Prof. Rabczuk joined the Bauhaus University Weimar as Full Professor.