COMPLAS 2027

Invited Session on

Theory of fracture, crack propagation criteria, and crack tracking algorithms

Organized by

Anna Pandolfi, Politecnico di Milano, Italy

Kerstin Weinberg, University of Siegen, Germany

Michael Ortiz, California Institute of Technology, USA and UPC Barcelona, Spain

Cracks in brittle and quasi-brittle materials often initiate and grow in unpredictable ways when the material is subjected to complex combinations of loads. A central challenge is determining where a crack will form and how it will propagate, especially when multiple forces interact and lead to unstable or sudden failure.

Fracture mechanics provides mathematical tools to describe this process, which involves the creation of new surfaces inside the material at locations and orientations that are not known in advance. These theoretical models form the basis for numerical simulations, where accuracy can be assessed and improved through controlled computational strategies.

Crack growth is typically governed by physical criteria related to the material reaching its local strength limits. More recently, energy-based formulations have enabled the development of new computational approaches. Many widely used methods rely on finite element models, where cracks are explicitly represented by inserting discontinuities between or through elements. Phase-field methods have gained attention because they allow cracks to emerge naturally without tracking their geometry explicitly. Boundary element methods have also proven effective in certain cases. In addition, newer mesh-free approaches avoid the need to modify the computational grid as cracks evolve, simplifying implementation. Some advanced models combine multiple numerical techniques or operate across different scales to capture complex fracture behavior more accurately.

This invited session at COMPLAS aims to bring together researchers working on both theoretical and computational aspects of fracture. The goal is to discuss emerging methods for predicting crack initiation and tracking crack paths, as well as improvements and applications of established techniques.