20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

Towards advanced modeling of crack propagation in anisotropic materials thanks to Additive Manufacturing

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Paper ID: 442
Symposium S8: Fracture, and damage of materials

Abstract

Anisotropic materials are gaining importance in industry, driven by new applications and environmental concerns, from wood construction, single crystals for photovoltaic applications, or aerospace turbines, to materials manufactured by 3D printing. However, due to the lack of certified damage tolerance models guaranteeing their resistance to failure, their use in sensitive components where failure must be avoided at all costs is limited. The aim of my presentation is to show that the versatility of additive manufacturing enables the design of experiments to challenge advanced experimental and numerical approaches to fracture mechanics. To this end, I will present an overview of our recent studies on crack propagation in polycarbonate samples printed using fused deposition modeling. We chose this material specifically to fall within the framework of isotropic linear elastic fracture mechanics in order to focus on the effect of anisotropic fracture energy [1]. A close comparison between experiments and simulations led us to assess Digital Image Correlation for angular crack trajectories [2], to question crack propagation under monotonic [3] or cyclic loads for which different trajectories have been observed [4] (see S8 Ghita Bahaj-Filali talk), but also the numerical biases inherent in phase field simulations, even for isotropic materials [5, 6] (see S8 Flavien Loiseau talk).

Keywords:

Linear Elastic Fracture Mechanics Anisotropic fracture properties Fused Filament Fabrication Phase-field simulations

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