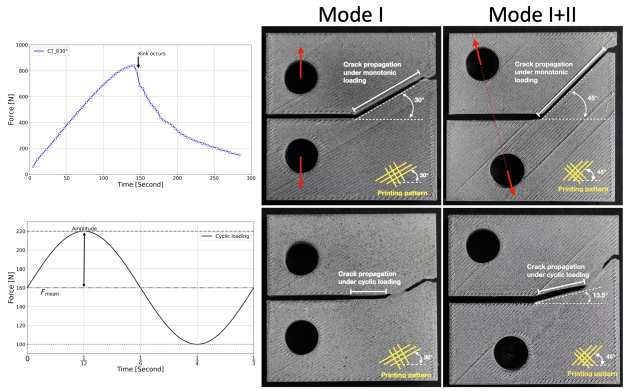
Master's internship and PhD proposal

Titre : Experimental and/or numerical study of fatigue crack propagation in anisotropic materials

Supervisor : Véronique LAZARUS (veronique.lazarus@ensta-paris.fr)

Hosting: IMSIA (ENSTA Paris/Department of Mechanics and Energetics IP Paris)



Scientific context: Due to the directional building process, additive manufacturing generally leads to anisotropic microstructures that highly influence crack propagation paths. It is thus crucial to be able to take this directionality into account in damage tolerance approaches. This is even essential to extend the use of additive manufacturing to sensitive components, for instance, in the field of aeronautics or aerospace where catastrophic failure has to be avoided at all costs. Benefits are expected in term of safety but also of carbon footprint reduction.

Several funded projects targeting this long term goal are currently in progress in our team. State-of-the-art experimental and numerical methods, together with an interdisciplinary mechanics-physics point of view, are geared toward (i) a deep and multi-scale understanding of the physical phenomena at play, and (ii) the development of safe, experimentally validated, mechanical methods to accurately predict crack propagation from fatigue to brittle fracture threshold. The methodology involves advanced and innovative tools, notably fracture experiments instrumented by Digital Image Correlation [1] in conjunction with variational phase-field approaches [2, 3].

Subject: In this context, we recently observed some unexpected crack propagation behavior in fatigue (see figure), that we aim to understand. As a first step, this internship aims to systematize these preliminary experimental results at different cyclic loading conditions. Thesis funding (ANR 3FAM) is available to extend this study theoretically, experimentally and numerically.

Collaborations: LMPS/ENS Paris Saclay, CIRCS/Northeastern university Boston

Candidate profile: Master 2 level student in physics, material or mechanical engineering. Some knowledge in fracture mechanics and a taste for physics will be appreciated.

Funding: secured within an academic collaborative project

Application procedure: Candidates should send a Curriculum Vitae and references to veronique.lazarus@ensta-paris.fr.

References

[1] Thomas Corre and Véronique Lazarus. Kinked crack paths in polycarbonate samples printed by fused deposition modelling using criss-cross patterns. *International Journal of Fracture*, 230(1):19–31, July 2021.

[2] Bin Li and Corrado Maurini. Crack kinking in a variational phase-field model of brittle fracture with strongly anisotropic surface energy. *Journal of the Mechanics and Physics of Solids*, 125:502 – 522, 2019.

[3] Benjamin E. Grossman-Ponemon, Ataollah Mesgarnejad, and Alain Karma. Phase-field modeling of continuous fatigue via toughness degradation. *Engineering Fracture Mechanics*, 264:108255, 2022.