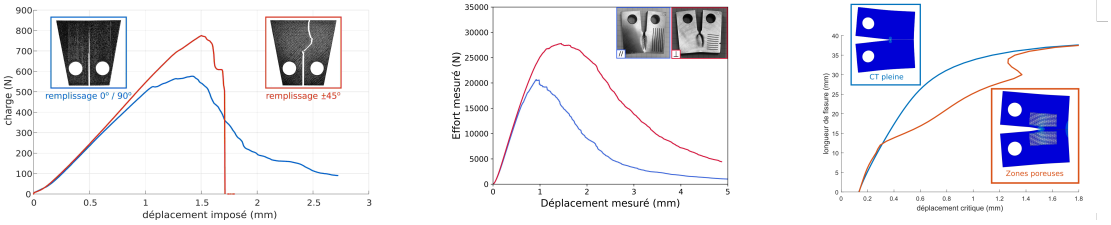
Postdoctoral position in fracture mechanics

Titre : Theoretical and numerical study of crack propagation in a heterogenous and/or anisotropic material

Responsable/contact : Véronique LAZARUS (veronique.lazarus@ensta.fr)

Host: ENSTA Paris / IP Paris (Centre Interdisciplinaire d'Etudes pour la Défense et la Sécurité, Department of Mechanics and Energetics, Department of Physics)



(a) Fused Deposit Modeling (postdoc T. Corre, projet Porocrack et thèse X. Zhai)

(b) Direct Energy Deposition (postdocs T. Corre et D. Roucou)

(c) Influence of a porous zone on the fracture resistance (Ph. D J. Triclot, INSA Lyon/ENSTA)

Figure 1: Influence of the microstructure on crack propagation

The durability of materials and structures is a major focus of the Institut Polytechnique de Paris. In particular, the FracAddi project (2023-27), aims to study the propagation of cracks in anisotropic and heterogeneous materials, from both an experimental and a theoretical point of view, with specific safety and environmental concerns, in the continuity of work in progress (see figures). It has received substantial financial support from the Direction Générale de l'Armement in terms of material and human resources, with the funding of two theses and around 70 months of postdoctoral position. It associates the departments of Mechanics (IMSIA, LMS) and Physics (PMC) of the Institut Polytechnique de Paris.

The postdoctoral fellow will participate to the theoretical and numerical parts of the project and take part in the supervision of the Ph.D students. He will have to develop fracture mechanics tools to deal with quasi-static and fatigue crack propagation in anisotropic and heterogeneous media. In line with previous studies, the tools will be based either (i) on classical Linear Elastic Fracture Mechanics [1] or (ii) on phase-field/variational approach to fracture [2, 3, 4]. We forcast to implement the models in Python using FEniCSx Partial Differential Equation solver. Particular attention will be given on the experimental determination of the material constants, at the macroscopic and microscopic scales. Extensive dialog between simulations and FracAddi experiments based on 3D printing facilities will aim to validate and enrich the models.

Skills: Ph.D in mechanics or physics of solids, structures or materials. Autonomy in computational mechanics. Self-motivation, enthusiasm for fundamental research and deep understanding. Taste for comparisons between experiments and theory. Good knowledge in continuum mechanics and if possible, in fracture mechanics. Good organisation and ability to work with people from different backgrounds.

When? The position may start as soon as possible. The duration of the position is forcasted for 24 months.

Application procedure: Resume including a list of publications, contact details of 2 referees, cover letter to be sent to veronique.lazarus@ensta.fr.

References

[1] X. Zhai, T. Corre, and V. Lazarus. A FDM-based experimental benchmark for evaluating quasistatic crack propagation in anisotropic linear elastic materials. *Engineering Fracture Mechanics*, 324(111175), 2025.

[2] B. Bourdin, G. Francfort, and J.-J. Marigo. The variational approach to fracture. *Journal of elasticity*, 91(1):5 – 148, 2008.

[3] X. Zhai, T. Corre, A. Mesgarnejad, A. Karma, and V. Lazarus. Path differences between quasistatic and fatigue cracks in anisotropic media. *Physical review E*, 110(6), 2024.

[4] Flavien Loiseau and Veronique Lazarus. How to introduce an initial crack in phase field simulations to accurately predict the linear elastic fracture propagation threshold? *Journal of Theoretical, Computational and Applied Mechanics*, Jun 2025.