Mathias **Lebihain**

UNDERSTAND THE EMERGENCE OF FRACTURE PROPERTIES FROM MICROSTRUCTURES AND MULTI-PHYSICS COUPLING

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Research experience

École des Ponts ParisTech – Laboratoire Navier *Champs-sur-Marne, Paris*

RESEARCH SCIENTIST *July 2021 – Today*

Permanent position as a researcher between the Geophysics and Multi-scale teams. Scientific project focused on the emergence of effective fracture and friction properties from microstructural heterogeneities and multi-physics coupling.

EPFL – Laboratoire Expérimental en Mécanique des Roches *Lausanne, Suisse*

POSTDOCTORAL SCIENTIST *January 2020 – July 2021*

Post-doctoral position between the LEMR of Marie Violay and the LSMS of Jean-François Molinari on the project "Coseismic off-fault damage characterization in crustal rocks". Developed homogenization techniques for rupture nucleation along faults with spatially varying frictional properties. Investigated the energy budget of thermally-driven ruptures during direct shear experiments. Designed tensile fracture tests to study the influence of crack velocity and stress biaxiality on the fracture energy of sandstones and carbonates.

Sorbonne Université – Institut Jean le Rond ∂'Alembert *Paris, France*

PH.D. STUDENT *September 2016 – December 2019*

Ph.D. thesis entitled "Large-scale crack propagation in heterogeneous materials : an insight into the homogenization of brittle fracture properties" conducted under the surpervision of J.B. Leblond, L. Ponson and M. Bornert. Developed a homogenization framework that predicts the macroscopic fracture properties of a composite material from the knowledge of its microscopic constituents. Designed statistical fractography analysis to extract failure parameters from the fracture surface roughness. Investigated to the dynamic fracture of heterogeneous 3D-printed polymers through Digital Image Correlation techniques.

EDF R&D – Département Analyses Mécaniques et Acoustiques *Clamart, France*

MASTER INTERN *March 2015 – July 2015*

Master internship supervised by Dr. The-Hiep Chau and Dr. Laïla Flandi. Conducted numerical simulations based on XFEM to investigate fatigue crack propagation under thermomechanical coupling of cracks located in primary pumps of a nuclear pressurized water reactor . Evaluated crack nocivity in such pumps depending on its depth, geometry and position.

CEA – Laboratoire de Comportement Mécanique des matériaux Irradiés *Saclay, France*

MASTER INTERN *Avril 2014 – Août 2014*

Master internship supervised by Dr. Matthew Bono. Conducted numerical simulations and experiments to characterize an expansion-due-to-compression test used in the study of irradiated cladding failure. Improved the test parameters to reproduce in-reactor stress triaxiality levels.

Formation

Sorbonne Université – ENPC *Paris, France*

PH.D. IN MECHANICS AND PHYSICS *2016 – 2019*

Ph.D. in Mechanics and Physics on the topic "Large-scale crack propagation in heterogeneous materials : an insight into the homogenization of brittle fracture properties".

École des Ponts ParisTech – AgroParisTech *Champs-sur-Marne, France*

MS IN PUBLIC POLICY *2015 – 2016*

MS in Public Policy and Sustainable Development for French state engineers enlisted in Corps des Ponts, des Eaux et des Forêts.

École des Ponts ParisTech – Sorbonne Université *Champs-sur-Marne, France*

MSC IN MECHANICS AND PHYSICS *2014 – 2015*

MSc "Durability of Materials and Structures" in Mechanics and Physics; Graduated with highest honors; GPA 4.0/4.0

École polytechnique *Saclay, France*

INGÉNIEUR POLYTECHNICIEN PROGRAM *2011 – 2014*

Multidisciplinary in-depth training in Pure and Applied Mathematics, Physics and Mechanics (MSc). Graduated with very high honors; GPA 3.97/4.0

Awards and funding

Awards

2022	**Prix AFM Paul Germain,** awarded to the best Ph.D. work in mechanics by the Association Française de Mécanique during the 25th French Mechanics Congress	*Nantes, France*
2018	**Euromech best young researcher,** awarded to the best oral presentation by Euromech during the 10th European Solid Mechanics Conference	*Bologna, Italy*

Funded research project

2021	**CNRS NEEDS,** NEEDS funding, awarded by the French CNRS for the exploratory project PoreFrac "Influence of hydromechanical couplings on the rupture of saturated porous materials" – 17k€	*POREFRAC*
2020	**SNF Spark,** Spark grant, awarded by the Swiss National Science Foundation for the project "Coseismic off-fault damage characterization in crustal rocks" – 100kCHF.	*COFRAC*

Publications

- Lebihain M., Roch T., Molinari J. F. (2022). Quasi-static crack front deformations in cohesive materials. Journal of the Mechanics and Physics of Solids, 168:105025
- Lebihain M., Leblond J. B., Ponson L. (2022). Crack front instability in mixed-mode I+III: the influence of non-singular stresses. European Journal of Mechanics – A/Solids, 104602
- Paglialunga, F., Passelègue, F. X., Brantut, N., Barras, F., Lebihain, M., and Violay, M. (2022). On the scale dependence in the dynamics of frictional rupture : Constant fracture energy versus size-dependent breakdown work. *Earth and Planetary Science Letters*, 584 :117442.
- Lebihain, M., Roch, T., Violay, M., and Molinari, J.-F. (2021). Earthquake nucleation along faults with heterogeneous weakening rate. *Geophysical Research Letters*, 48(21) :e2021GL094901.
- Lebihain, M., Ponson, L., Kondo, D., and Leblond, J.-B. (2021). Effective toughness of disordered brittle solids : A homogenization framework. *Journal of the Mechanics and Physics of Solids*, 153 :104463.
- Albertini, G., Lebihain, M., Hild, F., Ponson, L., and Kammer, D. S. (2021). Effective toughness of heterogeneous materials with rate-dependent fracture energy. *Physical Review Letters*, 127(3) :035501.
- Lebihain, M. (2021). Towards brittle materials with tailored fracture properties : the decisive influence of the material disorder and its microstructure. *International Journal of Fracture*, 230(1) :99–114.
- Lebihain, M., Leblond, J.-B., and Ponson, L. (2020). Effective toughness of periodic heterogeneous materials : the effect of out-of-plane excursions of cracks. *Journal of the Mechanics and Physics of Solids*, 137 :103876.

Conferences and seminars

Invited lectures and presentations

- 24ème Congrès Français de Mécanique, Brest, France. 2019

International conferences

- 25ème Congrès Français de Mécanique, Nantes, France. 2022
- AGU Fall Meeting 2022, Virtual congress. 2022
- 25th International Congress of Theoretical and Applied Mechanics (ICTAM20+1), Virtual congress. 2021
- 14th World Congress in Computational Mechanics (WCCM14), Virtual congress. 2021
- 24ème Congrès Français de Mécanique, Brest, France. *Invited keynote presentation*. 2019
- Scientific symposium in honor of Jean-Baptiste Leblond, Paris, France. 2019
- 110th European Solid Mechanics Conference (ESMC2018), Bologne, Italie. 2018.
- Euromech symposium, Séville, Espagne. 2018.
- International Conference on Fracture (ICF14), Rhodes, Grèce 2017.
- Conference on Computational Modeling of Fracture and Failure of Materials and Structures (CFRAC2017), Nantes, France. 2017.

Seminars

- GDR CNRS IDE, Zoom webminar. 2022
- Physics of Complex Systems Laboratory, EPFL, Lausanne, Switzerland. 2021
- Computational Solid Mechanics Laboratory, EPFL, Lausanne, Switzerland. 2019
- Journées scientifiques et techniques de l'AMAC, Marne-La-Vallée, France. 2019
- Rencontres Franciliennes de Mécanique, Paris, France. 2019
- Laboratoire Navier, ENPC, Marne-La-Vallée, France. 2018
- GDR CNRS MePhy, Paris, France. 2018