



HAL
open science

Microbranching instability using a variational phase-field model

Jeremy Bleyer, Jean-François Molinari

► **To cite this version:**

Jeremy Bleyer, Jean-François Molinari. Microbranching instability using a variational phase-field model. CFRAC 2017 Fifth International Conference on Computational Modeling of Fracture and Failure of Materials and Structures, 2017, Nantes, France. hal-01625627

HAL Id: hal-01625627

<https://enpc.hal.science/hal-01625627>

Submitted on 27 Oct 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

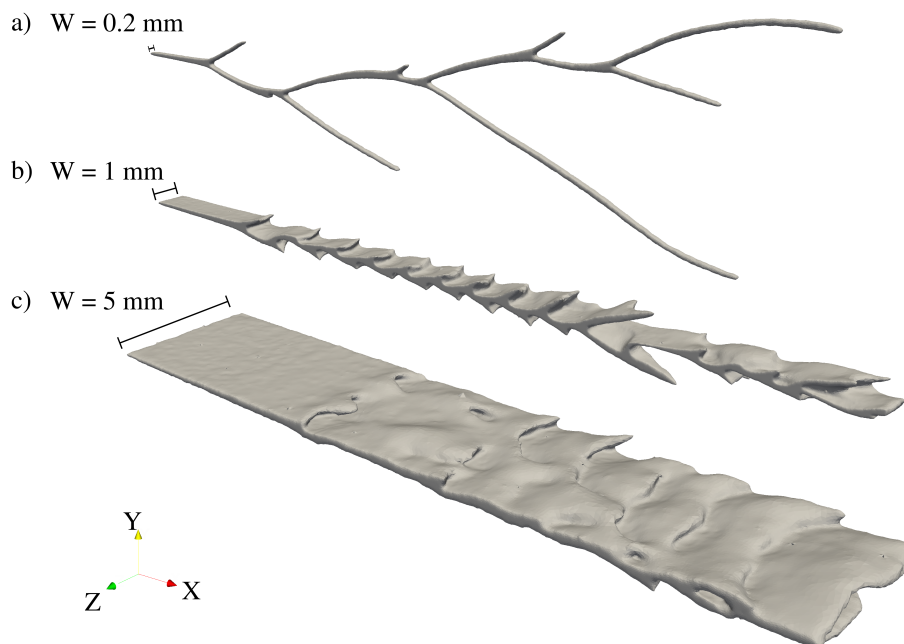
L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Microbranching instability using a variational phase-field model

J. Bleyer^{1,2}, J.F. Molinari²

¹ Université Paris-Est, Laboratoire Navier, (Ecole des Ponts-IFSTTAR-CNRS UMR 8205), jeremy.bleyer@enpc.fr

² Ecole Polytechnique Fédérale de Lausanne, Département de Génie Civil, {jeremy.bleyer,jean-francois.molinari}@epfl.ch



Many aspects of the microbranching instability [1] are not fully understood such as the difference of crack patterns observed in PMMA on one hand and glass or brittle gels on the other hand [2]. In this work, we simulate the microbranching instability of fast propagating cracks using a variational phase-field approach and show that three-dimensional effects are fundamental for understanding the origin of this instability.

In particular, following on a previous work regarding the branching mechanism in 2D phase-field simulations [3], we show that microbranching does not occur in 2D simulations or for very thin 3D samples and that different microbranching regimes are obtained when increasing the sample thickness, ranging from translationally invariant across the thickness and quasi-periodic patterns to localized microbranching events driven by complex 3D dynamics (cf. Figure). We further show that the transition between these different

regimes is controlled by the value of the regularization length scale inherent to the phase-field modelling of brittle fracture.

References

- [1] E. Sharon, J. Fineberg, Microbranching instability and the dynamic fracture of brittle materials, *Physical Review B*, APS, 1996, 54, 7128
- [2] E. Bouchbinder, I. Procaccia, Nonuniversality in microbranching instabilities in rapid fracture, *Physical Review E*, APS, 2005, 72, 055103
- [3] J. Bleyer, C. Roux-Langlois, J.F. Molinari, Dynamic crack propagation with a variational phase-field model: limiting speed, crack branching and velocity-toughening mechanisms, *Int. J. Frac.*, in press, (2016) 10.1007/s10704-016-0163-1.