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Extreme thermal aggression on one face of a microstructurally heterogeneous plate: a rapidly evolving multiphysical and multiscale problem

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The problem of an engine fire for an aircraft in flight raises the question of the degradation of the structural parts impacted by flames or exposed to extreme heat. Some of them are made of carbon fiber-reinforced polymers and are intended to support the engine. This role is maintained in a fire situation, as least for a finite number of minutes as prescribed by international regulations. So how could then be the degradation anticipated and predicted, this is the question addressed both experimentally and numerically in [1, 2] for thermoplastic-based carbon reinforced laminates.

This presentation will first provide a view on the multiphysics encountered, on the rapidity at which they evolve, and on the strong heterogeneities resulting from both the heterogeneous character of the laminate and high thermal gradient through the thickness of the plate. Then a focus will be made on the modeling of the involved thermomechanics on a large span of thermal, chemical and mechanical properties. A particular attention will be paid to the methodology for the identification of a meso-structured based model on the full range of temperatures from the ambient to the degradation of the polymer matrix. Both the experimental analyses and the modeling developments provide promising methodologies for problems of heterogeneous plates exposed to extreme heat.

References

- [1] Y. Carpier, B. Vieille, A. Coppalle, F. Barbe. Study of thermomechanical coupling in carbon fibres woven-ply reinforced thermoplastic laminates: tensile behaviour under radiant heat flux. *Polymer Composites*, 9:3552–3563, 2020.
- [2] Y. Carpier, B. Vieille, F. Barbe, A. Coppalle. Meso-structure-based thermomechanical modelling of thermoplastic-based laminates subjected to combined mechanical loading and severe thermal gradients. *Composites Part A*, 162:107165, 2022.