Using FEM and a crack band model with damaged induced anisotropy to predict damage on continuous fiber ceramic matrix composites

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This work proposes the use of a damage approach based on the crack band model (see e.g.: E. J. Pineda, B. A. Bednarcyk, A. M. Waas, and S. M. Arnold, "Implementation of a Smeared Crack Band Model in a Micromechanics Framework," *NASA*, 2012), to predict the damage in continuous fiber ceramic matrix composites (CMCs) at its fiber-matrix scale.

Randomly created representative volume elements (RVE) were generated using Digimat, Hexagon's material modeling platform. The detailed finite element models, where fibers, fiber coatings and matrix are explicitly represented, allow for the investigation of the material behavior under transverse mechanical loads.

The finite element models were then imported and solved in Metafor (http://metafor.ltas.ulg.ac.be), the fully implicit in-house finite element code developed by the MN2L laboratory of the University of Liège, where the Crack Band Model has been implemented. The results of transverse tension are compared with results from Meyer and Waas (P. Meyer and A. M. Waas, "FEM predictions of damage in continuous fiber ceramic matrix composites under transverse tension using the crack band method," *Acta Mater.*, vol. 102, pp. 292–303, 2016). The implemented damage model offers two options to degrade the compliance tensor of the damaged Gauss point: one that causes damaged induced anisotropy and another that isotropically degrades the compliance tensor. Using a complex load configuration, for instance transverse tension followed by shear, the results of both options are compared. The RVEs were also subjected to transverse compression and shear loadings to evaluate the model's capacity to capture the effect of friction between closed crack lips, which is an additional feature to existing crack band model implementations.