3D analysis of void coalescence mechanisms in nodular graphite cast iron based on finite element computation driven by digital volume correlation and in-situ laminography observations

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This work aims at better understanding and modeling void coalescence mechanisms in nodular graphite cast iron made of a ferritic matrix, graphite nodules, and no significant initial porosity. The methodology is based on the combination of three techniques, namely, *in-situ* tests monitored via synchrotron radiation computed laminography [1], digital volume correlation (DVC) [2], and finite element simulations with advanced meshing and remeshing capabilities [3]. This experimental-numerical framework is employed to carry out numerical simulations at the microscale with immersed microstructures and realistic boundary conditions via DVC analyses. It is therefore possible to model damage events and compare them to X-Ray laminography observations.
This work enables, for the first time, to access local strain levels at the onset of coalescence for real microstructures and realistic boundary conditions [4-6]. Comparisons with DVC results are discussed in terms of accuracy and extensive mesh sensitivity analyses are carried out to estimate the accuracy of the FE computations. These FE computations help getting a better understanding of coalescence mechanisms depending on 3D void arrangements and loading conditions.
Last, after evaluating different approaches, the results of the simulations are used to define and validate a coalescence criterion based on local strain-stress based criteria or intervoid distance.

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