Modeling of ductile fracture mechanisms at the microscale using a new adaptive body-fitted monolithic method

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ABSTRACT

At the microscale, metallic materials ductile fracture process involves nucleation (particles fracture or interface debonding), void growth and coalescence mechanisms. A physical and accurate modelling of such mechanisms at the microscale for large plastic strain and complex loading path would be very useful to improve mean field models used at the macroscale. In [1, 2], a new finite element approach based on level set functions and anisotropic mesh adaptation was developed to model such mechanisms. In order to improve volume conservation and interfaces description a body-fitted immersed method was developed and is detailed in [3] with applications to coalescence. To model discontinuities, the single mesh used in these developments also embodied the void phase that appears at the onset of fracture, which was then modeled by an appropriate fluid behavior, as in [1].

This adaptive body-fitted immersed method is used to study the influence of multiaxial and non-monotonic loading conditions on ductile failure mechanisms. For a given macroscopic strain, it is shown that modifying the loading path leads to the activation of different nucleation mechanisms and thus different final void volume fraction. The approach is also applied to the influence of void arrangements on coalescence. Unit-cell methods usually employed to study the onset of coalescence assume periodic arrangement of the void phase. Periodic arrangements are compared here to random arrangements for equal void volume fraction for 2D plane strain conditions. Finally, extension to the modelling of nucleation growth and coalescence for 3D configurations are presented and discussed.

REFERENCES

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