Multi scale computational modelling of closed cell metallic foams with microstructural morphological control using consistent 3D and shell RVEs

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ABSTRACT

This contribution addresses the computational modelling of closed cell metallic foams using RVEs based on 3D and shell geometries. 3D RVEs are produced by means of a generation strategy allowing a morphological control to reproduce fine scale geometrical features (cell size and cell wall thickness distributions, cell wall curvatures, …). The strategy is built on four computational ingredients: (i) a random packing algorithm based on random sequential addition assisted by neighbour distance control [1], (ii) a distance field-based shape tessellation (morphing) that allows reproducing cell wall curvatures and varying cell wall thicknesses, (iii) a close control of the cell shape distribution [2] and (iv) a mesh generation technique tailored for heterogeneous microstructures represented by implicit functions [3].

Yet, 3D models remains computationally expensive, which calls for developing an approach to generate alternative shell geometries starting from the 3D geometries. To achieve this, the 3D cell walls geometry defined implicitly by distance fields can be exploited. Extracting exactly the corresponding shell geometry based on the zero level of distance fields describing the 3D geometry of cell walls is computationally impossible. Therefore a procedure to extract the corresponding shell geometry is proposed using careful cutting operations [4]. The effect of the different microstructural geometrical features of interest (cell wall thickness distributions, wall curvatures, etc) on the average behaviour of the foam can then be investigated through finite element analyses for both the 3D and shell-based models. The computational cost and the accuracy of the proposed models are then assessed and compared.

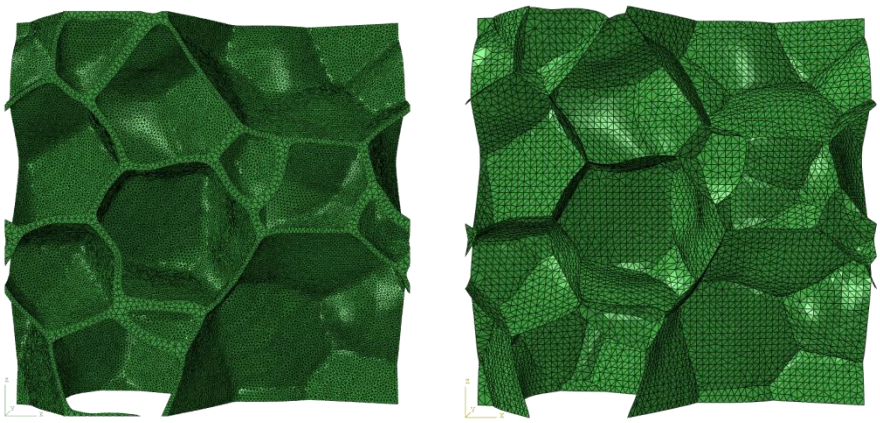

Figure 1: Finite element mesh of the generated RVE for the 3D model (Left) and the corresponding shell model (Right).

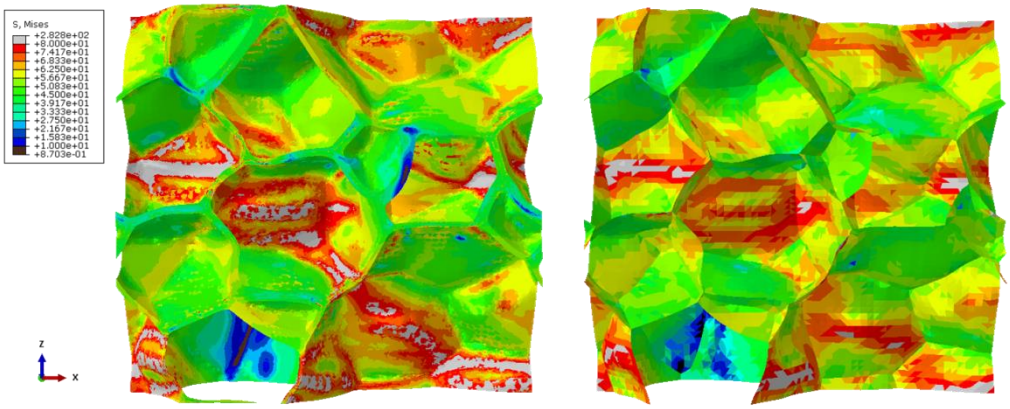

Figure 2: Distribution of von Misses stress in 3D model (Left) and corresponding shell model (Right) in compression test.

REFERENCES

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[4] A. Ghazi, P. Berke, K. Ehab Moustafa Kamel, B. Sonon, C. Tiago and T.J. Massart, Multiscale computational modelling of closed cell metallic foams by using shell modelling. *In preparation.*