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Towards high-fidelity fuel pellet fracture modelling in current and new fuel designs

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Abstract

Cracking of UO_2 clearly requires detailed understanding of local microscopic and macroscopic stresses. Also, the structural details and their effects on the microcracking should be known. To improve the fuel fracture modelling, we have started the work towards binding the structural features of the pellets with the crack behaviour modelling. The report shows measurements of a standard pellet with EBSD techniques and reviews macroscopic stress behaviour in 2D horizontal plane for differently sized pellets applying the BISON fuel performance code.

The SEM-EBSD results of a standard UO_2 pellet showed a dense microstructure with small and round pores in inter- and intra-granular locations, which are characteristic of such a fuel. There was no preferential crystallographic orientation in the sample.

The stress behaviour in the fuel pellets was modelled during different power-up ramp rates. The varying diameter of pellets did not show any particular differences in the stress behaviour, except for the maximum stress location due to reduced pellet-cladding gap. Introducing a macroscopic crack in the pellet caused localization of the stress and the smeared cracking model of the BISON code worked well.

Key words

SEM-EBSD, UO_2 structure, BISON fuel performance code, von Mises stress, cracking

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