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EFFECTIVE VISCOPLASTIC BEHAVIOUR OF AN IRRADIATED POROUS NUCLEAR MOX FUEL

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MOX MIMAS fuels, due to production processes, are commonly considered as multi-phases materials: one of these phases corresponds to agglomerates rich in plutonium. During irradiation, microstructure evolves and these agglomerates begin to be extremely porous. This work focuses on the overall viscoplastic behavior of this material taking into account this specific distribution of porosities into the aggregates. High temperatures $T \in [1300°\mathrm{C}, 2200°\mathrm{C}]$ and high loadings $\sigma \in [10\,\mathrm{MPa}, 100\,\mathrm{MPa}]$ are considered here in order to take into account specific conditions which could be encountered during a postulated Reactivity Initiated Accident (RIA). The viscoplastic matrix behavior is described by polynomial power-law with different exponents related to different temperature-activated creeping mechanisms [1, 2] (1-Dimensional formulation):

$$\dot{\epsilon^{vp}} = A\sigma \exp\left(-\frac{Q_1}{RT}\right) + \sigma^{4.4}\left[B\exp\left(-\frac{Q_2}{RT}\right) + C\exp\left(-\frac{Q_3}{RT}\right)\right]. \qquad (1)$$

The material of the study (model material) is composed of an isotropic matrix including pores forming clusters which are randomly distributed in space. In order to estimate the effective fuel properties, Representative Volume Elements are chosen. The method is based on microstructure sampling with respect to morphological descriptors extracted from 2-Dimensional images representing real material. Overall properties are estimated within the framework of periodic homogenization approach and computational Fast Fourier Transform method implemented in CraFT [3].

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