Radiation effects on SiC/SiC composites for advanced accident-tolerant fuel cladding

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Following the beyond-design-basis (BDB) accidents at Fukushima, Japan, the need to develop advanced accident tolerant fuel cladding using innovative materials, such as SiC/SiC composites, has been recognized [1-3]. The understanding of the overall radiation response of SiC/SiC composites under irradiation condition relevant to light water reactor is important for its application as cladding material and to predict its condition as spent fuel tubes.

In this work, the radiation effects in SiC/SiC composites using ion-accelerators, coupled with state-of-art characterization techniques like transmission electron microscopy (TEM), Raman spectroscopy, atomic force microscopy and optical profilometry will be presented to understand the overall radiation-induced microstructure evolution. The observed ion beam induced defects in SiC/SiC composite are contrastingly different from monolithic β-SiC. From decades of research, SiC is known to swell under irradiation. However, our work has revealed that irradiation-induced shrinkage occurs in the fibers of the SiC/SiC composite. This shrinkage is attributed to the presence of impurities (or excess carbon) in the fiber. To better understand the reason for shrinkage, Raman spectroscopy measurements were conducted on TEM foils. Also, analytical TEM techniques, like electron energy loss spectroscopy (EELS), high angle annular dark field (HAADF) imaging and energy filter TEM (EFTEM), were used to characterize the irradiation-induced defects in parallel.

[1]. Kuprin et al. J. Nucl. Mater. 465 (2015) 400.
[2]. Maier et al. J. Nucl. Mater. 466 (2015) 712.
[3]. Deck et al. J. Nucl. Mater 466 (2015) 667.