Effects of electronic and nuclear interactions in SiC

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Refractory nanostructured ceramics (NSC) show promising properties for the nuclear industry of the fourth generation. The enhancement of the mechanical properties of NSC compared to conventional ceramics has already been demonstrated, but the behaviour of such materials under irradiation is still not known.

3C-SiC NSC was irradiated at room temperature with 95 MeV Xe ions. This energy allows the combined observation of electronic (S_e) and nuclear (S_n) interactions with matter. Even at the highest Xe fluence of 5×10^{15} cm⁻², complete amorphization of the irradiated layer was not observed, despite the fact that the number of dpa (~ 8) largely overcomes the amorphization threshold determined for monocrystalline 6H-SiC at room temperature with low energy ions (~ 0.2).

In order to understand the results obtained on 3C-SiC NSC, 6H-SiC single crystals were irradiated at room temperature with 910 MeV Xe ions. The samples were analyzed by RBS and channelling (RBS/C) in a depth region where S_e is much higher than S_n . RBS/C data show that almost no disorder was observed after Xe irradiation. But in a crystal which was pre-damaged by irradiation with 700 keV I ions, Xe post-irradiation induces a clear recovery of the disorder created by low-energy I ions. This result demonstrates a competing effect between electronic and nuclear interactions, which likely prevents amorphization of samples irradiated with 95 MeV Xe ions.