Radiation and its effect on materials

The influence of radiation on the characteristics of solids is of great interest, particularly in nuclear reactors, where the nuclear reactions produce energetic radiations of the neutron, which further cause radiation damage and deteriorate materials with time. Radiation damage happens when an energetic incoming neutron collides with a lattice atom in a material. The interaction or collision allows a significant amount of kinetic energy to be transferred to the lattice atom, which then is dislocated from its lattice position. Such an atom is called the primary knock-on atom (PKA). Because of the presence of PKA in the vicinity of the other atoms, its movement through the lattice causes numerous successive collisions and the formation of secondary knock-on atoms. This results in the collision cascade, which can cause point defects and dislocations in the material. The generation of defects and dislocations constitutes a major reason for structural alterations in materials, which further causes materials to become embrittled at high neutron irradiation. This can have a substantial influence on the functioning of materials and hence reducing their longevity. It is also possible that nuclear transformation of the elements within the material takes place, causing the material to swell. To comprehend the effects of radiation, a thorough understanding of the radiations and their interaction mechanisms with the material, as well as the characteristics of the irradiated material, is required. Atomistic modelling is crucial in this regard, as it provides insight into the fundamental physics governing the radiation damage processes.