Macroscopic elastic stress and strain produced by irradiation

We present a method for computing macroscopic elastic stress and strain arising in components of a fusion power plant during operation. In a microstructurally isotropic material, the primary cause of macroscopic elastic stress and strain fields is the spatial variation of neutron exposure. Under traction-free boundary conditions the volume-average elastic stress always vanishes, signifying the formation of a spatially heterogeneous stress state, combining compressive and tensile elastic deformations at different locations in the same component, and resulting solely from the spatial variation of radiation exposure. Several case studies pertinent to the design of a fusion power plant are analysed analytically and numerically, showing that a spatially varying distribution of defects produces significant elastic stresses in ion-irradiated thin films, pressurised cylindrical tubes and breeding blanket modules.