



Neutrons and radiation damage in structural materials



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In a nuclear reactor, neutrons do not only cause fission of actinides, they also interact with nuclei in the structural materials of the system. All these interactions cause damage in one or the other way. The most common mode of damage is a displacement of the constituent atoms of the structural material from their equilibrium lattice position, leading to formation of vacancies and interstitials. In fast neutron reactors, we will also have a significant rate of nuclear transmutations taking place, leading to formation of elements that tend to degrade mechanical properties and shorten the service time of both fuel and reactor vessel. When designing Generation IV nuclear systems, it is therefore important to fully understand such reactions in order to reduce the probability for failure. One would of course also like to develop materials that are more transparent to interactions with neutrons than the ones present in use.

After this lecture, you will be able to explain how the following nuclear reactions leads to radiation damage in steels that may be used for fuel clad or pressure vessels:

- Scattering of neutrons
- Capture of neutrons
- Neutron induced production of helium
- Neutron induced production of hydrogen

You will also be able to identify nuclear systems where the rate of damage due to scattering is lower than in others. Finally, you will be able to select structural materials that permit to reduce the rate of neutron capture and helium production.