Within the European Union, the two major breeding blanket concepts presently being developed are the Helium Cooled Pebble Bed (HCPB), and the Helium Cooled Lithium Lead (HCLL) blankets. For both concepts, different conceptual designs are being discussed with temperature windows in the range 250-550°C for conservative approaches based on reduced activation ferritic-martensitic (RAFM) steels like the European 9CrWVTa reference steel Eurofer, and in the range 250-650°C for more advanced versions, taking into account Oxide Dispersion Strengthened (ODS) steels.

Tensile specimens of Eurofer and ODS-Eurofer have been irradiated in the High Flux Reactor (HFR) in Petten at temperatures between 250 and 450°C to doses up to 15dpa. Tensile tests (T\text{test}=T\text{irr}) on irradiated and unirradiated samples of both steels exhibited a totally different tensile behaviour below 400°C. Eurofer shows a significant increase of the ultimate tensile strength after irradiation between 250 and 350°C of 50-60% compared to the unirradiated material, which is more than twice as much as observed for ODS-Eurofer. The Yield strength is increased by 75-84% compared to around 45% increase for the ODS variant. At the same time the uniform elongation of Eurofer is reduced by 70% to values around 0.3%, while the reduction for irradiated ODS-Eurofer is moderate, reaching values of about 7%. The total elongation is reduced by 40% for Eurofer and by 20% for ODS-Eurofer, reaching about 13% in both cases.

This totally different deformation behaviour is also reflected in the different shape of stress-strain curves. While ODS-Eurofer shows even after irradiation a substantial work hardening, tensile strength of Eurofer breaks down immediately after having reached the ultimate strength. This breakdown can be attributed to plastic instability, which has been observed earlier for fcc, bcc, and hcp alloys after irradiation at low temperatures. The Y_2O_3 particles in the ODS steel, which are not dissolved during irradiation, are strong enough barriers for the moving dislocations, to cause work hardening during deformation. On the other hand they may act as trapping sites for irradiation-induced defects, thus leading to lower irradiation hardening. The results of TEM and SEM examinations will be presented to link the macroscopic and microstructural behaviour.