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Registering micro-indentation of neutron-irradiated low-activation steel at high temperatures

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An ongoing study about the influence of neutron irradiation on the mechanical properties of the first wall's structure materials is presented in this work. EUROFER97 and an Oxide Dispersion Strengthened EUROFER steel were irradiated in the Petten High Flux Reactor up to a nominal dose of 15 displacements per atom at temperatures between 250 and 450℃ and investigated by an advanced method of registering micro-indentation. For the purpose of characterizing irradiated and thus radioactive samples at future fusion reactor conditions i.e. at high experimental temperatures, the Karlsruhe High Temperature Indenter (KAHTI) was developed. In order to safely handle radioactive samples, KAHTI itself is operated by remote control inside a Hot Cell. Due to a new optical depth sensing method, it now is possible to perform registering micro-indentation at temperatures up to 650℃ with highly accurate displacement measurement. The results gained by KAHTI show the increase of hardness by neutron irradiation and its dependency on the irradiation temperature. In addition, the sensitivity of the hardness to different testing temperatures is investigated. These results lead to a better understanding and quantification of the different neutron induced damages. The possibility of recombining neutron induced Frenkel-pairs and thus the reduction of irradiation damage without affecting the material's grain structure is investigated by performing post irradiation annealing inside KAHTI at 550℃. First results indicate an almost complete recovery of mechanical properties. Comparing the results of this study to conventional testing methods approves KAHTI being a complementary testing method with a very high specific amount of information per sample and per sample volume.

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