Revealing the role of oxygen on the microstructure of electron- irradiated tungsten: A combined experimental and simulation study

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Faced with the new challenges in energy production, thermonuclear fusion could be one of the key solutions to address the need to reduce the greenhouse effect and the growing global demand.

Tungsten will cover the ITER divertor and is considered for the first walls in the Demonstration power plant (DEMO). Such components have to withstand high heat flux and irradiations. It is already known that under such severe operational conditions, material properties will be degraded. To dimension the reactor components, it is essential to predict precisely their impact. Among the critical open questions, better knowledge is required on the actions of radiation-induced defects and their interactions with impurities embedded in the materials and in the plasma. Theoretical studies show strong interactions that could impact the microstructural evolution under irradiation.

We performed electron irradiations, expecting to introduce quantifiable single vacancies (V_1). In addition to the pure single vacancy, an unexpected defect was detected by Positron Annihilation Spectroscopy (PAS) using both Doppler Broadening Spectroscopy (DBS) and positron annihilation lifetime spectroscopy (PALS. PALS reveals that more than half of the positrons annihilate in another state namely the X-defect. No defect is observed by TEM. SIMS analysis shows the presence of a high Oxygen concentration. By comparing the experimental PAS data with the annihilation characteristics calculated by DFT, as well as the cluster dynamics, we propose that the X-defect is a mixture of oxygen decorated vacancies (V_1-O_X).

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