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Plasma-surface interactions under extreme conditions: challenges and opportunities GREGORY DE TEMMERMAN, FOM Institute DIFFER — In a fusion reactor, power from the hot core plasma has to be exhausted by the plasma-facing components which are exposed to extreme heat (>10MW.m^{-2}) and particle fluxes (up to 10^{24}m^{-2}s^{-1} or 1.6x10^{5}A.m^{-2})- orders of magnitude higher than in conventional plasma processing technique. Much of the fundamentals of the materials behaviour under such extreme ion irradiation conditions is not yet fully understood and limits our ability to develop materials able to survive those conditions. Combining a high efficiency plasma source and a strong magnetic field, linear plasma devices (LPD) allow to reproduce and even exceed the conditions expected in a fusion reactor. Owing to the good access to the plasma-material interaction zone for diagnostics and sample manipulation, those devices allow advanced experiments necessary to the fundamental understanding of plasma-surface interactions. In addition, the ion flux is such that a direct comparison with MD modelling, traditionally hampered by the large gap between fluxes in model and experiments, is now possible. This presentation will give an overview of the research performed to understand materials behaviour under extreme conditions with a focus on irradiation-driven modifications of metals. In parallel, the non-equilibrium conditions induced by the surface bombardment by extreme fluxes of low-energy particles open a novel route for the synthesis of advanced nanostructured materials, an illustration of which will be given.

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