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Impact of Helium Ion Energy Modulation on Tungsten Surface Morphology and Nano-Tendrils Growth

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Helium (He) ion energy modulation is demonstrated, for the first time, to affect the development of the tungsten (W) nano-tendrils morphology that results from He irradiation. Dramatically isolated nano-tendrils bundles (NTBs) grow from the surface instead of a uniform nano-tendrils layer, or so called fuzz, leaving ~90% of the surface without nano-tendrils growth at all. The growth parameters for NTBs are the same as for fuzz except for the radiofrequency modulation of the ion energy. Analyses of the newly discovered NTB growth regime strongly support models of nano-tendrils growth that take adatom kinetics as their basis. Additional modeling of the ion energy distribution function of the ITER divertor must take place in order to assess the scope of nano-tendrils growth that might occur, and of what type. Through mass loss measurements and electron microscopy, the minimally supported NTBs are shown to be a greater threat to plasma-facing component erosion and dust production than previously observed for uniform fuzz.

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