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RF plasma based Nanostructurization of Tungsten for Plasma Facing Component Material Applications

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Abstract
Tungsten is the choice for first wall material for future nuclear fusion reactors owing to its properties like high melting point, good ablation resistance, good thermal conductivity, low deuterium/tritium retention etc. The thermal and radiation loads within experimental nuclear fusion reactors like ITER is expected extremely high in the diverter region where the transient and continuous loads are the highest. The mechanical properties of tungsten thus needs to be improved without affecting other thermal and adsorption properties. It is known that nanostructurization of the material surface can lead to better mechanical properties. This paper deals with the improvement of the surface hardness of tungsten substrates by surface nanostructurization using RF plasma. Tungsten substrates were exposed to a capacitively coupled RF plasma in an N2 environment to nanostructurize its surface. The plasma parameters were studied using optical emission spectroscopy and a Langmuir probe. The exposure conditions were optimized so that nanostructures of required dimensions could be achieved. The surface morphology and the chemical structure was studied using SEM and XPS spectroscopy while the surface hardness was studied using a nano-indentor. In order to study the performance of the treated tungsten samples to fusion conditions, the substrates were then exposed to the focused mode operation of the dense plasma focus device and the changes in morphology and hardness were measured.

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