Accepted Manuscript

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PII: S0022-3115(17)31484-8

DOI: 10.1016/j.jnucmat.2018.03.023

Reference: NUMA 50844

To appear in: *Journal of Nuclear Materials*

Received Date: 20 October 2017

Revised Date: 13 March 2018

Accepted Date: 13 March 2018

Please cite this article as: T.J. Novakowski, A. Sundaram, J.K. Tripathi, S. Gonderman, A. Hassanein, Deuterium desorption from ion-irradiated tantalum and effects on surface morphology, *Journal of Nuclear Materials* (2018), doi: 10.1016/j.jnucmat.2018.03.023.

Deuterium desorption from ion-irradiated tantalum and effects on surface morphology

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Abstract

Compared to tungsten (W), tantalum (Ta) has shown superior resistance to helium (He)-induced surface morphology changes under fusion-relevant irradiation conditions. However, Ta is also expected to have a stronger interaction with hydrogen isotopes, potentially limiting its use as a plasma-facing material. Despite these concerns, detailed investigations on hydrogen irradiation effects on Ta are scarce. In this study, pristine and fuzzy (He^+ ion-irradiated) Ta samples are irradiated with 120 eV deuterium (D) ions at various temperatures and examined with a combination of thermal desorption spectroscopy (TDS), scanning electron microscopy (SEM), and optical reflectivity. TDS reveals discrete D desorption temperatures at 660 and 760 K, corresponding to trapping energies of 1.82 and 2.11 eV, respectively. Although D is retained in Ta both in higher quantities and at higher temperatures compared to W, extreme surface temperatures expected in tokamak divertors may exceed these desorption temperatures and counteract retention. Furthermore, this study indicates that Ta is relatively resistant to adverse surface structuring under D^+ ion irradiation. In fact, D^+ is shown to prevent and suppress Ta fuzz formation in sequential D^+/He^+ ion irradiation experiments. While further investigations are needed to elucidate this behavior, these initial investigations show a strong potential for the use of Ta as a PFC material.

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