Accepted Manuscript

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PII: S0022-3115(17)30961-3

DOI: 10.1016/j.jnucmat.2017.10.027

Reference: NUMA 50559

To appear in: *Journal of Nuclear Materials*

Received Date: 3 July 2017

Revised Date: 6 October 2017

Accepted Date: 10 October 2017

Please cite this article as: T. Yao, B. Gong, L. He, J. Harp, M. Tonks, J. Lian, Radiation-induced grain subdivision and bubble formation in U_3Si_2 at LWR temperature, *Journal of Nuclear Materials* (2017), doi: 10.1016/j.jnucmat.2017.10.027.

Radiation-induced Grain Subdivision and Bubble Formation in U_3Si_2 at LWR Temperature

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Abstract:

U_3Si_2, an advanced fuel form proposed for light water reactors (LWR), has excellent thermal conductivity and a higher fissile element density. However, limited understanding of the radiation performance and fission gas behavior of U_3Si_2 is available at LWR conditions. This study explores the irradiation behavior of U_3Si_2 by 300 KeV Xe^+ ion beam bombardment combining with *in-situ* transmission electron microscopy (TEM) observation. The crystal structure of U_3Si_2 is stable against radiation-induced amorphization at 350 °C even up to a very high dose of 64 displacements per atom (dpa). Grain subdivision of U_3Si_2 occurs at a relatively low dose of 0.8 dpa and continues to above 48 dpa, leading to the formation of high-density nanoparticles. Nano-sized Xe gas bubbles prevail at a dose of 24 dpa, and Xe bubble coalescence was identified with an increase of irradiation dose. The volumetric swelling resulting from Xe gas bubble formation and coalescence was estimated with respect to radiation dose, and a 2.2% volumetric swelling was observed for U_3Si_2 irradiated at 64 dpa considering fission gas only.