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P90 - Multiscale characterization of helium migration in transition metal carbides and nitrides

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Multiscale characterization of helium migration in transition metal carbides and nitrides

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Transition metal carbides and nitrides exhibit very interesting thermomechanical and radiation tolerance properties and are considered as possible candidate materials for use in advanced nuclear fission and fusion applications. The accumulation of helium mainly produced by neutron induced nuclear reactions (n, ⍰) may have detrimental effects on the ageing process of nuclear ceramics such as TiC, ZrC and TiN. A thorough characterization based on quantitative analytical tools needs to be carried out to identify and describe the key mechanisms able to drive helium migration in these compounds. In this paper, we show that combining ion milli- and micro-beam analysis using the nuclear reaction 3He(d, p0)4He together with transmission electron microscopy open the way to obtain quantitative informations on the evolution of the distribution of helium atoms implanted in these compounds after controlled isothermal annealing treatments. The following figures illustrate the behavior of 3He implanted in TiN investigated from the millimeter to the nanometer scale.

3He depth profile measured by milli-NRA in TiN as implanted at 0,27 1016 ions cm-2 and annealed for 2 hours at 1100 or 1500℃. TEM observation of helium bubble distribution in TiN as implanted at 0.27 1016 ions cm-2.

Two dimensional 3He distribution in TiN as implanted at 5.0 1016 ions cm-2 measured by μNRA. Two dimensional 3He distribution in TiN annealed for 2 hours at 1600℃ measured by μNRA.

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