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Yoshio Ueda

Graduate School of Engineering-Osaka University, Japan

Nano-fiber formation of transition metals by He plasma process

From material research aspect of fusion energy development, He plasma induced nanostructure (HIN) on tungsten is very interesting and attractive phenomenon, which has not reported in the other fields. Dense nanofiber (fiber thickness of a few tens of nm) structure grows up to several μm under appropriate ion energy and temperature conditions. Important underlying processes to produce this structure are He agglomeration and nanoscale bubble formation in tungsten (also seen in various metals). Detailed formation mechanism, especially growth mechanism of nanofibers, however, has not been understood well. Once we understand formation mechanisms in detail and find appropriate control methods of the nanofiber structure, various applications will emerge such as catalyst and sensors due to mainly large surface area of the structure. In this presentation, systematic experimental results of nanofiber formation on various transition metals (Hf, Ta, W, Re, Ir, Pt, Au, Nb, Mo) are shown, indicating relations between nanofiber characteristics and material properties. The most critical experimental parameter is temperature. Around 30% of melting temperature in K, nanofiber structure grows fastest for most of the metals. But there are some exceptions such as Ta and Nb, in which thick nanofiber layers are hardly produced, while relatively large surface holes with diameter of sub μm appear. There are some correlations of growth rates of nanofibers with mechanical properties of metals as well as agglomeration energy of He atoms calculated by a DFT calculation. Some applications of nanofiber structure will be briefly discussed.

Biography

Yoshio Ueda has completed his PhD from University of Tokyo and Postdoctoral studies from Princeton Plasma Physics Laboratory. He is the Professor of Graduate School of Engineering, Osaka University. He has published more than 190 papers in reputed journals and has been serving as an Editorial Board Member of Nuclear Fusion, Journal of Nuclear Materials and Nuclear Materials and Energy. His major research area is development of nuclear fusion energy and he is currently involved in plasma-material interactions in fusion energy devices and applications of this knowledge to the other fields.

yueda@eei.eng.osaka-ua.c.jp

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