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FTP/P7-14: Research on Tritium/Heat Transfer and Irradiation Synergism for First Wall and Blanket in the TITAN Project

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The research in Japan-USA fusion cooperation program TITAN (Tritium, Irradiation, and Thermofluid for America and Nippon, from April 2007 to March 2013) is highlighted by tritium transfer in PFM exposed to tritium-plasma, effects of neutron irradiation on deuterium retention in PFM, MHD flow of Li-Pb in magnetic fields, synergistic neutron irradiation and helium injection effects for structural materials, and irradiation effects on advanced materials including joints and coatings. These unique results were obtained through unprecedented experiments using a nuclear reactor (HFIR), a tritium-plasma test facility (TPE), a thermofluid test facility with a magnet (MTOR) and so forth, including their combined use.
Tritium concentration was measured by Tritium Imaging Plates for W and RAFM Steel (F82H) after exposure to D+0.2%T plasma at 200℃. The cross sectional detection clearly showed higher tritium diffusion into bulk (˜3mm) in F82H.
Deuterium depth profiles in W were obtained by NRA after deuterium plasma exposure at 100, 200 and 500℃ with and without prior neutron irradiation to 0.025 dpa at 50℃. A high deuterium concentration was detected only in neutron-irradiated specimens in the case of deuterium plasma exposure at 500℃, showing that the defects formed by neutron irradiation captured deuterium in the specimen and significantly increased the deuterium retention at 500℃.
Joint samples of F82H with NiAl alloy (He implanter) were irradiated in HFIR. During the neutron irradiation, He produced by transmutation of Ni with thermal neutrons was injected into F82H. A comparison was carried out for microstructures at 480℃ to 10 dpa and 380 ppm He by this technique and those obtained by Ni/He dual ion irradiation, respectively. Large voids were observed only by neutron irradiations. The difference would be attributed to the large difference in damage production rate between neutron and ion irradiations.
Modeling studies for tritium and heat transfer, thermofluid in magnetic fields, and materials performance have been enhanced in the project keeping close connections with the experimental studies, for the purpose of increasing contributions to the integration modeling and the MFE/IFE reactor designs.

Country or International Organization of Primary Author

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Collaboration (if applicable, e.g., International Tokamak Physics Activities)

Japan-US Fusion Cooperation Program TITAN

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