Characterization of VPS-W coating as armor materials for graphite tiles of tokamak first wall


Southwestern Institute of Physics, Chinese Physical Society of Nuclear Fusion & Plasma Physics, P.O.Box 432, 610041 Chengdu Sichuan, China

Advanced Fusion Research Center, Research Institute for Applied Mechanics, Kyushu University, 6-1 Kasugakoen, Kasuga, 816-8580 Fukuoka, Japan

Radiochemistry Research Laboratory, Faculty of Science, Shizuoka University, 836, Ohya, Suruga-ku, 422-8529 Shizuoka, Japan

Shanghai Institute of Ceramics, Chinese Academy of Science, 1295 DingXi Rd, 200050 Shanghai, China

National Institute for Fusion Science, 322-6 Oroshi-cho, Toki-shi, 509-5292 Gifu, Japan

xliu@swip.ac.cn

Graphite tiles commonly used as the first wall structure of current fusion devices. In order to investigate the compatibility of other armor materials with fusion plasma in these devices without first wall structure changes, one of the best options is to coat other armor materials, such as boron and tungsten, on the graphite tiles. HL-2A is a tokamak machine with graphite tiles and tungsten will be tested in this device or the modified one. Therefore, vacuum plasma sprayed tungsten coating on graphite (VPS-W/C) with multi-layer Si, W interface pre-deposited by physical vapor deposition (PVD) has been developed and its thermo-mechanical properties and heat load resistance capabilities were evaluated. In this paper, the compatibility of VPS-W/C coating with fusion plasma will be studied. First, annealing tests of VPS-W/C coating at 800-1200 °C for 2 h were performed, and C, W, Si atom diffusion was studied and potential phase transfer was investigated. Experimental results indicated that brittle WC phase did not form after 1200 °C annealing for 2h although SiC phase was observed. The formation of SiC phase acts as the diffusion barrier of carbon and restrains carbon atoms diffusing towards tungsten coating. It also indicated that Si is a suitable intermediate layer for VPS-W/C coating. After annealing processes, the bonding strength (bending strength) of VPS-W/C coating was measured and the post thermal process technique was optimized. Deuterium and helium retention in VPS-W coating were also investigated by 3 keV D and He ion implantation at a facility of thermal desorption spectroscopy (TDS) equipped with X-ray photoelectron spectroscopy (XPS). Retained D and He amounts in this coating were evaluated and their trap and release behaviors were studied.

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