ICFRM2007/336
A Study of Al₂O₃ Films on CLAM Substrate

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The Dual-Functional Lithium-Lead Blanket Module (DFLL-TBM) system is designed to demonstrate and validate the technologies of both the helium-cooled blanket and the helium/lithium-lead dual-cooled blanket, and there will be several relevant concept designs in China. Considering the fugacity of the tritium and its very low solubility in liquid LiPb, tritium is very easy to permeate out of the blanket, and this will result in the losing of nuclear fuel and the potential radioactive hazard to the circumstance. Additional liquid LiPb flowing in the blanket will produce serious MHD effects and corrupt the structural material. After many years of research in this field, it's considered possible to produce a coating on the structural materials which have advantages such as anti-irradiation-swelling, low thermal expansion coefficient and higher thermal conductance, to reduce tritium permeation, mitigate MHD effects and corrosion by the liquid LiPb. Chinese Low Activation Martensitic (CLAM) Steel was designed to be used as the structural material in the DFLL-TBM and the future DEMO reactor because of its high quality.

It is recognized that large quantities of ceramics will be needed in the future for the fabrication of ITER test blanket modules and the ITER driver blanket. Aluminum oxide (Al₂O₃) ceramic has long been recognized as a promising tritium-breeding material for fusion reactor blankets. Al₂O₃ films were prepared on CLAM Substrate with the ratio of O₂/Ar from 0.1 to 1.2 by RF Magnetron Sputtering method, and the base and the sputtering pressure are 2 × 10⁻⁴ Pa and 1 Pa respectively. The existence of nano-scale Al₂O₃ grains was observed by the Scanning Electronic Microscope(SEM); the structure of the films was investigated by means of X-Ray Diffraction (XRD); the samples were submitted to hydrogen permeation; the resistivity was calculated according to the resistance and the thickness which was measured by interferometer. In this paper, the relationships between the characters and the microstructures of the films were discussed.