The Pack-Cementation Process of Iron-Aluminide Coating on China Low Activation Martensitic and 316L Austenitic Stainless Steel

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Preparing a continuous and dense Al_2O_3, Er_2O_3 or Y_2O_3 layers by in-situ oxidation process, MOCVD process, Sol-Gel, etc., is one effective way to improve its corrosion resistance and to reduce the tritium permeation rate through the structural material of the DEMO fusion blanket and tritium system. The pack-cementation aluminide coating as a transition layer has been developing on two kinds of substrates such as the Reduced Activation Ferritic/Martensitic (RAFM) and 316L stainless steel by our research team of tritium materials and technology (TMT Team).

Because of the importance to prepare the transition aluminide layer with a certain aluminum content and thickness on these substrates, wide research efforts have been made on the effect of different pack chemistry, temperature and time on the properties and thickness of the aluminizing layers. The results indicated that a dense and uniform coating with a thickness about 20μm was formed on 316L and CLAM (a Chinese RAFM steel) substrates for the pack material with low Al content (about 32wt.%). This aluminide coating had a surface aluminum content about 25 wt.% and was mainly consisted of ductile FeAl phase. A dense and continuous Al_2O_3 layer were formed on this aluminide coating after in-situ oxidation, and a gas tritium permeation rate factor was measured more than three thousands. For the pack material with high Al content (about 50wt.%), the thickness and the surface aluminum content of the aluminizing coating had great increases and there were mainly brittle Fe_2Al_5 phase in this aluminide coating, and especially some cracks were observed across this coating on CLAM substrate due to the mismatch in coefficient of thermal expansion (CTE) between the coating and substrate. More systematic studies will be done on the aluminide coating formation on these substrates in the pack aluminizing process in relation to determining the effects of processing conditions on the growth kinetics and resultant microstructures and properties of the coatings.

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