§29. Nitriding Treatment of Reduced Activation Ferritic Steel as Functional Layer for Liquid Breeder Blanket

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The development of functional layers such as a tritium permeation barrier and an anti-corrosion layer is the essential technology for the development of a molten salt type self cooled fusion blanket. In the present study, the characteristics of a nitriding treatment on a reduced activation ferritic steel, JLF-1 (Fe-9Cr-2W-0.1C) as the functional layer were investigated.

The nitriding treatment of the specimen surface was performed at the condition presented in Table 1. Fig.1 shows the schematic mechanism of the ion nitriding treatment and the radical nitriding treatment. The ion nitriding treatment on the specimen was performed by the deposition of nitrides, which were made by an ion sputtering on the surface due to a glow discharge. The specimen was marked as IN/JLF-1. The radical nitriding treatment was performed by chemical nitridation of the surface with reactive NH radical, which was made by glow discharge in the gas mixture of hydrogen and ammonia. The specimen was marked as RN/JLF-1.

The chemical stability of the RN/JLF-1 specimen in the molten salt Flinak was investigated by means of a simple immersion test at 600ºC for 2216 hours. The test results (Fig. 2) indicated that the nitriding treatment can improve the compatibility in the Flinak. The nitrided layer uniformly covered on the steel surface. The layer suppressed the corrosion of the steel matrix in the Flinak. Also, the results indicated the layer was stable in the Flinak.

The hydrogen permeability of the RN/JLF-1 specimen was investigated by a hydrogen permeation test. The hydrogen permeability of the RN/JLF-1 at 400ºC was 2.66 x 10^{-11} mol/m/s/$Pa^{0.5}$. This value was the same to that without the treatment. The Fe-Cr nitride layer was unstable in the atmosphere at high hydrogen concentration, and the layer was removed during the test.

The influence of the nitriding treatment on the thermal diffusivity was investigated by means of laser flash method. The specimens of IN/JLF-1 and RN/JLF-1 were used for the test. The test results indicated that the treatment can not decrease the thermal diffusivity. This was possibly because the layer was much thinner than the steel matrix.

The nitriding treatment can improve the compatibility in the Flinak without the decrease of the thermal diffusivity, though there was little improvement as the hydrogen permeation barrier.

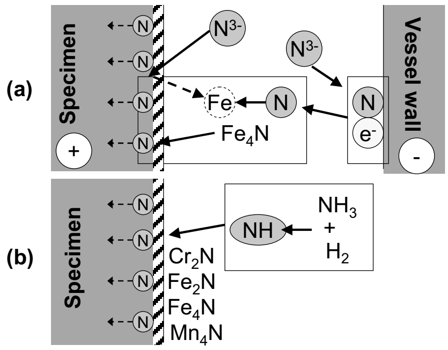

Fig. 1 Schematic mechanism of (a) ion nitriding treatment and (b) radical nitriding treatment

Table 1 Conditions of nitriding treatment

	Ion Nitridation (IN/JLF-1)	Radical nitridation (RN/JLF-1)
Temp.	560 ºC	450ºC
Time	5 hour	5 hour
Gas	N_2:H_2:Mix gas =2:1:1 (Mix gas: N_2 and CO)	H_2:NH_3=8:2 (130Pa)

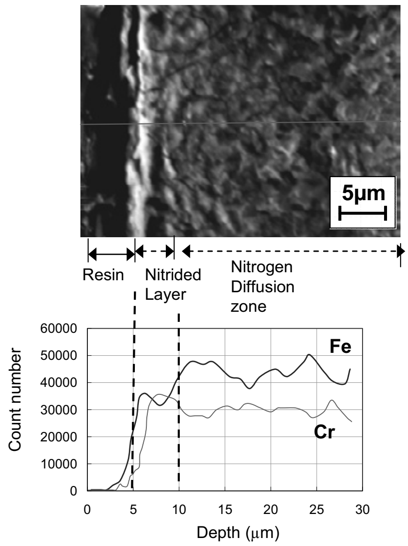

Fig.2 Cross sectional SEM/EPMA analysis of RN/ JLF-1 specimen after exposure to Flinak