# §1. Fluoridation and Oxidation Behavior of JLF-1 and NIFS-HEAT-2 Low Activation Structural Materials

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Corrosion of structural materials is paid attention most in Flibe blanket development. Possible corrosion agents in Flibe are HF, $H_2O$, $O_2$ and metal impurities. In order to clarify the corrosion mechanism in Flibe, it is essential to understand the competitive process by fluoridation and oxidation. Purpose of the present study is to characterize corrosion products of the low activation materials after fluoridation, oxidation and Flibe exposure tests, and to evaluate corrosion resistance of the materials in Flibe condition.

Low activation materials used were 1-inch-thick plate of JLF-1 JOYO-II heat (Fe- 9.00Cr- 1.98W- 0.090C- 0.20V- 0.083Ta) and NIFS-HEAT-2 (NH2, V- 4.02Cr- 3.98Ti- 0.0069C- 0.0122N- 0.0148O). 1-mm-thick plate of pure metal (99.9~99.99 %) of Fe, Cr, W, Ni, V and Ti were also prepared. The specimens were exposed to Flibe (2LiF + BeF2) molten salt at 823 K for 2003 hr, $H_2O$- 47%HF solution at room temperature (RT) for 2 min and He- (0~1%) HF gas mixture at 823 k for 2.5~100 hr. He gas contained moisture ($H_2O$) and $O_2$ as impurities. The moisture and $O_2$ concentrations were measured.

Figure 1 shows weight change after the corrosion tests. Weight loss of pure Ni was negligible in H2O-47%HF solution. The low activation materials, JLF-1 and NH2, showed similar weight losses, which were comparable to the base metal, V and Fe. Cr and W exhibited 1/30~1/50 of weight loss compared with the low activation materials. Weight gain of JLF-1 in He- (0~1%) HF gas mixture was 1/10~1/30 of NH2. Weight loss in Flibe was not significantly different from the other corrosion conditions, therefore they were expected to be accelerated condition tests for Flibe exposure.

The composition of corrosion products on the surface was analyzed by XPS with Ar sputtering. Fig. 2 shows the typical depth profiles for the composition. In all the specimens, intensity of photoelectron from O atom was much higher than F atom, even composition of the He- 1% HF gas was He- 0.96%HF- 0.055$H_2O$- 0.0016$O_2$, where F atom was 16 times more than O atom. At the peak of F atom in Fig. 2 (a) for Flibe condition, the ratio of F / O was calculated by using atomic sensitivity factors for X-ray, as 0.25. In the case of exposure to He- HF gas mixture, F / O was less than 0.36 for both JLF-1 and NH2 at all the HF concentrations. According to the F / O ratio, fluoridation occurred much less than oxidation. Corrosion products mainly consist of $Cr_2O_3$ in both NH2 and JLF-1. Weight gain is mainly caused by oxidation, which was much larger for NH2 than JLF-1. Vanadium alloys are known to show serious degradation of mechanical properties by increase in oxygen concentration, therefore oxygen reduction is required for application of vanadium alloy to Flibe blanket system.

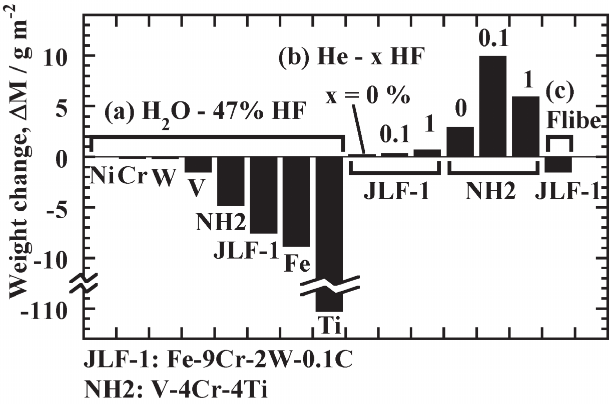


Fig. 1 Weight change after corrosion tests. Corrosion conditions were (a) RT x 2 min, (b) 823 K x 100 hr for He, 25 hr for He- 0.1% HF, 2.5 hr for He- 1% HF and (c) 823 K x 2003 hr.

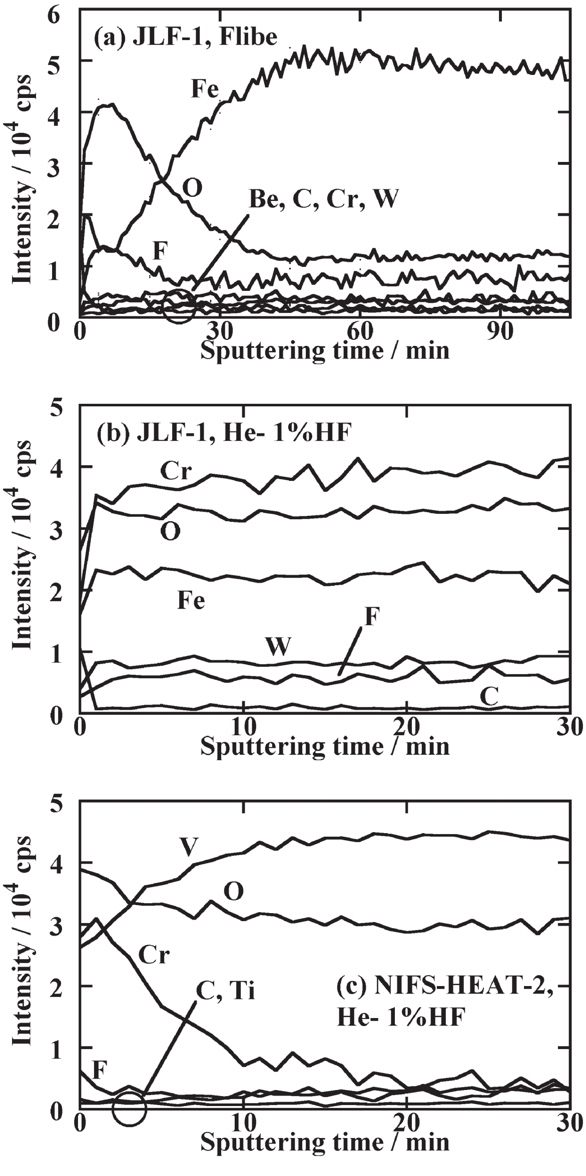


Fig. 2 Depth profile of the intensity of photoelectron. Sputtering rate was 4.87 nm in $SiO_2$.