§1. Long Term Corrosion Test on JLF-1 Steel in Static High Purity Flibe

Nagasaka, T., Kondo, M., Noda, N., Muroga, T., Sagara, A.,
Nishimura, H., Yakata, T., Suzuki, A., Terai, T. (Univ. Tokyo)

Reduced activation ferritic steels (RAF, Fe-Cr-W steels) are recognized as candidate structural materials for a fusion blanket. Flibe ($LiF+BeF_2$) is an attractive coolant, also tritium breeder and neutron multiplier for an advanced fusion blanket system. One of critical issues for the Flibe blanket system is corrosion of the structural materials in Flibe. Recently, a purification system for Flibe has been successfully developed in TNF (The University of Tokyo-NIFS Flibe Grove box) facility. Typical Fe, Cr and W impurity levels in the Flibe are 5, 10 and <1 wppm, respectively. Especially the Fe impurity level, 5 wppm, is much lower than 260 wppm in the conventional Flibe. The high purity Flibe makes it possible to analyze materials transfer from RAF to Flibe in ppm levels.

1-inch-thick plate of JLF-1 JOYO-II heat (Fe-9.00Cr- 1.98W- 0.09C- 0.49Mn- 0.20V- 0.083Ta) was machined into coupon specimens with the size of 20 x 10 x 1 mm or 15 x 10 x 1 mm. Crucibles made from the JLF-1 and Ni were prepared. The coupon specimen and 3-4 g of the Flibe was set into the crucible. Crucibles containing the coupon and the Flibe were sealed in stainless steel (SS304) capsule filled with high purity helium. The capsules were heated at 823 K for 2003 hr.

Results in weight loss measurements on the coupon specimens exposed to Flibe test are shown in Table 1. The weight loss for the JLF-1 coupon exposed in Ni crucible was 1 order larger than the one in JLF-1 crucible. Possible mechanism for the enhancement of the large weight loss in Ni crucible is electrochemical reaction among JLF-1, Flibe and Ni crucible. Since JLF-1 plate was not completely insulated from Ni crucible, they could form a circuit of electrochemical cell. Fig. 1 shows a comparison of weight loss between JLF-1 in Flibe (present study) and 316 type stainless steel (316SS) in liquid metal Na[1]. As well known, 316SS-Na system has been adopted for fast breeder reactor circuit. Weight loss of JLF-1 specimen in JLF-1 crucible is smaller than the ones for 316SS in Na, whereas it is much larger, if Ni crucible is used. The corrosion rate is expected not to be significant compared with 316SS-Na system. Compatibility of JLF-1 with high purity Flibe is inherently good. While, dissimilar metal contact and bonding, such as Ni, will increase weight loss of JLF-1 by electrochemical corrosion. Moreover, electrode potential change at, for example, weld joint may cause similar enhancement of corrosion of JLF-1.

Figure 2 presents line analysis results on the interface between JLF-1 specimens and Flibe. The peak at

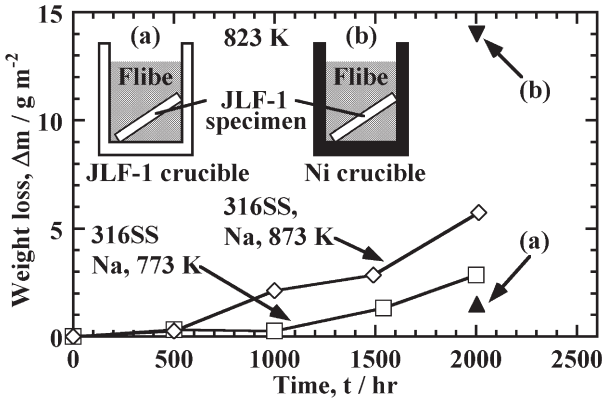

Fig. 1 Comparison of weight loss between JLF-1 in Flibe (present study) and 316 type stainless steel (316SS) in static liquid metal sodium[1]. Crucible for Na tests was also stainless steel.

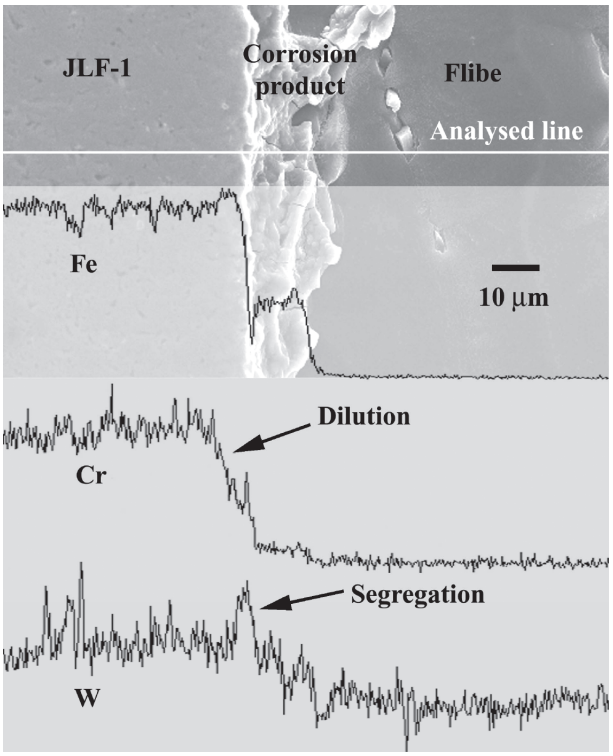

Fig. 2 Fe, Cr and W intensity by SEM-EDX line analyses at the interface between JLF-1 specimen and Flibe.

the JLF-1 specimen edge is considered as W segregation. Main corrosion agent in Flibe is HF, so that fluoride is possible as the corrosion products. Since Gibbs formation free energy of WF_6 is -251 kJ mol^{-1} per F atom is higher than -276 kJ mol-1 for HF, metal state of W should be stable in Flibe. Such behavior of W enables us to expect development of protective coating against Flibe corrosion.

Reference

[1] Vaidehi Ganesan and Vedaraman Ganesan, J. Nucl.Mater. 256 (1998) 69-77.

Table 1 Weight loss and evaluated lost depth during the Flibe exposure test.

Material		Weight of the coupon, m / g		Weight loss		Lost depth
Coupon	Crucible	(1) t = 0 hr	(2) t = 2003 hr	Δm = (1) – (2) / g	$\frac{\Delta m}{S_I}$ / g m^{-2}	D_L, μm
JLF-1	JLF-1	1.13117	1.13067	0.00050	1.5	0.19
JLF-1	Ni	1.13350	1.12900	0.00450	14	1.7