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§3. Compatibility of Low Activation Ferritic Steels with Liquid Lithium

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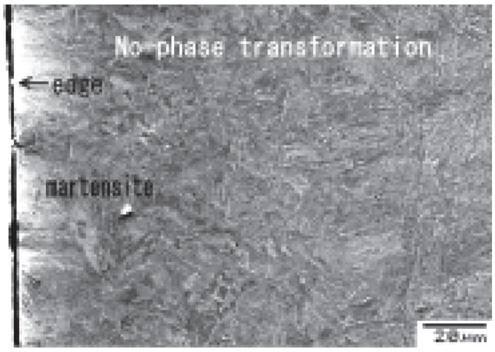
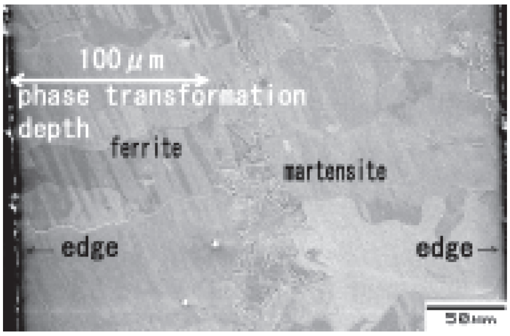
Fe-Cr-W based reduced activation ferritic steels are widely regarded as promising blanket structural materials for fusion reactors, while liquid lithium breeder/coolant concept provides an attractive option for high efficiency and simplicity of blanket system. However, past compatibility tests of ferritic steels with liquid lithium were almost limited to conventional Fe-Cr-Mo steels. In this study, the corrosion behavior of the candidate reduced activation ferritic steel, JLF-1(Fe-9Cr-2W-0.1C) in lithium was investigated.

JLF-1(JOYO-Ⅱ heat) coupon specimens with the size of 26×5×0.25mm were cut from sheet. Static exposure experiments in liquid lithium were carried out at 973K and 873k for 100h with molybdenum crucible, which were placed in stainless steel autoclave filled with argon. In thermal convection loop test, the temperature in hot leg and cold leg were 773K and 673K, respectively. The flow velocity was estimated as 0.05m/s. The exposure time was 250h. After experiment, specimens were cleaned by water, and the weight losses were measured. SEM/EDS analysis and hardness test were conducted on the surface and cross section.

According to static exposure test, at 873K, no phase change was found in microstructure of JLF-1 exposed to lithium for 100h, as shown in Fig 1(a). On the other hand, JLF-1 showed a phase transformation from martensite to ferrite with the depth 100μm from surface after exposed at 973K for 100h, as shown in Fig 1(b). In flowing condition, 10μm of phase transformation was also found on JLF-1 specimen exposed in hot leg (773K) after 250h exposure, as indicated in Fig 2. The chemical analysis showed that 2/3 of carbon in specimens dissolved into lithium at 973K after 100h static test, as shown in table 1. The phase transformation seemed to be caused by C dissolution. An EDS result indicated that depletion of Cr and W occurred during the lithium exposure. Phase transformation and element depletion resulted in softening on the surface. The softening depth was consistent with the phase transformation depth.



(a) 873K, 100h



(b) 973K, 100h

Fig.1 JLF-1 phase transformation after static lithium exposure

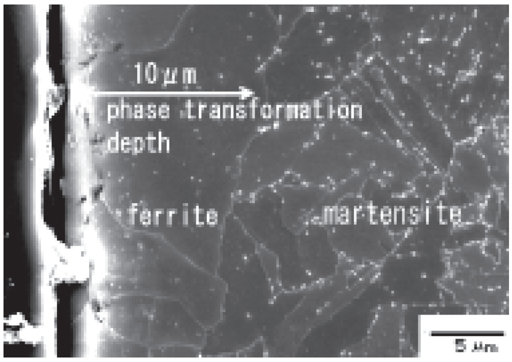


Fig.2 phase transformation in flowing condition at 773k, 250h

Table 1 chemical analysis results of JLF-1 exposed at 973K for 100h

Materials	C	Cr	W
Before exposure	0.09	8.92	2.00
700°C 100h	**0.03**	8.88	1.95
600°C 100h	0.10	8.89	1.99