§6. Compatibility of Ceramic Materials for in Natural Convection Lithium Loop

Suzuki, A., Nagura, M. (Univ. Tokyo),
Kondo, M., Muroga, T.

The magneto-hydrodynamic pressure drop is a critical issue for liquid lithium blanket system. As the resolution, fabrication of insulating coating on the inner surface of the channel was proposed. The compatibility of some insulating ceramic materials for coating materials has been investigated and the Er_2O_3 shows better compatibility than other candidate materials.[1)] On the other hand the corrosion behavior under flowing and non-isothermal condition is not investigated. In this study, the corrosion test of bulk ceramic materials in the natural convection lithium loop was carried out.

The Natural Convection Lithium Loop is made of SS 316 and equip drain tank and charge tank. The lithium ingots were loaded into the charge tank in the grove box which the atmosphere was displaced with pure argon gas. The temperature difference of the high temperature region and low temperature region makes the natural convection in the loop.

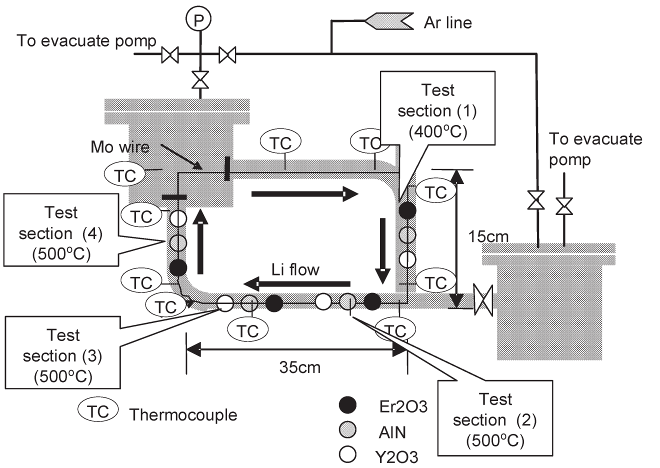

Fig1. Schematic of natural convection loop

Table 1. Operating condition

Temperature (°C)	Low temperature region (Test section (1))	400
	Heating region 1 (Test section (2))	500
	Heating region 2 (Test section (3))	500
	High temperature region (Test section (4))	500
Estimated flow velocity (m/s)		0.06
Operation time (hour)		250

The flow rate was estimated by calculating the driving force, friction loss by the loop wall and local losses by the elbows and tanks. However the specimens may have occurred more local losses and it can not been calculated. Other properties of the loop are shown in Table 1. Bulk ceramic specimens of Er_2O_3, $Y_2O_3$and AlN were set at four test section for each specimen in the loop. After the operation, the specimens were cleaned with water and the corrosion behavior was analyzed.

Some Er_2O_3 specimens were broken in the cleaning process, however, the analytical result of scanning electron microscope (SEM), X-ray diffraction (XRD) and X-ray photoelectron spectrum (XPS) shows the good compatibility. The fracture is considered as the result of its porosity. In the cleaning process, hydrogen gas was generated and may stress the specimens. The Y_2O_3 specimens which exposed at 500 ^oC formed $LiYO_2$ on the surface. This corrosion behavior was reported previously.[2)] The XRD peaks of $LiYO_2$ were detected and the crystal growth was observed in SEM images. From the XRD analysis, the specimens exposed at 400 ^oC do not form $LiYO_2$. The AlN specimen at heating region formed some corrosion products on the surface. The corrosion products seem like whiskers and this product affects the XRD spectrum. From the XPS analysis some oxygen enrichment were detected on the surface. Although there is some possibility that the corrosion products on AlN are an alumina which reported previously,[3)] it cannot identify in this study.

For all specimens, the weight change was negligible and the corrosion occurs only on surface. It can be said that the Er_3O_3, Y_2O_3 and AlN have good compatibility with liquid lithium, especially the Er_2O_3. On the surface of every specimen, cross-contamination by other specimens or SS316 loop wall could not detected in the XPS analysis.

The corrosion behaviors described above correspond to previous studies. So, the non-isothermal or flowing condition do not affects the corrosion behavior of Er_2O_3, Y_2O_3 and AlN, and these materials do not corrode drastically even in such condition.

Reference

1) Pint, B. A. et. al. :J. Nucl. Mater. 3297-333 (2004) 119
2) Terai, T. et. al.: J.Nucl. Mater., 233-237(1996) 1421
3) Brumm et. al.: Corr. Sci.,33 (1992) 1677