

§35. Compatibility and Mass Transfer Study for Liquid Breeder Blanket System

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Self cooled Liquid breeder blanket system is considered as advanced blanket system for possibility for reprocessing and simple structure. However, the corrosion of structural or coating material is critical issue for these blanket system development. In this study, purification of Flibe (LiF-BeF_2 molten salt) and corrosion test of Li was carried out for development of Flibe or Li blanket system.

Flibe blanket system has low chemical reactivity with air and it is free from MHD pressure drop for high electrical resistivity. Reduced Activated Ferritic Steels (RAF Steels), such as JLF-1 is considered as structural material for its compatibility with Flibe. To carry out corrosion study of these materials, pure Flibe is necessary which without the elements contained in candidate structural material. Presence of these elements will affect the corrosion rate. Oxygen also affects the corrosion test, since oxidation is one of the most important reactions in corrosion. These elements can be eliminated by chemical and mechanical processes. In previous study, 50 g of Flibe was purified by the chemical and mechanical process. However large scale purification is desired for further corrosion tests. In present study, 300 g of Flibe was purified for the first step to fabricate mass purification system.

At first the reagent of BeF_2 and LiF were prepared and packed into purification pod in vacuum groove box which atmosphere is He. The reagents are dehydrated by vacuum pumping. Next, the reagents were melted and fluoridated with 10% HF gas. The gas was generated from reacting H_2 with NiF powder. From this process, oxides like BeO , Fe_2O_3 or Cr_2O_3 become fluorides like BeF_2 , FeF_3 or CrF_3 . For the final step, these fluorides were reduced by H_2 gas. These metal fluorides become metal and were segregated in the cooling process. Figure 1 shows crushed Flibe after cooling. Metal impurities are condensed in gas-Flibe interface and the interface became black. ICP analysis shows that Ni was segregated efficiently in black part. Fe and Cr are considered to be segregated as Ni by prolonging the reduction process.

Liquid Li blanket system has high tritium breeding ratio and good heat exchangeability. Fabrication of insulating coating inside the duct is proposed to reduce the Magneto hydrodynamic (MHD) pressure drop. Er_2O_3 is promising material for chemical stability. Although reaction of Er_2O_3 with Li is minimal, corrosion behavior of Er_2O_3 in Li must be clear to evaluate the duration of coating. In this study Er_2O_3 were immersed in liquid Li under static and flowing condition. Corrosion behavior of

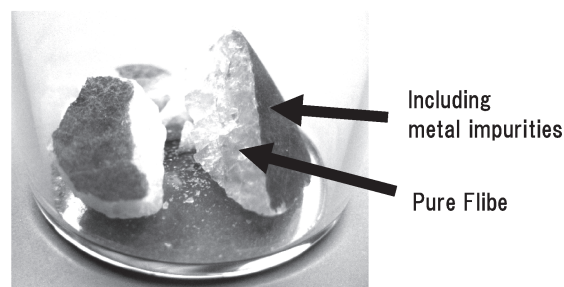


Fig.1. Crushed Flibe after cooling. White part is pure Flibe without Ni. Metal impurities are segregated in gas-Flibe interface.

Er_2O_3 in the Li became clear.

Sintered Er_2O_3 tablets were immersed as specimen. For static test, capsule made by type 316 stainless steel was used as crucible. For flowing test natural convective Li loop which is made by 316 stainless steels is constructed. Test temperature was up to 600 °C for both tests. After immersion, specimen was analyzed with Scanning Electron Microscopy (SEM), X-ray diffraction (XRD) spectrometry and weight measurement. These analyses showed that the Er_2O_3 increase its weight in Li. Figure 2 indicates the relation of weight increase with the test temperature in static condition. Corrosion products are observed in SEM images and it causes the weight increase. Diffraction patterns appeared in the XRD spectrum of the specimen on which corrosion products are observed by SEM observation. Corrosion product is considered as LiErO_2 from the XRD pattern. In the flowing test, almost same corrosion behavior was observed. Mass transfer, which happens sometime for other materials corrosion in such flowing condition, was not detected. Therefore production of LiErO_2 will be a problem in practical use of Er_2O_3 in Li blanket system.

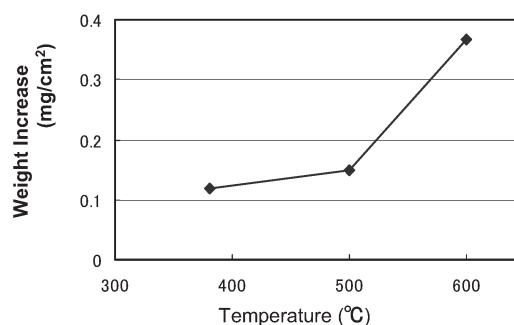


Fig.2 Weight increase of Er_2O_3 tablet in static Li.

For summary, purification of 300 g Flibe and corrosion test of Er_2O_3 in Li were carried out. For Flibe purification, Ni in Flibe was segregated efficiently. Fe and Cr can be removed by prolonging the reduction process. From Er_2O_3 corrosion test, corrosion behavior becomes clear that LiErO_2 forms in Li. The formation of LiErO_2 must be suppressed.

1) Nagura, M., et al. Fusion Sci. Tech. **52**, (2007) 630