§23. Compatibility Research for Flibe and Li Blanket System

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Liquid blanket system is considered as advance blanket system for its reprocessing capacity through the reactor operation. BeF_2-LiF mixture molten salt (Flibe) and liquid Li are considered as a tritium breeder and coolant. For these two liquid breeders, material corrosion is regarded as critical issue because these liquids are reactive with materials at high temperature. In current research, we are focusing on two compatibility issues. Reduced activated ferritic steel (RAF steel) corrosion in Flibe and ceramic material corrosion in Li.

In Flibe blanket system, RAF steels are the candidate material for its comparatively good compatibility with the molten salt. Detailed corrosion behavior or mechanism is not well understood because corrosion specimen is sensible for corrosion condition such as impurities in Flibe and treatment after the immersion.[1] Surface condition or corrosion chemistry in Flibe was hardly observed directly by current equipments. To solve this problem, we planned to develop electro chemical cell for corrosion study to carry out electro chemical measurement. This kind of electro chemical devise for Flibe was not established before. Schematic diagram of the cell is shown in Fig. 1. This cell is equipped with three electrodes which are working electrode, counter electrode and reference electrode. Voltage is applied between working and counter electrode. Current is measured with voltage applied to Flibe. The reference electrode shows standard voltage through the measurement. This reference electrode needs to maintain two conditions, such as constant voltage during the measurement and have an electric contact with working electrode via Flibe. To achieve these conditions, the reference electrode in current cell uses H_2 redox reaction in the Flibe.

$$H_2 \leftrightarrow 2H^+ + 2e \qquad (1)$$

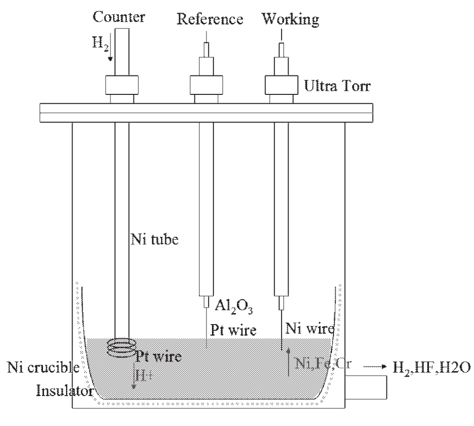

Fig.1. Electrochemical measurement cell for Flibe

By keeping this reaction on the surface of Pt, the reference electrode can maintain constant voltage. Test run of this cell is shown in Fig.2. Negative voltage was applied to working electrode. The reduction of Be^{2+} appears from around -2.2V, and after reversing the sweep direction, oxidization of Be to Be^{2+} appeared. From this test measurement, it was confirmed that this newly developed electro chemical cell for Flibe corrosion study performed as our planning.

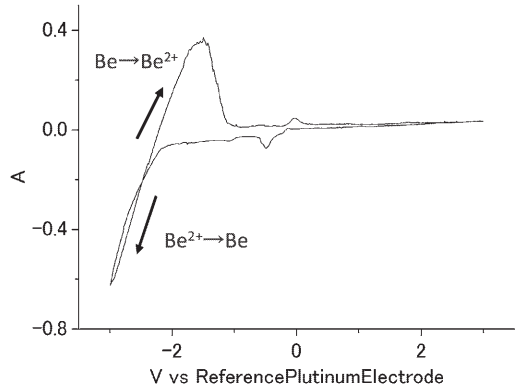

Fig.2. Reduction and oxidization of Be by electrochemical measurement

For the liquid Li blanket system, development of insulating coating to prevent MHD pressure drop is one of the critical issues. Erbium Oxide (Er_2O_3) is a promising candidate as coating material for its high thermodynamic stability. In this study, corrosion of Er_2O_3 in high temperature Li is investigated. From the previous research, it became clear that Er_2O_3 forms $LiErO_2$ in high temperature liquid Li[2]. Corrosion test of Er_2O_3 in Li with several O concentrations was newly carried out. Fig. 3 shows the corrosion rate of specimens with additives to Li. Er and Ca additives decrease O concentration in Li. Therefore, it is clear that corrosion rate of Er_2O_3 in Li depends on O concentration in Li.

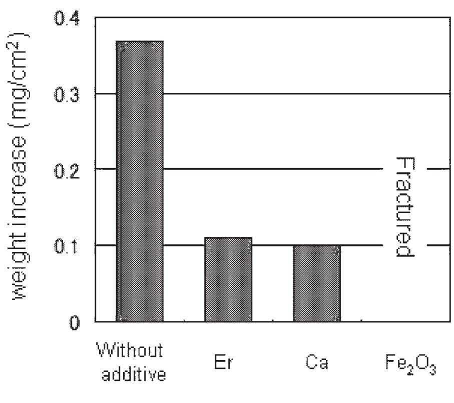

Fig.3. Corrosion rate of Er_2O_3 in several O conditions

1) Nishimura, H. et al.: J. Nucl. Mater. **282-283** (2000), 1326
2) Nagura, M. et al.: Fusion Eng. Des. **84** (2009) 1384