§50. Compatibility of Structural Materials with FLIBE

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A molten salt mixture of LiF-BeF_2 (FLIBE) is considered as a candidate for tritium breeding material in a liquid blanket system. It has favorable characteristics as follows:

1) chemical stability, and
2) lower electric conductivity then liquid metals (which results in the lower MHD pressure drop)

As for FLIBE, however, essential information such as the behavior of tritium in it and its corrosion behavior data against structural materials is still very poorly provided and experimental data are strongly required.

Then, the compatibility of FLIBE with such materials is one of the critical issues for the system design. As a fundamental research, this work aims to elucidate the process and mechanism of the corrosion under static conditions at high temperature by both experimental and theoretical studies.

The corrosion behavior of FLIBE against structural materials has been studied for, *e.g.* Ni-based alloys, which has been practically utilized for the core container of Molten Salt Reactor Experiment (MSRE). In general for molten salt corrosion, impurities in the system tend to play an important role. As for FLIBE blanket system, HF, H_2O and O_2 would be generated under neutron irradiation, and its chemical behavior should be investigated thoroughly. Ferritic steel, JLF-1, or V-based alloy is supposed to be used as structural materials in FFHR, but no experimental study is so far found for these materials. Moreover, almost nothing is known about the compatibility of these materials with FLIBE under a metallic-beryllium-coexisting system which causes a highly complex redox condition.

Thus, the followings were performed:

1) thermochemical calculation for screening practically conditions in experimental systems
2) preliminary dipping experiment, and
3) design an apparatus for the compatibility examination

In the computational study, the compatibility of structural materials with FLIBE under the atmosphere containing HF, H_2O, and O_2 was simulated using an integrated thermochemical data base system, MALT2[1,2] and an attached Gibbs free energy minimizer, *gem* code[3] for the calculation of chemical equilibria.

It was found that structural materials would be ready not to be fluorinated but to be oxidized if oxidizing species existed. The constituents of FLIBE itself and its atmosphere under neutron irradiation were estimated in consideration of nuclear transmutation for arranging the definitive condition for experimental study. Though fluorination was found under the atmosphere containing HF, structural materials such as ferritic steel, JLF-1, V-based alloy, and molybdenum would have sufficient corrosion-resistance when those oxides functioned as protective scales. Moreover, it can be considered that corrosion behavior is more moderate when the practical blanket system is taken into account. On the other hand, it was confirmed that addition of metallic beryllium is very effective for removal of corrosive specimens, and that structural materials are not attacked at all in the beryllium-added systems. It was shown, however, that SiC has no satisfactory corrosion-resistance and that graphite may have corrosion-resistance if metallic beryllium is added in the system and graphite is insoluble to FLIBE.

In the preliminary experiment, molybdenum and 430 ferritic steel (Fe-18Cr) were examined on corrosion-resistance against molten FLIBE. Lithium fluoride (LiF) of 99.9% in purity and beryllium fluoride (BeF_2) of 99.5% supplied by Furuuchi Chemical Corporation were used to prepare the fluoride mixture. Molybdenum and 430 ferritic steel samples supplied by the Nilaco Corporation were used for examination specimens. Dipping experiments were performed in a glove box. Molybdenum crucibles were used as containers, in each of which a test specimen was put with fluoride components weighed to be a 2:1 mixture of LiF and BeF_2 and sufficiently mixed in an agate mortar. The fluoride mixture was dried at *ca.* 673 K for about 3 hours, and then, the crucible was kept at elevated temperature, 823 K. Finally, the specimen was taken out of the cooled-down and frozen salt. Remarkable corrosion was not observed, but some problems to be solved were found on experimental procedure.

References

1) S. Yamauchi: Netsu Sokutei **12** (1985) 142
2) H. Yokokawa: Netsu Sokutei **12** (1985) 144
3) T. Matsumoto, H. Yokokawa: Netsu Sokutei **19** (1992) 170