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Double wall confinement for XAFS analysis on molten thorium fluoride mixtures

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Introduction

It is important to develop the system of nuclear energy continuously, though a lot of other renewable energy sources would be introduced in the near future. Current nuclear fuel cycles are mostly based on using uranium-plutonium cycle, but thorium-uranium cycle can be considered as another option. By using this cycle, it would be possible to construct more harmless reprocessing process for environment, because it produces lower amount of minor actinides. The molten salt reactor (MSR) is one of the reactors using thorium based fuel. However, the basic structural data of molten metal fluorides containing actinide fluorides is still lacking to construct a global model for expecting physico-chemical properties and behaviour of these materials in each step of fuel reprocessing. To make a realization of EXAFS measurements of molten metal fluorides containing ThF_4, some of the LiF-ZrF_4 systems have been used for testing confinement.

Experimental

The sample is prepared as a pressed pellet with boron nitride powder, and sealed by two pyrolytic boron nitride plates tighten by 6 volts and nuts (1st wall, which is based on the design experienced [1]), and furthermore, installed to airtight crucible (2nd wall) made by boron nitride in high grade (Fig. 1) under argon circulated glove box. A sample was installed in an electric furnace located between ionization chambers. Transmitted XAFS spectra have been collected, using Si (111) double crystals monochromator at Zr-K X-ray absorption edge. Normal transmission mode is used for EXAFS measurement. Gases of ion chambers for incident and transmitted are N_2-Ar(50%) and Ar, respectively. The size of beam irradiated to the sample is adapted to the pellet size, normally 1 mm vertical and 2 mm horizontal.

Results and discussion

EXAFS oscillations of ZrF_4-LiF (x_{ZrF4}=0.21) at various temperatures equilibrated using the cell design described above and using the cell design shown in [1] have been carried out. Figure 2 shows the structure functions of the sample obtained at the same temperature, i.e. 700 ^{o}C. Both results are identical each other. After the EXAFS measurement, the characterization of the sample has been also performed. Zr element could not be identified both inside the 2nd wall and outside of the 1st wall. Furthermore, the sample containing ZrF_4 did not reach to the holes for volts and nuts, and the chemicals in the pellets did not be oxidized according to the results at various positions by EDX. It means that this construction works well for the protection from any contamination of ThF_4 to outside. For the experiments using ThF_4 at high temperature, we are now going to test using exactly the same confinement under the condition of the real sample heated by completely closed furnace (3rd wall), i.e. hot offline test.

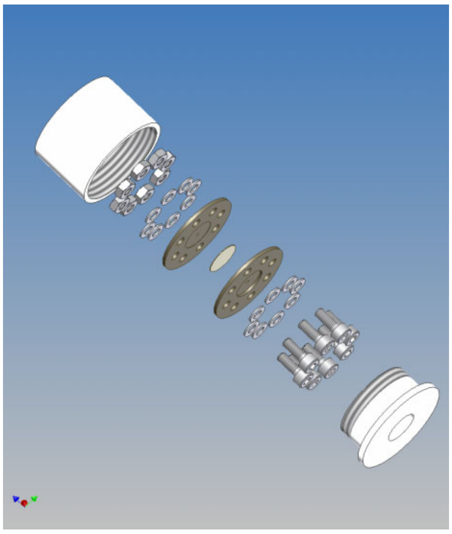

Fig. 1 double wall confinement designed for EXAFS measurements of metal fluorides containing ThF_4 at high temperature.

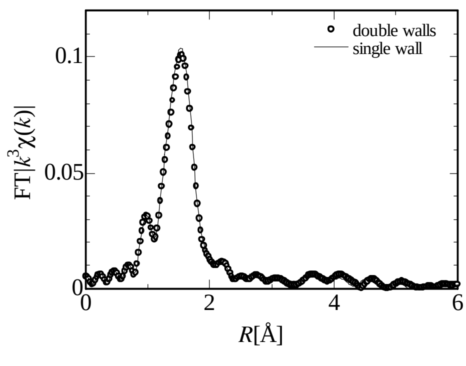

Fig. 2 Structure functions of ZrF_4-LiF (x_{ZrF4}=0.21) at 700 ^{o}C using double wall confinement and single wall only.

References

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