Investigation of chemical reactivity between Cs-U-O compounds and Zr materials

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1. Introduction

The chemical interactions among fission products, actinides and zircaloy cladding material are known to give a lot of complex compounds in the gap region of nuclear fuel[1]. These compounds could give rise to the adhesion between pellet and cladding, and the formation of third phases which should have an effect on the efficiency of nuclear fuel. In this work, Cs-U-O compound was synthesized as a simulated compound of the reaction between Cs and UO_2[2,3] and its chemical reactivity with Zr and ZrO2, which are main components of Zircaloy cladding, was tested using Thermogrvaimety and Differential Thermal Analysis (TG-DTA).

2. Experimental

2.1. Preparation of Cs- U-O compounds
A mixture of UO_2 and Cs_2CO_3 was pressed in pellet form and the pellet was heated in air at 670 ℃ for 24 hours. The heated sample was characterized by XRD (Fig. 1).

2.2. Reaction of UO2 with Zr
Thermal properties against compressed mixed powder of UO_2 and Zr was measured in continuous Argon flow at 1 atm. and temperature ranging from 20 ℃ to 670 ℃ at heating rate 1 ℃.min. using TG-DTA (Fig. 2).

2.3. Reaction of Cs-U-O with ZrO_2
Thermal properties against compressed mixed powder of Cs-U-O and ZrO_2 was measured with the same method as 2.2 (Fig. 3).

2.4. Reaction of Cs-U-O with Zr
Thermal properties against compressed mixed powder of Cs-U-O and Zr was measured with the same method as 2.2 (Fig. 4).

3. Results and discussion

3.1. Preparation of Cs-U-O compounds
As shown in Fig. 1, two coexisting phases of Cs_2UO_4 and $Cs_2U_2O_7$, as the Cs-U-O compounds, were found.

3.2. Reaction of UO2 with Zr
In fig.2, no distinctive peak is shown in the thermogravimetric and heat flow curves. It means that there is no chemical reactivity between two compounds on the contact surface of UO_2/Zr.

3.3. Reaction of Cs-U-O with ZrO_2
As shown in fig.4, no distinctive peak is shown. It means that there is no chemical reactivity between two compounds on the contact surface of UO_2/ZrO_2.

3.4. Reaction of Cs-U-O with Zr
In fig.5, a distinctive peak is shown in the thermogravimetric and heat flow curves which is different from two cases (3.2., 3.3.) aforementioned. It means that there is especially chemical reactivity between two compounds, Cs-U-O and Zr.

4. Conclusion

Among three reaction tests of UO2/Zr, U-Cs-O/ZrO_2 and U-Cs-O/Zr, only the third one shows a reactivity between two compounds. This result could be useful information for understanding chemical interaction occurred in the gap region of UO_2 nuclear fuel.

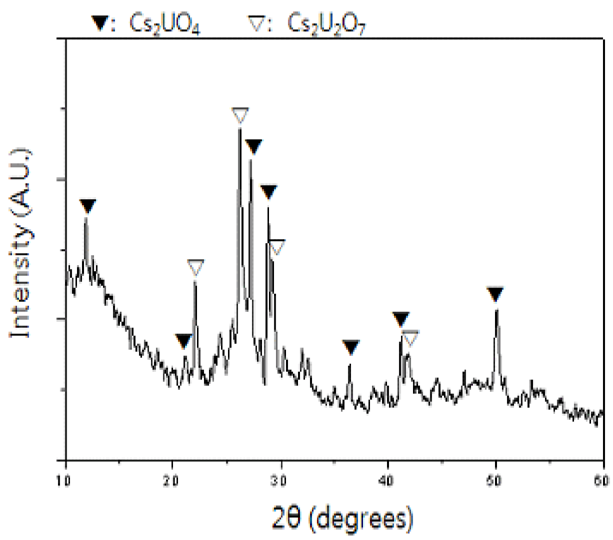

Fig. 1. X-ray diffraction patterns from U-Cs-O compound synthesized.

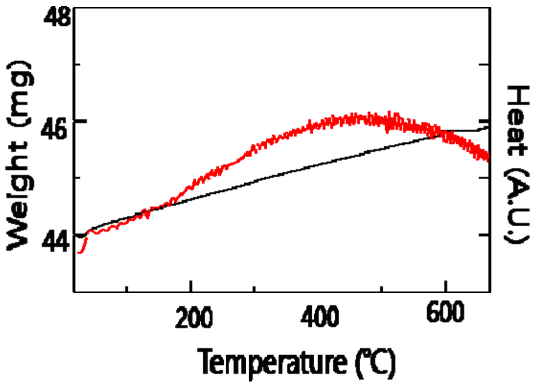

Fig. 2. TG-DTA curves for the interaction between UO2 and Zr.

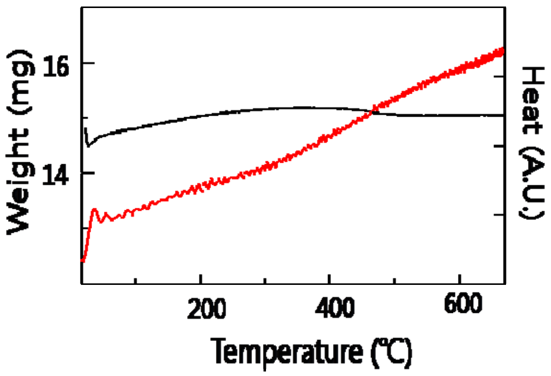

Fig. 3. TG-DTA curves for the interaction between U-Cs-O and ZrO_2.

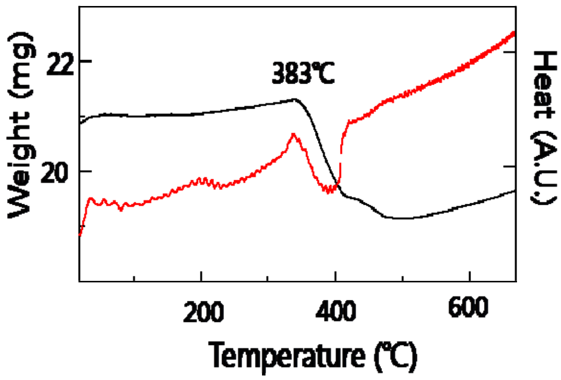

Fig. 4. TG-DTA curves for the interaction between U-Cs-O and Zr.

REFERENCES

[1] Heiko Kleykamp, "The Chemical State of the Fission Products in Oxide Fuels", J. Nuclear Materials, **131**, 221-246 (1985).

[2] "Chemistry of the UO_2 Fuel Periphery-Properties of Cs-U-O Compounds", ITU Annual Report 1992 (EUR 15154), Page 124

[3] "Interaction of Fuel with Structural Materias", ITU Annual Report 1995 (EUR 16368), Page 145