# Phase analysis of Zr doped $UO_2$

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## 1. Introduction

In a hypothetical case of a nuclear reactor severe accident, the reactor core could melt and form a mixture (called corium) of $UO_2$, $ZrO_2$ and other elements. Therefore, a characterization of the corium is needed. For this purpose, XRD analyses for molten simulated corium samples have been performed [1-3].

In this study, the phases of the $UO_2$ - $ZrO_2$ mixture sintered at high temperature and its oxidized sample were investigated by X-ray diffraction for a basic phase study.

## 2. Experimental and Results

### *2.1 Sample preparation*

The sintered pellets were prepared with the composition of 0, 5 and 25 at% - Zr in $UO_2$-$ZrO_2$ mixture by heating for 12 h at 1700 $^oC$ in an atmosphere of $H_2$. The oxidized samples of the solid solutions were prepared by a heating from a room temperature to 500 $^oC$ with a velocity of 1 $^oC$ / min. in air.

### *2.2 XRD system*

The X-ray diffraction system (D5000, SIEMENS) with a Cu$K_\alpha$ line filtered through a Ni foil was used to obtain XRD patterns of the sintered $UO_2$-$ZrO_2$ samples and the oxidized $UO_2$-$ZrO_2$ solid solution samples. The measurement was carried out with a scanning step of 0.02° for 1s per each count and a divergence slit of 1 mm and a detector slit of 0.1 mm in width. The X-ray beam current was 40 mA at a 40 kV beam generation power.

### *2.3 XRD spectrum of the sample sintered at 1700 ℃*

The XRD patterns of the $UO_2$-$ZrO_2$ samples sintered at high temperature with the composition of 0, 5 and 25 at% - Zr are shown in Fig. 1. The pure $UO_2$ has a cubic phase and showed a value of a = 5.464 Å. In XRD pattern of the sample of 5 at% - Zr, cubic phase of $UO_2$ sample was maintained but the peaks were shifted to the high degrees(2Θ ). Therefore, the size of its unit cell was reduced and the lattice parameter showed a value of a = 5.430. In case of the sample of 25 at% - Zr, the value of a = 5.377 was obtained. In the result, the increase of the composition of Zr solute into the $UO_2$ lattice decreases the volume of the $UO_2$ unit cell without a change of the cubic phase.

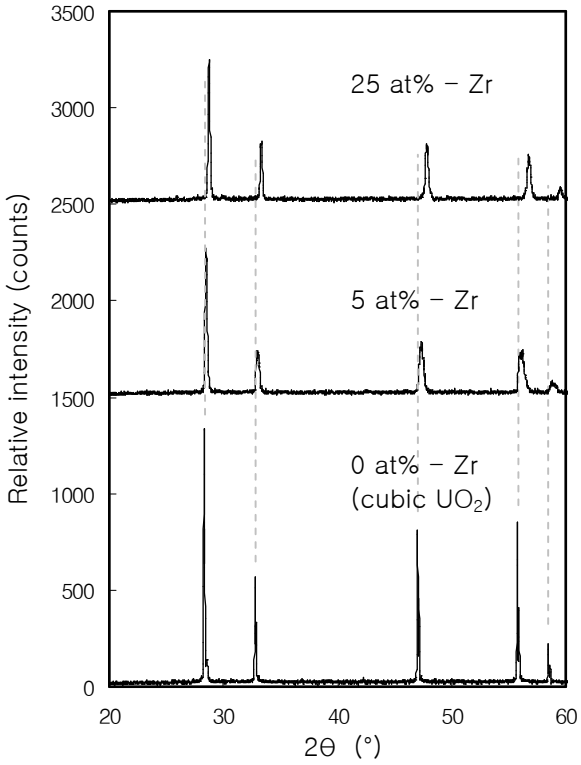


Figure 1. XRD patterns of the sintered $UO_2$-$ZrO_2$ samples with the composition of 0, 5, 25 at% - Zr

### *2.4 XRD spectrum of the oxidized sample of solid solution*

The XRD patterns of the oxidized samples of the $UO_2$-$ZrO_2$ solid solutions as stated above are shown in Fig. 2. The $UO_2$ sample with 5 at% - Zr was oxidized to $U_3O_8$ of the orthorhombic phase. On the other side, the $UO_2$ with 25 at% - Zr was oxidized to $U_3O_8$ of the hexagonal phase, and $ZrO_2$ of tetragonal phase not monoclinic that the pure

$ZrO_2$ has a monoclinic phase in general was shown in XRD spectrum.

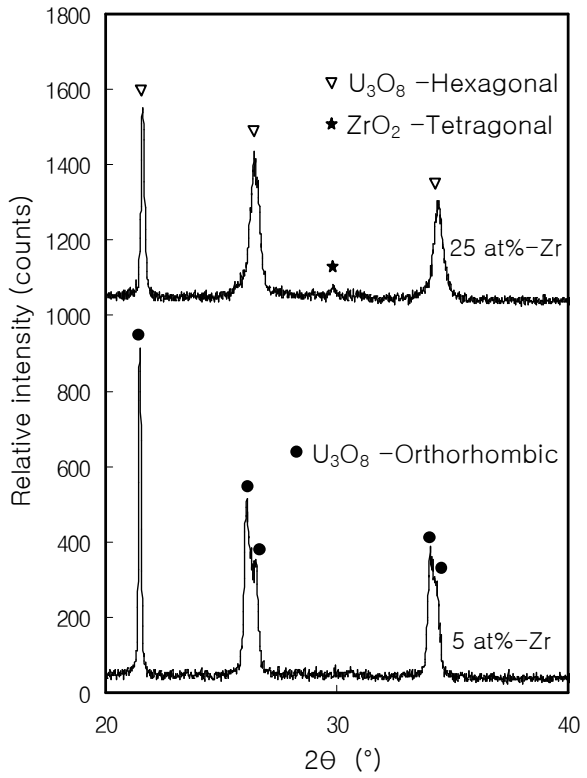


Figure 2. XRD patterns of the oxidized $UO_2$-$ZrO_2$ solid solution samples with the composition of 5, 25 at% - Zr

### 3. Conclusion

It was identified that $ZrO_2$ was soluted into the lattice of a cubic phase of $UO_2$ and contracted the size of the unit cell. And, in the oxidation of the solid solution sample, the $UO_2$ was oxidized to $U_3O_8$ of the hexagonal phase not orthorhombic due to the solute $ZrO_2$.

We are planning to analyze the phases by an XRD for samples with various composition of Zr for a basic phase study about corium.

### REFERENCES

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