Study of Trivalent Cation doped Uranium Oxides through In-Situ X-ray Diffraction

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Introduction

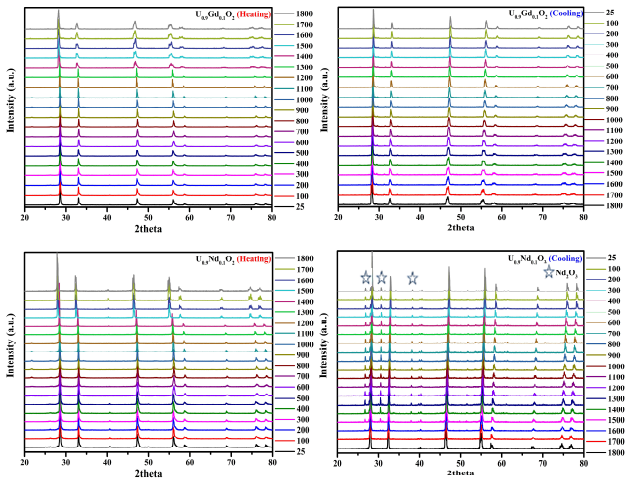
- Uranium oxide materials have been of particular interest in broad nuclear fuel fields because of the structural changes derived from various oxidation state numbers such as UO_2, U_4O_9, U_3O_8 and UO_3.
- In the case of nuclear fuel material, since the structure of the nuclear fuel can be observed during the reaction at high temperature, the difference of the nuclear fuel structure measured can be clearly identified at room temperature.
- We measure the variation of temperature on the size of crystalline, which is a cell parameter in the reaction process. And then, the change of lattice parameters is calculated by Rietveld refinement method.

Results & Discussion

High-temperature x-ray diffraction

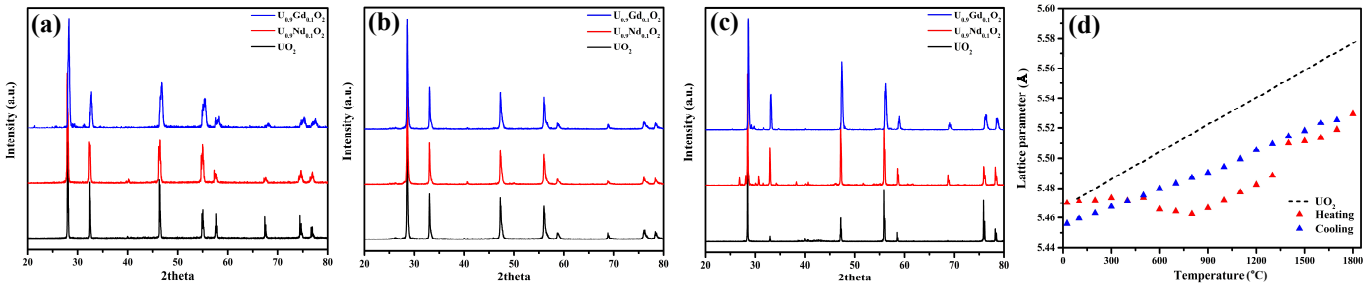
- Model : HTK 2000N (Anton Paar)
- Temperature range : 25 °C ~2300 °C (W strip)
- Atmospheric condition : Air, N_2

Powder X-ray diffraction patterns of $U_{0.9}M_{0.1}O_2$ (M=Nd^{3+} and Gd^{3+})



- $U_{0.9}Gd_{0.1}O_2$: $UO_2 + Gd_2O_3$ (25 °C) → $U_{0.9}Gd_{0.1}O_2$ (1800 °C) → $U_{0.9}Gd_{0.1}O_2$ (25 °C)
- $U_{0.9}Nd_{0.1}O_2$: $UO_2 + Nd_2O_3$ (25 °C) → $UO_2 + Nd_2O_3$ (1800 °C) → $UO_2 + Nd_2O_3$ (25 °C)

Powder X-ray diffraction patterns and Lattice parameters



- (a) room temperature, (b) 1800 °C, (c) after the cooling of $U_{0.9}M_{0.1}O_2$ (M=Nd^{3+} and Gd^{3+}), and (d) lattice parameters of $U_{0.9}Gd_{0.1}O_2$
- Gd case : decreasing lattice parameter (doping effect)
- Nd case : similarly UO_2 (not doped Nd)

Conclusion

- We investigated the temperature dependence of the UO_2 material using in-situ x-ray diffraction.
- The cell parameters were characterized by calculation methods (TOPAS).
- The controlled condition of $U_{0.9}M_{0.1}O_2$ (M=Nd^{3+} and Gd^{3+}) was heated gradually to above 1800°C.
- The change of lattice parameter of $U_0.Gd_{0.1}O_2$ crystal structures was confirmed by XRD patterns.

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