Development of ultramicro analysis technology for fuel debris analysis (17) Comparison of the powderization effect of non-equilibrium plasma oxidation and thermochemical oxidation powders of uranium dioxide solids for actinide analysis

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Abstract

A non-equilibrium plasma oxidation device was developed to verify the powderization of uranium dioxide solids and to compare the results with thermochemical oxidation. For the results of the plasma oxidation experiment, Uranium dioxide solid (42mg) can be partly converted to powder by plasma oxidation (6.5h, O_2:0.4 L/min) with a low temperature (less than 200℃). Small uneven bumps of 1μm or less appears on the surface of powders produced by oxidation using non-equilibrium plasma.

Keywords: nuclear fuel debris, non-equilibrium plasma oxidation, voloxidation,

1. Introduction

The amounts of actinide and isotope ratios of actinides in the nuclear fuel debris from the Fukushima accident are required to known for the determination of the plan of the treatment and disposal of nuclear fuel debris. For these analyses, the dissolution of debris, and the nuclide separation are necessary[1].

Thermal oxidation can lead to the powderization of solid uranium dioxide and the volatilization of volatile radioactive materials. It is desirable to cause oxidation reactions under the milder conditions possible for analysis. We therefore developed a non-equilibrium plasma oxidation device to verify the powderization of uranium dioxide solid under lower temperature condition and to compare the results with thermochemical oxidation.

2. Experiment method and results

The heating and oxidation experiment of uranium oxide solid was carried out by using electric furnace and plasma oxidation device. As results of the plasma oxidation experiment, the powderization of uranium dioxide solid was confirmed, and that uranium dioxide was converted to triuranium octoxide by XRD. We found that the particle size distribution is obeyed the logarithmic normal distribution with $30.32 \pm 20.07\ \mu$ m. From results of SEM observation, the very small uneven bumps of 1μm or less appears on the surface of powders produced by oxidation using non-equilibrium plasmas was observed, therefore, the increasing the surface area required for dissolution or chemical conversion to soluble compounds can be expected.

3. Conclusion

As a conclusion, a oxidation reactor using non-equilibrium plasma was developed and the feasibility of the powderization of solid Uranium Dioxide material was possible with a lower temperature(less than 200℃) compared to the thermochemical oxidation (600℃).

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References

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