7–5 The Effect of Am upon the Themophysical Properties of MA-MOX Fuel

— The Relationship between Oxygen Potential and the O/M Ratio of $(Pu_{0.928}Am_{0.072})O_{2-x}$ —

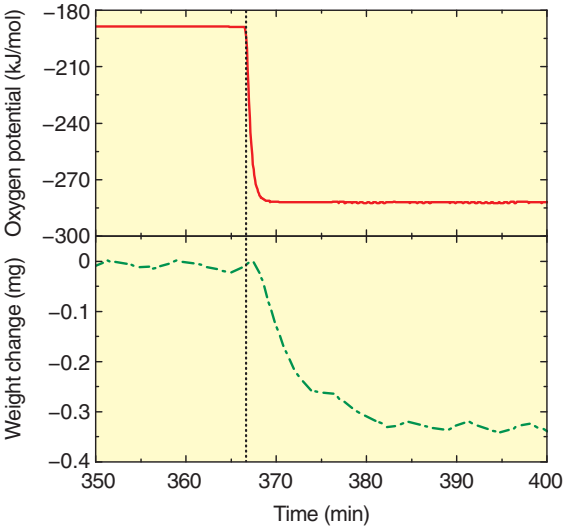

Fig.7-9 The change of oxygen potential and specimen weight
The upper and lower figures show the change in the oxygen potential and specimen weight, respectively. The specimen weight decreased with decrease in the oxygen potential, indicating that the specimen was reduced.

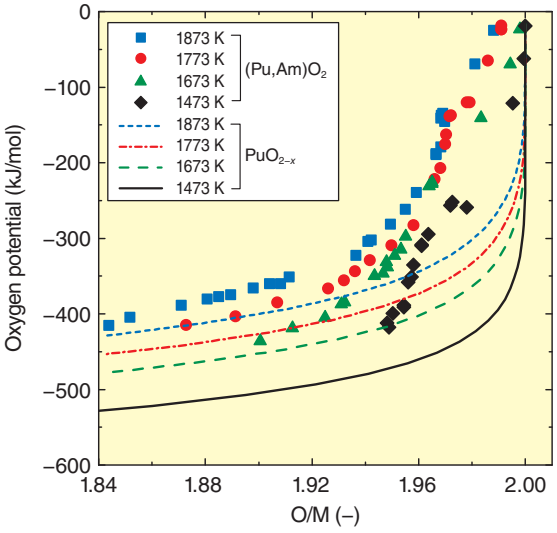

Fig.7-10 Oxygen potentials of $(Pu_{0.928}Am_{0.072})O_{2-x}$ and PuO_{2-x}
It was observed that the oxygen potential of $(Pu_{0.928}Am_{0.072})O_{2-x}$ was approximately 200 kJ/mol higher than that of PuO_2 in the near-stoichiometric region.

The spent nuclear fuels discharged from nuclear power plants contain minor actinides (MAs) such as americium (Am) and neptunium (Np). Since these MAs have high and long-term radiotoxicity, it is better to transmute MAs into stable or less-radiotoxic nuclides by leveraging fast reactors (FRs). MA-bearing oxide fuel is a major fuel candidate for FRs and is therefore required to measure various physical properties of the oxide fuel. Among MAs, Am significantly influences oxygen potential (ΔGO_2), which is an important physical property. ΔGO_2 has a direct effect upon the oxidation or reduction of oxide fuel. The change in ΔGO_2 causes a change in the oxygen-to-metal (U, Pu, MAs) ratio (O/M ratio) in oxide fuel. It is well known that such a change significantly affects the sintering and irradiation behavior of oxide fuels.

In this study, we evaluate the relationship between ΔGO_2 and the O/M ratio in Am-bearing PuO_2 ($(Pu,Am)O_2$) using thermogravimetry and estimate the effect of Am content upon ΔGO_2. The oxygen is released into the atmosphere from a specimen or absorbed into the specimen from the atmosphere as the ΔGO_2 value of the atmosphere changes. Weight change by release or absorption was measured using thermogravimetry (Fig.7-9). By means of measuring the change in the specimen weight under various atmospheres and temperatures, the relationship between ΔGO_2 and the O/M ratio was evaluated.

The measured ΔGO_2 data are plotted against the O/M ratio, together with the literature data for PuO_{2-x} (Fig.7-10). ΔGO_2 increased along with the increase in temperature. In particular, the ΔGO_2 value of $(Pu_{0.928}Am_{0.072})O_{2-x}$ markedly increased in the near-stoichiometriy (O/M = 2.00) region compared with that in PuO_2 at the same temperature. Am is known to be more reductive than Pu; therefore, the increase in ΔGO_2 of $(Pu,Am)O_2$ in the near-stoichiometry region is considered to be caused by preferential reduction of Am.

We are going to conduct a test using Am-bearing MOX fuel to clarify the detailed mechanism by which Am affects ΔGO_2.

Reference

Matsumoto, T. et al., Oxygen Potential Measurement of $(Pu_{0.928}Am_{0.072})O_{2-x}$ at High Temperatures, Journal of Nuclear Science and Technology, vol.52, issue 10, 2015, p.1296-1302.