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## FABRICATION OF MIXED OXIDE FUEL USING PLUTONIUM FROM DISMANTLED WEAPONS

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### INTRODUCTION

The Department of Energy's Office of Fissile Materials Disposition has funded Los Alamos National Laboratory (LANL) to investigate key technical issues unique to the use of plutonium from dismantled weapons in MOX fuel for commercial power reactors. These issues include how the methods of separating the plutonium from the other weapons materials and of converting it to  $\text{PuO}_2$  would affect the fuel fabrication process, how the gallium in the weapons plutonium would affect the fuel fabrication process and MOX pellet quality and performance, how the gallium content in the plutonium might be reduced, and how this removal process would affect fuel fabrication and quality. A number of experimental studies have been conducted to investigate these issues.

### EXPERIMENTAL PROCEDURES

Plutonium dioxide produced from a dismantled weapon by the hydride/oxidation process at LANL was obtained. Because initial experiments indicated that the gallium in the plutonium evolved at high temperatures in a reducing atmosphere, thermal treatment tests on the plutonium dioxide powder were performed to determine if an effective dry gallium removal process could be devised. These tests included heating the  $\text{PuO}_2$  powder in an Ar-6%H atmosphere at temperatures of 400°C, 900°C, 1000°C, and 1100°C for 2 hours, and 1000°C for 4 hours. To determine the effects of the thermal treatment on the fabrication process and final pellet quality, MOX pellets were fabricated using the  $\text{PuO}_2$  treated at 1100°C for 2 hours concurrently with pellets containing untreated  $\text{PuO}_2$ , and the quality assessed. Additional fabrication tests were performed to determine the effects of various processing parameters on pellet quality. These parameters included milling techniques, the use of a binder, sintering parameters, and variation in the uranium feed source.

### RESULTS

The results of the  $\text{PuO}_2$  powder treatment tests are given in Table 1. The results show that the final gallium content is highly dependent on the treatment temperature, with practically no gallium evolving at 400°C and the 1100°C treatment reducing the gallium by 97%. Using the 1100°C treatment, less than 10 ppm gallium in the final MOX blend can be obtained. Fabrication tests using the 1100°C treated plutonium showed that MOX pellets made with the treated material sintered to the same density as untreated plutonium (93% theoretical density) when high energy milling was used.

Results of additional experiments indicated that no substantial change in pellet quality was introduced by the elimination of the binder, but that the milling process, sintering parameters, and uranium feed did effect various pellet properties.

### CONCLUSIONS

Work is continuing at LANL to resolve issues associated with using weapons plutonium in MOX fuel in commercial power reactors. A thermal treatment for reducing the gallium content in the plutonium has been demonstrated. Activities will continue for optimizing this process. Additional fabrication experiments have demonstrated the ability to fabricate MOX fuel with acceptable properties using plutonium derived from weapons

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using the hydride/oxidation process. Future work will concentrate on identifying the changes in fabrication process parameters that are needed to handle the variations in feed material expected for large-scale plutonium disposition activities.

#### REFERENCES

H. THOMAS BLAIR and KEVIN B. RAMSEY, "Experience Making Mixed Oxide Fuel with Plutonium from Dismantled Weapons," *Proceedings of the International Conference on Nuclear Engineering, Vol. 4*, 465-470, New Orleans, LA, March 11-14, 1996.

Table 1. Results of Thermal Treatment Tests for Gallium Removal

Thermal Treatment	Gallium Content (ppm)
None	5030
400 °C for 2 hours	5017
900 °C for 2 hours	918
1000 °C for 2 hours	365
1000 °C for 4 hours	312
1100 °C for 2 hours	127

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