Thermophysical Properties of $(Th,Pu)O_2$ Mixed Oxides

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Thorium dioxide and thorium-plutonium mixed oxides (MOX) can be used as nuclear fuels in advanced reactors. Although not fissile itself, thorium-232 absorbs slow neutrons to produce uranium-233, which is fissile. The measurement of the thermal conductivity of these materials is essential in order to be able to predict their in-pile behaviour and margin for safe operation.

The thermal diffusivity and specific heat of $(Th,Pu)O_2$ (with 3, 8 and 29 % Pu) and for the single oxides PuO_2 and ThO_2 were measured using the laser flash technique and DSC. These measurements were performed in the temperature range from 500 K up to 1600 K and were compared with the literature data. Addition of plutonium in the thorium mixed oxide induces a decrease of the thermal diffusivity, as already observed for the uranium-plutonium mixed oxide $(U,Pu)O_2$. In several samples, a further degradation in the thermal diffusivity due to self irradiation damage was noted. Recovery can be achieved by thermal treatment. The ThO_2 and $(Th,Pu)O_2$ samples with 3 and 8% Pu were found to be semitransparent and had to be coated for the thermal diffusivity measurement. The specific heat measurements are compared with literature data, and with the predictions obtained using the Neumann-Kopp law. The experimental thermal conductivity of the fuels was calculated and analysed. The introduction of Pu was found to have an effect similar to that observed in $(U,Pu)O_2$ mixed oxides: small decrease in the range 3-8% and higher decrease at 30% Pu content. Using the classical phonon transport model in crystal structures, a new correlation for the thermal conductivity of $(Th,Pu)O_2$ mixed oxides is proposed.