



Contribution ID: 39

Type: not specified

## Sintering behaviours and microstructure analysis of UN-UO<sub>2</sub> composite fuels prepared by spark plasma sintering

*Tuesday 5 November 2019 18:00 (3 minutes)*

Uranium mononitride (UN) has been considered a potential accident tolerant fuel (ATF) mainly because its high uranium density, high melting point, and high thermal conductivity. Composite fuels like UN-UO<sub>2</sub> have been proposed so as to combine the good properties of both fuels. This study is focused on analysing the first results regarding the sintering behaviours and the microstructures of an innovative UN-UO<sub>2</sub> composite fuel concept, prepared by mixing UN microspheres with UO<sub>2</sub> powder followed by spark plasma sintering (SPS).

Pure UO<sub>2</sub> powder, 30 wt.% of UN microspheres in UO<sub>2</sub>, and pure UN microspheres were sintered using SPS at 1100°C and 1500°C. The UO<sub>2</sub> powder used in this study was provided by Westinghouse Electric Sweden AB. The UN microspheres were fabricated at Chalmers University of Technology by internal sol-gel method, with a chemical composition of U(N<sub>0.98</sub>C<sub>0.02</sub>) ( $a = 4.8904 \text{ \AA}$ ,  $TD = 14.31 \text{ g/cm}^3$ ) and density of about 52 %TD.

The sintering behaviours of UO<sub>2</sub>(1100°C) and UO<sub>2</sub>(1500°C) were similar. The shrinkage started and finished at 450°C and 900°C, respectively, with a characteristic “S shape” sintering curve. Conversely, the sample UN(1500°C) started to sinter at approximately 1100°C and was still densifying at 1500°C. Regarding the composites, the initial behaviours were similar to pure UO<sub>2</sub> until about 600°C. Afterwards, there were a sintering blockage in both samples up to ~900°C, where the shrinkage rates started increasing again.

The sintered densities were measured using a modified Archimedean method with chloroform as the medium. For UO<sub>2</sub>(1100°C), UO<sub>2</sub>(1500°C), UN-UO<sub>2</sub>(1100°C), UN-UO<sub>2</sub>(1500°C), and UN(1500°C) densities above and around 90 %TD were achieved. Additionally, the microstructure analysis are presented and discussed in this study.

This work shows that it was possible to fabricate an innovative UN-UO<sub>2</sub> composite fuel concept by SPS. The preliminary results of the sintering behaviours show that the UN microspheres suppressed the UO<sub>2</sub> matrix densification in both UN-UO<sub>2</sub>(1100°C) and UN-UO<sub>2</sub>(1500°C) samples. This fact might be related to the UO<sub>2</sub>-UO<sub>2</sub> particle separation by the addition of 30 wt.% of UN, impairing the stage where neighbouring necks grow and interact to give a network of tubular pores. Moreover, the UN microspheres alone also sintered when the temperature is higher than 1100°C. Additional studies are under development in order to better understand the UN/UO<sub>2</sub> interaction during sintering.

**Author:** Mr RIBEIRO COSTA, Diogo (KTH Royal Institute of Technology and Westinghouse Electric Sweden AB)

**Co-authors:** Dr HEDBERG, Marcus (Chalmers University of Technology); Dr CLAISSE, Antoine (Westinghouse Electric Sweden AB); Mr PUIDE, Mattias (Westinghouse Electric Sweden AB)

**Presenter:** Mr RIBEIRO COSTA, Diogo (KTH Royal Institute of Technology and Westinghouse Electric Sweden AB)

**Session Classification:** Poster flash talks