Technology portfolio

High Burn-up Nuclear Fuel Pellets

Description

This invention relates to the trend of operators of electronuclear reactors (in particular PWR and BWR) to reduce production costs and amount of waste by increasing burn-up of the uranium dioxide pellets contained in the fuel rods. Although the main constraint to achieve this target resides in an increase of the 235U-enrichment of the UO2 matrix, additional constraints arise from the fuel assembly materials, whose properties are altered during irradiation, or notably by the release of fission gases (FGR) like Xe and Kr into the rod interior.

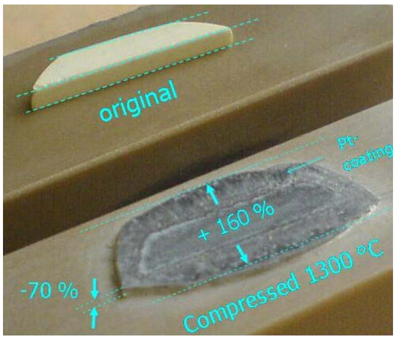

Fig. 1. Example of superplastic deformation of a nanocrystalline 4%Y_2O_3-ZrO_2 ceramic tested under compression, fabricated with a tailored porosity of 12 %. In the represented case-study, the ZrO_2-base ceramic is envisaged for use as inert matrix support for actinides burning (Transmutation). (Transmutation).

For different reasons, conventional methods to reduce FGR, consisting of using large grained UO2 fuels, are not entirely satisfactory.

Contrary to these methods, the present invention proposes the use of nanocrystalline ceramic materials with grain sizes in the nanometer-range as initial fuel for PWR/BWR reactors or other nuclear plants. Due to the closed porosity that is developed in this kind of pellets, the generated fission gases are trapped and retained within the material, thereby reducing the poisoning of the fill-gas with fission gases, and the risk of fuel-rod failures by gas overpressurization.

A further advantage of the present method is the enhanced plasticity and accelerated creep rate of the material, which will favours reduction of the interaction stresses with the cladding and the possibly derived damage to this material in situation of Pellet-Cladding-Mechanical-Interaction (e.g. less risk of intergranular fracture). The improved mechanical behaviour of the fuel will also facilitate the production process, for example by enabling reduction of rejects due to pellet-chipping. Moreover, since creep velocity is increased solely by grain refinement, there is no need for special additives, which allows for a higher fraction of U-atoms to be packed in the lattice, and hence a higher specific burn-up to be achieved.

Innovative aspects and main advantages

- Reduction of Fission Gas Release (FGR)
- Reduction of damage to the cladding material in case of Pellet-Cladding-Mechanical-Interaction
- Improved production process.
- Higher specific burn-up.

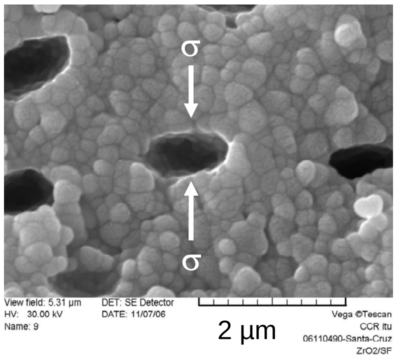

Fig.2. High magnification migrograph of a freshly-fractured 4%Y_2O_3-ZrO_2 specimen similar to that of Fig. 1, after compression test at intermediate stress. The picture evidences the closed character of the (fabrication) pores and the high ability of the material to accommodate plastic deformation (pore closure), without undergoing local fracture.

Areas of application

Production of fuel-rods for

- Pressurize Water Reactor
- Boiling Water Reactor

Stages of development

Patent	Priority date	03/10/2006
	Patent pending	EP06121688.3

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Reference: file n°2743