The results and perspectives of the Safety of Advanced Nuclear Fuels project at ITU

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Abstract

This paper will present the current status and perspectives for the action (or project) "safety of advanced nuclear fuels" at ITU. This action forms part of the EURATOM contribution to the Generation IV (Gen IV) International Forum (GIF) and the Sustainable Nuclear Energy Technology Platform of the EU.

Fuel safety aspects of the Gen IV Gas, Sodium, and Lead fast reactor (GFR, SFR, LFR) systems are covered in a comprehensive set of investigations covering basic fuel properties, fuel coolant and cladding interactions, and irradiation behaviour with the final goal of establishing safety limits for fabrication, and in pile performance of the advanced fuels required for these reactor systems. Fuel fabrication methods are developed for the safe production of nitride, carbide and oxide fuels containing minor actinides, in both homogeneous and heterogeneous recycling strategies. The phase diagrams of these fuels in the major regions of interest are investigated and thermodynamic properties (free energy, thermal conductivity, melting point, helium and vaporisation behaviour) determined along with fuel/cladding and fuel/coolant interactions. The deterioration and recovery of these parameters in fresh fuel due to irradiation by alpha emitter dopants is used to complement detailed post irradiation examination (PIE). Through international programmes and indirect actions funded by DG RTD such as the F-BRIDGE and ESFR projects, new irradiation programs and PIE with advanced fuels are conceived under the specific conditions appropriate for the specific reactor system (cladding, operating temperature, etc.). The integration of the information and development of models to predict the performance of these fuels are necessary steps in the determination of the in pile operational limits of these advanced fuels.

Following the general overview of the action, the paper will go into more detail on relevant topics for multi-time scale modelling such as the work for nitride and mixed oxide fuel. Finally, ideas for further development will be proposed for discussion.