STUDY OF THE PHASE TRANSFORMATIONS DURING A STIPULATED LOCA EVENT IN ZIRCONIUM CLADDED TUBES (in cooperation between Westinghouse Electric Sweden AB and Department of Materials and Manufacturing Technology at Chalmers)

Background
Westinghouse delivers fuel products to the nuclear industry. The fuel elements consist of uranium pellets sealed within Zirconium tubes. During operation the fissile uranium is being consumed to generate heat. During steady-state operation the heat is transferred to the coolant which limits the temperature of the Zirconium cladding. In case of LOCA (loss-of-coolant accident) event the cladding temperature increases. If the Zirconium cladding reaches a temperature of around 900 °C a phase transition will occur from $\alpha$ to $\beta$-Zr.

Thesis work is focused on investigation of the phase transformations that occur during a stipulated LOCA event. The work will include a theoretical background and simulations of phase transformations using ThermoCalc software with the special database. Experimental work will include thermal analysis of the phase transformation in zirconium alloys of interest using state-of-the-art differential scanning calorimetry in different processing conditions. Microstructural and phase analysis of the material using additionally required microscopy techniques will be applied as well. Attempt to use thermodynamic modeling software ThermoCalc to simulate the microstructure in the as-manufactured product and compare to actual outcome will be the core focus of the proposed thesis.

Objective
Department of Materials and Manufacturing Technology at Chalmers is well equipped with advanced characterization techniques required for identification of microstructural changes and phase transformations. Thermodynamic and kinetic modeling of the phase transformation and microstructure formation is another key area of the research work at the department. Thermodynamic modeling and experimental work will be performed mostly at Chalmers and coordinated by Westinghouse Electric Sweden AB.

Requirements
- good knowledge of material science;
- knowledge of basics of inorganic chemistry and phase transformations.
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