

Behavior of advanced ceramic breeder pebbles in long-term heat treatment

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Lithium orthosilicate pebbles with additions of lithium metatitanate are considered as advanced tritium breeders within the European Union. The addition of the lithium metatitanate phase, substituting lithium metasilicate which is present in reference grade pebbles, enhances the mechanical strength of the pebbles and leads to a more stable microstructure in medium-term heat treatments as was recently shown.

In order to increase the relevancy of the heat treatment experiments with regard to operation in the breeder blanket, the existing experimental setup for long-term heat treatments at KIT was modernized. The setup permanently monitors and controls the absolute pressure and the mass flow rate of the purge gas (He/0.1%H₂). Furthermore, the temperature in close vicinity of the samples is constantly monitored as well as the oxygen and moisture content of the gas stream.

The main goal of this experiment is to investigate possible changes of the pebble quality as a function of treatment time at 900 °C, a temperature close to the maximum expected temperature within the EU solid breeder blanket for ITER. Sampling is performed after 4, 32, 64 and 128 days. The samples contain three different concentrations of lithium metatitanate, namely nominal 20 mol%, 25 mol% and 30 mol%.

The individual samples are characterized mechanically with uniaxial crush load tests. Other characterization includes optical and scanning electron microscopic analysis of pebble surfaces and cross sections as well as the determination of open and closed porosity by mercury porosimetry and helium pycnometry respectively. Also the specific surface area of the samples is measured by multi-point BET adsorption of nitrogen to compliment the porosity measurements. Chemical analysis of the samples and phase analysis is carried out by inductively coupled plasma optical emission spectrometry, X-ray fluorescence spectroscopy and X-ray diffraction analysis.