Recent Developments of the Melt-based Production of Lithium Orthosilicate Pebbles

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Lithium orthosilicate is the material of choice in the European Union for the breeding of tritium inside future fusion reactors, allowing them to be self-sustainable. The ceramic compound is to be featured inside the blanket of the reactor wall in the form of pebble beds with pebbles being approximately 1 mm in size. Recent material developments have seen the addition of lithium metatitanate as a secondary phase to improve various physical properties. The mechanical strength is particularly important due to thermal expansion forces and the effects of neutron irradiation that the pebbles will encounter while in operation.

In order to maximise the yield during production, multiple studies have been conducted to determine the optimum process parameters. Most recently, the effects of nozzle diameter and operating pressure on the pebble size distribution have been assessed. Other investigations include using a high-speed camera to analyse the dynamics of pebble formation using an automated analysis program developed specifically for this process.

Time dependent sampling was also conducted, which involved extracting a sample of pebbles from the jet twice a minute throughout the batch. This allowed for three-dimensional pebble size distribution graphs to be generated. The composition, including impurities, of each sample was also determined using RFA and ICP-OES.

Further developments of the process include the establishment of a different cooling method; namely using a liquid nitrogen spray to reduce the thermal stress during the cooling and solidification stage of the process. This new method has been shown to both increase the crush-load strength as well as the Weibull modulus.