

DEVELOPMENT OF CMC FOR NUCLEAR FUEL COMPONENTS

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SiC/SiC composites (CMC) are attractive engineering materials due to their excellent performance in areas such as thermal stability, high resistance to crack propagation, high wear resistance, high corrosion resistance, high thermal conductivity, low thermal expansion, and low density. In particular, the CVI-SiC/SiC composite has been investigated for use in nuclear reactor cores because of its inherent low activation, low neutron absorption cross-section, and stability under irradiation due to its high purity and crystalline SiC matrix. After the nuclear power plant accident in Fukushima in March 2011, it started to be developed in many research programs as a component of accident-tolerant fuels (ATFs).

To apply SiC ceramic to core materials in Light-Water Reactor (LWR), it shall be developed to meet the performance requirement for channel boxes or fuel claddings (nuclear fuel components), such as required mechanical properties, corrosion resistance or airtightness. In this project, extremely challenging technology is to be established to produce thin-walled and large ceramic composite materials with exceptionally high dimension accuracy. To realize it, manufacturing technology and material performance have been developed step by step.

Toshiba has been developing process technologies for thin-walled and elongated CVI/CVD-SiC/SiC-based tubes and boxes since 2012. The components are required to have good hermetic seal and resist hydrothermal corrosion in normal operation of LWR environments. Furthermore, they are also required to have a period of durability in a water vapor environment above 1200°C during an accident.

Through developing design and manufacturing technology, Toshiba has succeeded in optimization of manufacturing process, which shall meet the required performance for SiC fuel claddings and SiC channel boxes. Currently feasibility studies for mass production are being proceeded. After 2022, specific review shall be planned for practical use.

This study describes the material design and process technology for thin-walled and elongated CVI/CVD-SiC/SiC based tubes and boxes.

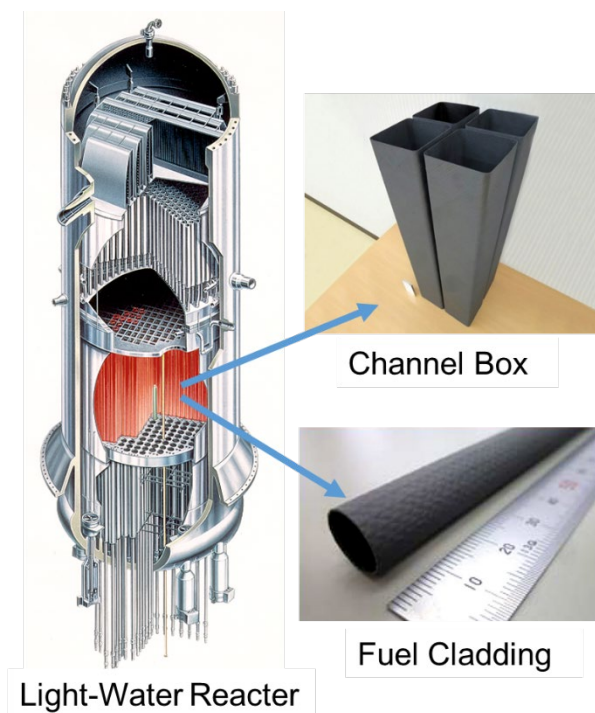


Figure 1 –CMC for nuclear fuel components