Microstructural characterization of TRISO particles in off-normal conditions

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High temperature gas reactors are a leading candidate for the next generation of nuclear power systems. An accident scenario for this reactor-type could result in fuel exposure to low amounts of steam and other inert gas contaminants. The mixed gas atmospheres could comprise the integrity of the tristructural-isotropic (TRISO) coated particle fuel. The layered TRISO particle structure includes a central fuel kernel, pyrolytic carbon buffer layer, dense pyrolytic carbon layer, silicon carbide (SiC) layer, and an outer, dense pyrolytic carbon layer. Silicon carbide has a high resistance to oxidation due to the formation of a passive SiO_2 layer, which has been proven in a number of off-normal conditions for a variety of reactor types. However, less attention has been paid to low partial pressures of oxidants. In the work presented, surrogate TRISO particles are exposed to off-normal flowing gas conditions in a thermogravimetric analyzer, specifically low partial pressure of steam (less than 0.1atm pH_2O) and oxygen atmospheres (up to 100 ppm pO_2) at high temperatures (800ºC<T<1600 ºC). At these low oxidant partial pressures and temperatures, both passive and active oxidation of the SiC layer is expected to be observed, and exposure to these conditions may lead to damage of the particle. The microstructural characterization of particles exposed to relevant simulated accident conditions and a preliminary analysis of TRISO particles exposed to pressurized water, simulating an LWR accident condition for fully ceramic microencapsulated fuel will be presented. The characterization serves to capture the nature and degree of oxidation experienced by the exposed particles at various test conditions to gain insight on the particle response and performance.