Kinetic studies on chronic and acute oxidation by water of matrix carbon for nuclear fuel

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Matrix carbon is an incompletely graphitized component of fuel compacts and pebbles designed for use in high-temperature gas-cooled nuclear reactors. During the reactor lifetime, matrix carbon could be exposed to extremely slow, but continuous (chronic) oxidation by water vapor that may be present in the coolant gas circuit. Moreover, in the improbable event of accidental water ingress in the reactor, the matrix carbon would suffer acute oxidation that would expose the fuel kernels. For safety and design purposes it is imperiously needed to determine the effect of moisture and temperature on oxidation rates by water. Detailed measurements were performed over an extremely broad range of partial pressures of water vapor ($5 < P_{H2O}$ (Pa) $< 30,000$), hydrogen ($0 < P_{H2}$ (Pa) < 100) and temperatures ($800 < T$ (ºC) < 1400). The results were analyzed in terms of classical (LH) and Boltzmann-enhanced (BLH) Langmuir-Hinshelwood models, and a general rate equation applicable from chronic (normal operating conditions) to acute (accident scenario) oxidation conditions was determined. This project was funded by the U.S. Department of Energy, Office of Nuclear Energy.