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Chemical Effects of Ionizing Radiation on Molten Salt Systems

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Ionizing radiation in the molten salt reactor environment will drive chemical changes in the composition of the salt and induce additional pathways for corrosive degradation of reactor components. Although the products of radiolysis are largely expected to recombine in the high-temperature molten salts, even a small mechanistic leakage out of the recombination cycle will result in substantial formation of permanent products, such as halogen gas (F₂ or Cl₂ depending on the salt) or metal particles that may deposit on surfaces in the reactor circuit. Thus, it is important to understand the initial products of molten salt radiolysis and their reaction kinetics with solutes including fission products. MSR fuel and corroded infrastructure materials are full of potential scavengers for these initial products.

The goal of the US Department of Energy Office of Basic Energy Sciences Energy Frontier Research Center for Molten Salts in Extreme Environments is to provide fundamental understanding, based in atomistic level descriptions, of molten salt bulk and interfacial chemistry including the effects of solutes, impurities, and intense ionizing radiation fields. State-of-the-art steady-state and pulse radiolysis techniques have been deployed to understand the radiation-induced chemistry of molten chloride salt systems and to develop a predictive multi-scale radiation chemical kinetics model. A brief summary of the experimental and modelling and simulation results will be presented.

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