Simultaneous proton irradiation can decelerate corrosion of Ni-20Cr in molten fluoride salt

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The successful construction and operation of molten salt reactors (MSRs) rely on the ability to understand and predict structural material performance in the extreme environment of high-temperature molten salt and high flux radiation. Corrosion of structural materials in molten fluorides has been extensively studied, proceeding mainly via selective dissolution of Cr from the alloys into the salts. The corrosion rate is influenced by a variety of parameters, such as temperature, salt corrosion potential, and radiation flux, among which, effects of radiation on corrosion of MSR-relevant alloys have rarely been studied. To fill this knowledge gap, we have constructed a simultaneous corrosion/irradiation facility for testing molten salt-facing materials. By firing a high energy proton beam at the center of the sample, direct comparisons between corrosion with and without radiation can be made on one sample, with the proton irradiation as the only difference. The first stage of experiments was conducted with Ni-20Cr model alloys to capture the influence of defects from proton irradiation on the kinetics of atom diffusion in the alloy, which directly influences corrosion in molten salt. These Ni-20Cr specimens show that proton irradiation *decelerates* corrosion in molten fluoride salt.

The preferential segregation of Ni and Cr atoms under proton irradiation might play a key role in decelerating corrosion. In a Ni-Cr alloy system, Cr segregates away from grain boundaries (GBs), while Ni is pushed to the grain boundaries via coupling differently to the defect fluxes. Microchemistry analyses around the grain boundaries using scanning transmission electron microscope (STEM) with energy dispersive X-ray spectroscopy (EDS) and electron energy loss spectroscopy (EELS) are going to be presented to support this proposed explanation. Linking irradiation-induced segregation to the deceleration of corrosion is not only a fundamental approach to tackle this complex problem, but also it provides a chance to peer at the influence of neutron irradiation on corrosion in molten salt.