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The Synergetic Effects of Irradiation and Corrosion on Structural Materials in Molten Salt Reactors

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The molten salt nuclear reactors, as an innovative type of Gen IV reactors, have a great potential due to their safety and efficiency. However, the synergetic effects of irradiation and corrosion of structural materials is not a fully explored area. Using a novel simultaneous corrosion-irradiation facility, a FLiNaK molten salt in a pure nickel corrosion cell is exposed to a proton beam through a 25m foil sample of the tested commercial alloys. Cross-section of each foil were specifically prepared using dry ion polishing to preserve salt-filled features and characterized. In order to evaluate the effects of irradiation on corrosion, assessments of the corrosion depth and corrosion acceleration factor have been undertaken. The net corrosion effect is determined by competing, simultaneous processes of acceleration via salt chemistry and deceleration from radiation enhanced diffusion, found to be greatly dependent on alloying elements and associated self-healing. Furthermore, we have discovered a subset of conditions, practically useful for nuclear structural materials, where radiation damage decelerates or has no effect on corrosion.

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