Irradiation-Accelerated Corrosion of Reactor Core Materials

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ABSTRACT

This project aims to understand how radiation accelerates corrosion of reactor core materials. The combination of high-temperature, chemically aggressive coolants, a high-radiation flux and mechanical stress poses a major challenge for the life extension of current light water reactors (LWRs), as well as the success of most all Gen IV concepts. Of these four drivers, the combination of radiation and corrosion places the most severe demands on materials for which an understanding of the fundamental science is simply absent. Only a few experiments have been conducted to understand how corrosion occurs under irradiation, yet the limited data indicates that the effect is large; irradiation causes order of magnitude increases in corrosion rates. Without a firm understanding of the mechanisms by which radiation and corrosion interact in film formation, growth, breakdown, and repair, the extension of the current LWR fleet beyond 60 years and the success of advanced nuclear energy systems are questionable. The proposed work will address the process of irradiation-accelerated corrosion that is important to all current and advanced reactor designs but remains very poorly understood. An improved understanding of the role of irradiation in the corrosion process will provide the community with the tools to address vexing problems, such as irradiation-assisted stress corrosion cracking, and to design more robust materials.

The objective of this proposal is to understand how radiation accelerates corrosion in high-temperature/high-pressure environments by conducting experiments that isolate the various possible contributions to irradiation-accelerated corrosion.