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Low Energy Muon Investigation of Corrosion-Resistant Polyaniline Film on Stainless Steel: Application in the Prevention of Flow-Accelerated Corrosion in Nuclear Reactors

The oxidative corrosion of steel in nuclear reactors is worsened by the removal of steel's passivizing oxide layer by flow-accelerated corrosion (FAC). Free radicals and hydrogen (H) species in feedwater greatly affect the rate of corrosion; film-forming amines (FFA) are therefore a candidate method to reduce FAC in the coolant systems of nuclear reactors by creating a barrier which limits the diffusion of H species and free radicals. Developing an understanding of the interaction of free radicals and FFA is crucial as a FFA coating will prevent corrosion damage in steel if free radicals react with the FFA instead of the steel. The proof-of-concept experiment described in this paper therefore aims to investigate the fate of H and free radicals within thin corrosion-resistant films on steel. To achieve this goal, low energy positive muons, which are analogous to light protons, were implanted within an idealized system consisting of a thin film of the corrosion resistant FFA, polyaniline (PANI) on a non-magnetic 304-stainless steel (SS) alloy substrate.

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