Contribution ID: **25279** Type: **Extended Abstract**

CrNb Coating System as a Novel Near-Term Accident Tolerant Fuel Solution for Boiling Water Reactors

Tuesday, 4 November 2025 15:06 (7 minutes)

This study presents the development and evaluation of novel chromium–niobium (Cr–Nb) alloy coatings as an accident-tolerant fuel (ATF) solution for Boiling Water Reactors (BWRs). Cr–Nb coatings with 15 and 25 at.% Nb were deposited via magnetron sputtering on Zr-based cladding and subjected to out-of-pile testing. Long-term dynamic autoclave corrosion tests exceeding 120 days under BWR Normal Water Chemistry (NWC) showed stable performance with no coating degradation, cracking, or delamination. In contrast to pure Cr coatings, which gradually dissolved, Cr–Nb coatings remained chemically stable. High-temperature steam oxidation at 1100 ℃ demonstrated that Cr–Nb coatings effectively delayed oxidation for up to approx. 45-60 minutes before protectivity was lost. SEM/EDS analysis revealed the formation of distinct Cr- and Nb-rich oxide phases, indicating separate oxidation behavior and limited interdiffusion. This layered oxide structure likely contributes to early-stage protectivity. These results highlight the potential of Cr–Nb coatings as a viable ATF option for BWRs, supporting further evaluation under irradiation and accident conditions.

Technical Track

Nuclear Materials

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Session Classification: Student Competition