Nuclear Fuel

AXIOM™ Fuel Rod Cladding

Background

The AXIOM™ alloy is Westinghouse's next generation of fuel rod cladding targeting high fuel duties, improved corrosion resistance, lower hydrogen pick-up and lower creep and growth when compared to current Westinghouse products.

Description

AXIOM™ cladding was developed based on the successes of Optimized ZIRLO cladding to target challenging fuel management practices and to provide margin for future restrictive regulatory LOCA criteria. After about 15 years of development and testing, Westinghouse has selected the final AXIOM cladding composition, based on the extensive PIE database of poolside and hot-cell results from various irradiation programs as well as out-of-reactor testing. AXIOM cladding is now being rolled out for full lead test assembly irradiation.

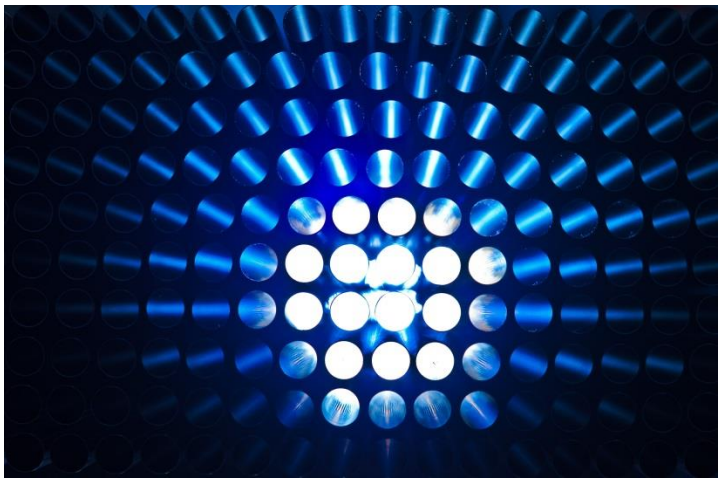
Benefits

The AXIOM alloy has demonstrated improved in in-reactor corrosion performance and hydrogen pick-up compared to ZIRLO and Optimized ZIRLO, especially in high duty operating environments. The oxide thickness data for AXIOM cladding is less than 50 µm for a Modified Fuel Duty Index (MFDI) up to 1,000 and burnups of about 70 GWd/MTU. The AXIOM alloy has shown excellent in-reactor dimensional stability. AXIOM has shown less irradiation growth in the axial direction and less creep in the diametral direction, as compared to ZIRLO and Optimized ZIRLO cladding. Both Optimized ZIRLO cladding and AXIOM cladding retain relatively high ductility after high burnup irradiation.

Oxide data for all AXIOM and Optimized ZIRLO rods are similar to those for ZIRLO rods at low burnups of 20-30 GWD/MTU. At higher burnups, the advantage of AXIOM and Optimized ZIRLO over ZIRLO cladding becomes significant. The advantage of AXIOM over Optimized ZIRLO cladding becomes even more significant at the highest burnups of about 70 GWD/MTU.

Deliverables

Westinghouse has selected the final AXIOM cladding composition, based on the extensive database of results as well as out-reactor testing. Alloy selection was based on the best overall performance to ensure that all operating requirements were considered, including: corrosion and hydrogen; creep and growth behavior; compatibility with fuel rod design criteria; tolerance for coolant chemistry variability; strength properties; anticipated compliance with 10 CFR 50.46c, emergency core cooling system performance during loss-of-coolant accidents (LOCA); manufacturability; and microstructure stability at high burnup.



AXIOM fuel tubes

Experience

Hundreds of AXIOM clad fuel rods have been irradiated in various reactors with burnup levels approaching 75 GWd/MTU achieved. Pool-side examination data including high resolution visual, oxide thickness, rod growth and profilometry are available at various burnup levels.

Westinghouse

Comprehensive hot cell examinations of high burnup AXIOM rods (over 75 GWd/MTU) have also been completed. All the non-destructive tests that have been conducted during pool side examinations were conducted in the hot cell again on selected segments for verification.

The performance data of both Optimized ZIRLO and AXIOM claddings demonstrate significant advantages over ZIRLO cladding.

AXIOM fuel tubing being produced at Westinghouse's Specialty Metals Plant in Blairsville, PA

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