Contribution ID: **2118** Contribution code: **THPB094** Type: **Poster Presentation**

Large-area atomic layer deposition of titanium nitride for RF windows

Thursday 5 June 2025 15:30 (2 hours)

High-power particle accelerators, like the Spallation Neutron Source, require reliable radio-frequency waveguide windows to transmit power while maintaining a vacuum. These windows face performance challenges due to multipacting, an electron cascade disrupting vacuum integrity. Thin TiN coatings can suppress this by reducing secondary electron emission, but traditional methods struggle to uniformly coat complex ceramic surfaces.

We developed an atomic layer deposition (ALD) process to create conformal TiN films (<10 nm) at low temperatures (130℃), achieving smooth, conductive coatings with a secondary electron yield below 2.0. Collaborating with Microwave Techniques LLC and Oak Ridge National Laboratory, we designed RF windows with replaceable TiN-coated ceramic disks to improve performance and reduce downtime.

In our next phase, we will scale up manufacturing and develop a modular ALD tool for in-situ coating of waveguide and SRF cavity metallic surfaces, crucial for next-generation accelerators operating at higher power. These innovations enhance efficiency, reliability, and design flexibility, advancing accelerator technology and fostering high-tech sector growth.

Footnotes

Paper preparation format

Word

Region represented

America

Funding Agency

This work is supported by the U.S. Department of Energy, Office of Science, U.S. Department of Energy, Office of Acquisition & Assistance, under Award Number DE-SC0021540.

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Session Classification: Thursday Poster Session

Track Classification: MC7: Accelerator Technology and Sustainability: MC7.T35 Advanced Manufacturing Technologies for Accelerator Components