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Atomic layer deposition of Ta2O5 - a new material for coating cavities

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To achieve higher acceleration gradients, we are investigating alternatives to classical superconducting niobium cavities. New concepts, such as passivating the high-loss native oxide surface or employing multilayer systems, are promising approaches. Atomic layer deposition (ALD) has proven to be a suitable method for coating the inner surface of a cavity homogeneously and with sub-nanometer precision without shadowing effects using various materials. Our research team has successfully coated several cavities with Al2O3 and conducted cryogenic RF tests. Preliminary measurements of the secondary electron yield and crystallization temperature of Ta2O5 deposited in our ALD reactor, reveal promising results compared to Al2O3. Consequently, process optimization for tantalum oxide must be conducted, focusing on minimizing the thermal load on the cavity to prevent parasitic diffusion of interstitial atoms. Samples will be placed at various positions in a cavity and characterized ex situ as-prepared and after post-deposition treatments by a variety of surface analysis techniques, e.g., SEM, EDX, SEY and XRD. Finally, after fully understanding the process, a single-cell SRF cavity will be coated and tested.

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