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The Next Generation Materials for Superconducting Radio-Frequency (SRF) Cavities of Modern Particle Accelerators

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While unbounded collective human mind continues to push beyond the boundaries in uncovering myriad mysteries of our universe, highly performing particle accelerators become indispensable tool to conduct successful experiments to shed light on such fundamental scientific inquires. On the path towards more efficient and sustainable particle accelerators, overcoming performance bottleneck of the current niobium-based SRF cavities is crucial. Hence, advanced material structures such as mono- and/or multi-layer structured superconducting thin films seem to promise increasing the maximum accelerating field set by pure niobium while decreasing RF losses for high quality factors (Q) in such resonators leading to high performance in SRF cavities. Therefore, our initial research endeavors have been focused on systematic experimental investigations of niobium nitride (NbN)-based superconducting thin films coated by reactive-direct current (DC) magnetron sputtering and the subsequent material characterizations of the coated thin films, whose preliminary results are discussed in detail, in order to address the key challenges such as obtaining stoichiometric films with low defect densities yielding to high crystalline quality along with establishing reproducible thin film deposition methods with up-scaling capacities to be used in industrial applications too so that paving the way to the next generation materials and their associated state-of-the-art production technologies.

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