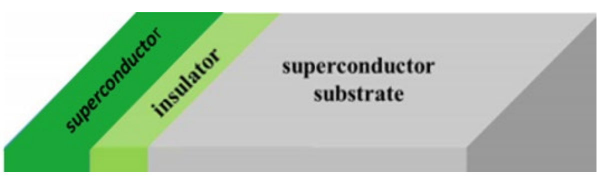
ARRADIANCE ***Sneak Preview***

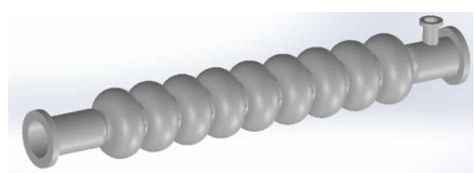
Thermal annealing of superconducting niobium titanium nitride thin films deposited by plasma-enhanced atomic layer deposition

October 18, 2023

Next-generation superconducting radio frequency (SRF) cavities, based on tailored thin films, would allow for more efficient and sustainable state-of-the-art particle accelerators operating at higher accelerating gradients (such as XFEL at DESY and at SLAC) with lower operational RF losses. In particular, thin films of superconductor–insulator–superconductor (SIS) multilayers were proposed as a potential alternative to bulk Nb. NbTiN combines excellent superconductivity of NbN and good metallic and stable structural properties of TiN. These materials also have the potential for use in large-scale superconducting nanowire single-photon detectors (SNSPDs) or as superconducting leads in quantum computing devices.

In the new report* by scientists from Universität Hamburg in Germany, NbTiN thin films were grown from readily available precursors by plasma-enhanced atomic layer deposition (PEALD) on AlN *in-situ*. PEALD allows for lower deposition temperatures than a thermal ALD and for more stoichiometric growth of metal nitrides. Post-deposition thermal annealing significantly improved the quality of PEALD-deposited NbTiN, achieving the highest superconducting critical temperature (Tc) of 15.9 K obtained for films deposited by atomic layer deposition (ALD) thus far; and a lower critical magnetic field of 213 mT, which overpasses the bulk Nb intrinsic limit of 200 mT. Film resistivity in varying magnetic fields was measured in AC and DC mode at cryogenic and room temperatures. Perfect linear control of the film elemental composition was achieved in an Arradiance GEMStar^{TM} PEALD system by adjusting the NbN to TiN supercycle ratio. Obtained films were sub-1nm smooth before thermal anneal, with significant increase in crystallinity and Tc after annealing.





*Isabel González Díaz-Palacio, Marc Wenskat, Getnet Kacha Deyu, Wolfgang Hillert, Robert H. Blick, Robert Zierold; *J. Appl. Phys.* ***134***, 035301 (2023); doi: 10.1063/5.0155557

Arradiance technology enables ALD films in superconducting detectors, quantum computing and electronic applications. For more information on GEMStar^{TM} Technology, ALD systems or Foundry services, please contact Arradiance