窒化アルミ絶縁層を用いたニオブ SIS 接合
Niobium Based SIS Junctions with Aluminum Nitride Barrier

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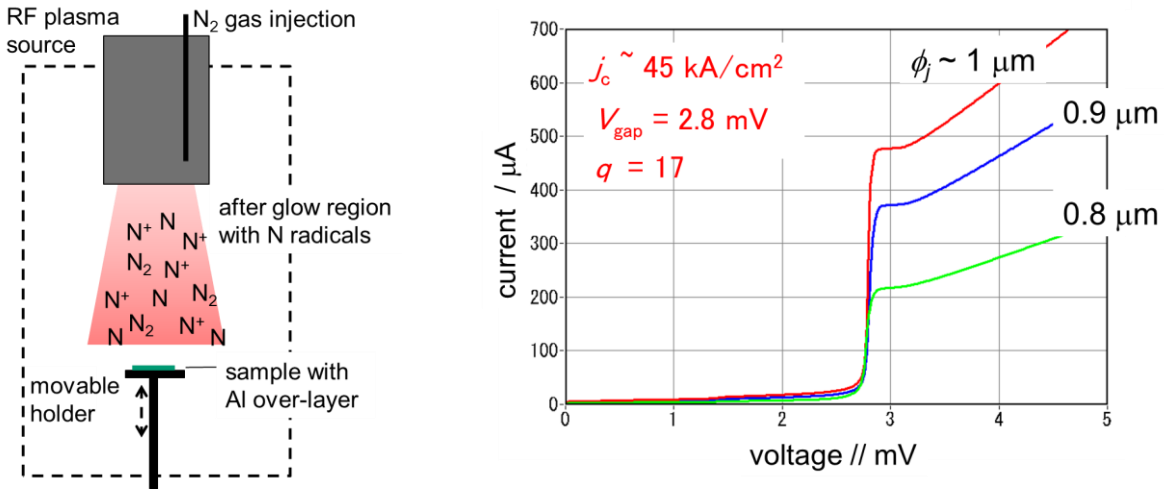
Niobium Superconducting-Insulator-Superconductor (SIS) tunnel junctions are most commonly fabricated from the layer stacks Nb/Al/AlO_x/Nb or Nb/Al/AlN_x/Nb, which are asymmetric with respect to the barrier. We have fabricated and characterized junctions using the symmetric layer stack Nb/Al/AlN_x/Al/Nb. The ultra-thin AlN_x barrier is formed by exposing the Al overlayer on the Nb base electrode to the afterglow region of a nitrogen plasma. Our experiments show that for the high current density regime, e.g. j_c > 10 kA/cm^2, junctions based on the symmetric layer stack have significantly lower sub-gap leakage than those made from the asymmetric layer stack. The μm-sized junctions, defined by optical lithography, have current densities up to 50 kA/cm^2 and quality factors of $R_{sub\text{-}gap}/R_{normal}$ = 15 or greater. Sharpness of the non-linearity and high gap voltage of V_{gap} ~ 2.8 mV are maintained as long as the thickness of the Al layers do not exceed 4 nm. SIS mixers based on high-j_c junctions have been integrated with sub-mm wave receivers and low noise performance has been demonstrated over large RF and IF bandwidths [1,2].



Schematics of the nitridation chamber employing an RF powered ICP plasma source (left). Current-voltage characteristics of junctions made from the symmetric layer stack Nb/Al/AlN_x/Al/Nb (right).

[1] Kojima, T., Kroug, M., Uemizu, K., . . . Uzawa, Y. (2017). Performance and Characterization of a Wide-IF SIS Mixer Preamplifier Module Employing High-Jc SIS Junctions. *IEEE Transactions on Terahertz Science and Technology, 7*(6).

[2] Kojima, T., Kroug, M., Gonzalez, A., . . . Asayama, S. (2018). 275–500 GHz Wideband Waveguide SIS Mixers. *IEEE Transactions on Terahertz Science and Technology, 8*(6).