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Nb/Al-AlN/Nb SIS junctions grown with substrate bias during plasma nitridation of the tunnel barrier

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***Abstract*—We investigate the influence of substrate bias on the plasma nitridation process to form tunnel barriers in superconducting tunnel junctions, especially focusing on the bias effects on the barrier transparency. In addition, we assess the role of substrate bias in the nitridation process in the enhancement of the reproducibility of AlN-SIS fabrication process. We find that this parameter is critical to optimize the fabrication of high-performance tunnel-junctions for superconducting mixer technology.**

***Keywords*—Superconducting tunnel junctions, Nb/Al-AlN/Nb junctions, AlN tunnel barrier.**

WE have earlier developed and characterized plasma nitridation based AlN-SIS junctions fabrication process [1], as well as demonstrated implementation of those into SIS mixer devices [2], [3].

We observe, however, batch-to-batch variations of the junction tunnel barrier transparency, that are not yet completely understood. While other barrier plasma nitridation parameters are kept well controlled, the substrate holder resistance to ground is somewhat indeterminate, difficult to control and subject to the holder pre-history.

This might cause differences between the nitridation plasma potential and that of the sample and in turn, variations in ionized nitrogen bombardment of the surface. We studied the dependence of an intentional bias of the substrate holder during plasma nitridation on the resulting SIS junction barrier transparency. From the current-voltage characteristic of the substrate holder exposed to the plasma nitridation environment (Fig. 1), we estimate the plasma potential to be about +25V, which suggests just a few volts bias be impactful to the barrier nitridation process. Indeed, we observe significant bias impact on the barrier specific resistance (Fig. 2).

At the conference, we intend to present further details of the study.

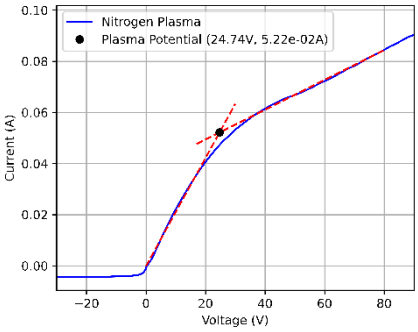

Fig. 2. Current-voltage characteristic of the substrate holder exposed to the plasma nitridation environment. Asymptotic lines to the IVC are shown with the dashed line and their intersection marked by dot gives an estimate of the potential of the nitrogen plasma.

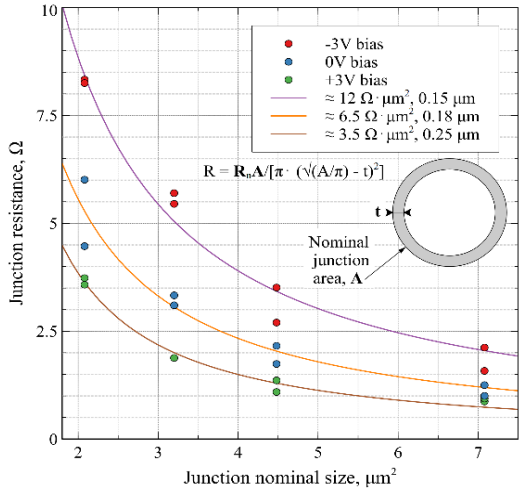

Fig. 1. Tunnel barrier specific resistivity, RnA, of Nb/Al-AlN/Nb junctions grown with different substrate bias during plasma nitridation of the tunnel barrier, as extracted from dependence of junction resistance on the nominal junction size.

REFERENCES

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