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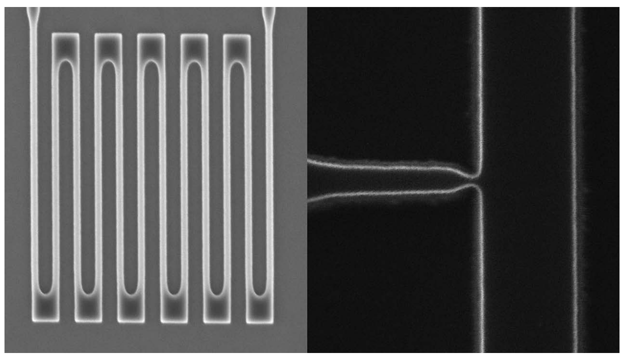
Simplicity of method should enable fabrication of high-performing single photon detectors for many applications.



Taking an empirical leap in a young field where experiment has raced ahead of theory, MIT scientists have devised a surprisingly simple room-temperature, thin-film method for fabricating niobium-nitride (NbN) superconducting nanowire single photon detectors (SNSPDs) with superlative performance. As reported in *Applied Physics Letters*, the resultant detectors, tested with infrared light (1,550 nm) at 2.5K, achieved near maximum quantum efficiency and a jitter of 38 picoseconds.

The method should greatly expand opportunities to make SNSPD devices for uses in telecommunications, deep space communication, and many other areas.

Aiming to optimize photon detection efficiency, counting rates, and timing jitter in a device made from a single material, the team experimented with applying an RF bias to an unheated silicon-dioxide substrate and tweaking the relative ratio of nitrogen and niobium during sputtering. Substrate biasing nearly doubled the critical temperature of some films, but for unknown reasons, according to first author and MIT graduate student Andrew Dane. So, Dane and colleagues undertook a thorough process of elimination to zero in on key parameters.

Films were fabricated under 10 different conditions. Thicknesses ranged from 46 nm to 23 nm. After characterizing deposition rates across processing conditions, the team adjusted rates to make 5-nm-thick NbN films, and then compared performance.

All films created without biasing were too rough for fabricating unconstricted nanowires and did not attain a T_c suitable for operating at liquid-helium temperatures. Biasing yielded smoother films with a T_c of 7.8K—73 percent higher than unbiased films. T_c increases only occurred in the 5-nm-thick films made with RF biasing, indicating a decoupling between resistivity and T_c. Dane says that while the findings point to new applications, the decoupling requires further study.

Source: "Bias sputtered NbN and superconducting nanowire devices," by Andrew E. Dane, Adam N. McCaughan, Di Zhu, Qingyuan Zhao, Chung-Soo Kim, Niccolo Calandri, Akshay Agarwal, Francesco Bellei, and Karl K. Berggren, *Applied Physics Letters* (2017). The article can be accessed at https://doi.org/10.1063/1.4990066.