Quantum Efficiency and Polarization Effects
in NbN Superconducting Single Photon Detectors

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Abstract—Superconducting Single Photon Detectors based on niobium nitride (NbN) nanowires have been optimized with regard to the quality of the epitaxial layer grown on M-plane 3-inch sapphire wafer, leading to T_c of nearly 13K and J_c reaching 5MA/cm^2 for a 5nm thick layer patterned down to 80nm stripe width using an e-beam writer. Using those films, 7 % of quantum efficiency at 4:2K for 100nm linewidth nanowires detectors has been achieved. We measured the kinetic inductance of our SSPD by 2 differents ways. Clear effects of light polarization on Detection Efficiency (DE) dependent has also been observed and quantified. DE varies by a factor 2 to 4 for a great number of tested SSPDs, meander width varying from 100nm to 300nm. The SSPD has been modeled as a detector with 2 different linear DEs as incident light can be polarized parallel or normal to the linewidth. This model is in good agreement with experimental data and roughly corresponds to the calculated absorption of the 5nm thick NbN layer. However, polarization effects also observed in multi-photon regime raise new issues.

Index Terms—NbN, superconducting single photon detector, thin films, light polarization, quantum optics, FDTD simulation

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