Patterning issues in Superconducting Nanowire Single Photon Detector fabrication

C. Constancias[(a)], R. Espiau de Lamaëstre[(a)], L. Frey[(a)]
J. C Villégier[(b)]
(a) CEA LETI – MINATEC
(b) CEA /DRFMC/SPSMS-GDS

CEA-LETI-Minatec 17 rue des Martyrs F38054 cedex

High speed photon counting at near infrared wavelength (1550nm) has many applications: quantum information, optical communications, semiconductor chips failure test. Ultra fast count rates up to the GHz with a single photon detection efficiency is of a great interest but not achievable with standard avalanche photodiode (APD) technology. Indeed, APD are not fast enough and photomultipliers have low detection efficiency and large dark counts at 1550nm wavelength. On the other hand, an IR photon incident on an ultrathin (~4nm) superconducting NbN nanowires, with a critical temperature Tc~10K, when it is absorbed, induces disruption of the superconductivity across the wire, resulting in a measurable voltage pulse of few tenth of picoseconds, Figure 1 and Figure 2. One issue in Superconducting Nanowire Single Photon Detectors (SNSPDs) high Quantum Efficiency resides in the achievement of the high filling factor pixel area coverage with an uniform and narrow strip (<120 nm) meander, Figure 3.

NbN SNSPDs have been fabricated, thanks to an ultra high resolution electron beam exposure tool allowing patterning at the nanometer size, on large diameter substrate up to 150mm. The lithography process has been developed with NEB22A, a standard negative tone electron beam resist manufactured by Sumitomo. Several detectors have been fabricated with different structures. Nanowire as narrow as 50nm covering 50% of the sensitive area has been achieved. We will present details of the SNSPD fabrication process and comparison with the state of art.

**This study is partly supported by the EC STREP 'Sinphonia' program*

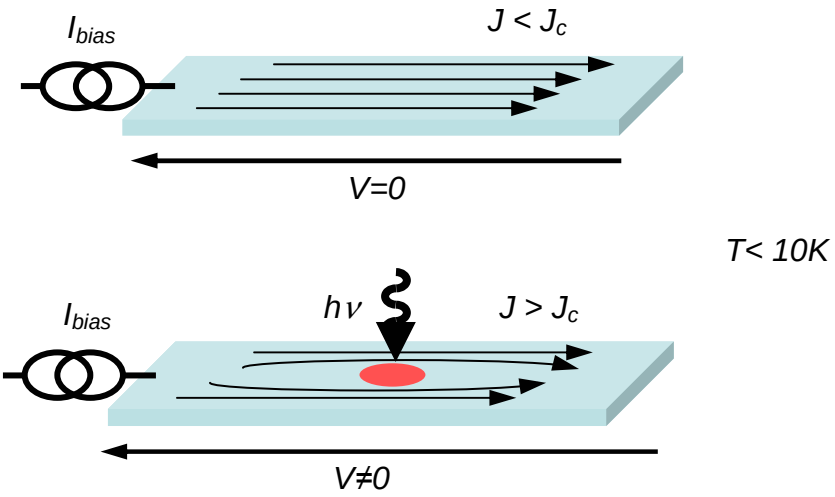

Figure 1: Schematic of Superconducting Nanowire Single Photon detection

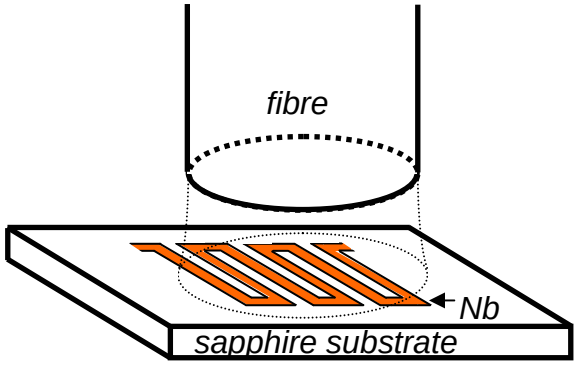

Figure 2: Schematic of the optical fibre coupling with NbN SNSPD, Transmission 60%, Reflexion 20%, Absorption 20% x 0.5 = 10%

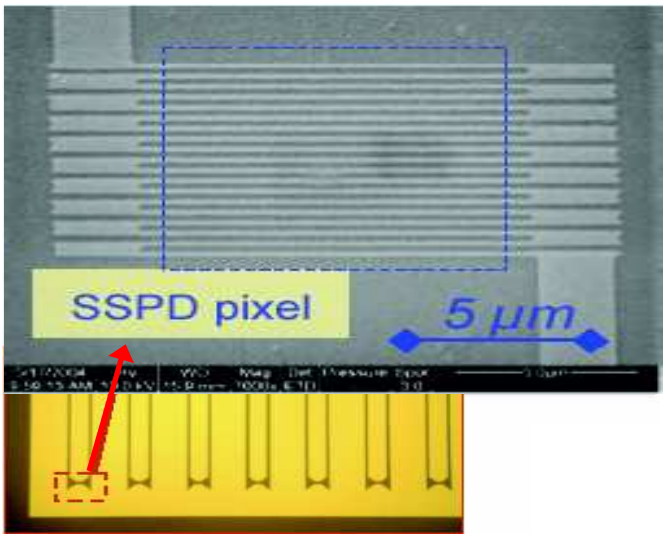

Figure 3: SEM Observation of the e-beam patterned NbN meander pixel with 60nm wide nanowire