Wafer-Bow Control in DIBS-Deposited Thin-Film Optical Stacks to Improve SNSPD Performance

Eva Raffalt[1,2], Maryam Nazari[1], Matthias Golling[1], Rico Benz[1], Boris Korzh[2]

[1]*RhySearch, 9471, Buchs, Switzerland*

[2] *Department of Applied Physics, University of Geneva, 1205, Geneva, Switzerland*

Superconducting nanowire single-photon detectors (SNSPDs) are among the most powerful single-photon detection technologies, offering high efficiency, low noise, and excellent timing performance [1]. Further improvements can be achieved by integrating highly reflective mirrors—such as distributed Bragg reflectors (DBRs) beneath the superconducting nanowire to enhance photon absorption [2]. Previous attempts have been limited by excessive surface roughness of the mirror layers, which is incompatible with the stringent smoothness requirements of SNSPD fabrication.

Dual ion beam sputtering (DIBS) enables the deposition of dense, homogeneous thin films with extremely low surface roughness (RMS < 0.1 nm) due to high particle energies and low process pressures. Using DIBS, multilayer Ta_2O_5/SiO_2 optical stacks are deposited on double-side polished 4-inch silicon wafers to form the DBR. However, the resulting film stress induces significant wafer bow, which must be reduced to below 2 µm to allow reliable lithographic processing. In this work, we investigate several approaches to control and minimize wafer bow in DIBS-deposited optical stacks and compare experimental results with corresponding simulations.

Funding acknowledgement

The project is supported by the Swiss Confederation through the State Secretariat for Education, Research and Innovation (SERI) as part of the federal contribution to research institutions of national importance (Art. 15 RIPA).

References

[1] Venza, F. P., & Colangelo, M., “Research trends in single-photon detectors based on superconducting wires”, APL Photonics (2025). https://doi.org/10.1063/5.0246490

[2] D. V. Reddy et al., “Superconducting nanowire single-photon detectors with 98% system detection efficiency at 1550 nm”, Optica Vol. 7, No. 12, 2020, https://doi.org/10.1364/OPTICA.400751.