Efficient generation of quantum light at telecom wavelength for long-distance secure communication and quantum network applications

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Quantum communication networks are formed of secure links, where information can be transmitted with security guaranteed by the quantum nature of light [1]. An essential building block of such a network is a source of single photons or entangled photon pairs compatible with the low-loss fibre windows around 1310 nm or 1550 nm. In this framework, InAs quantum dots (QDs) are considered mature candidates for the generation of quantum light because they can be engineered to achieve a wide range of desired properties and are compatible with conventional semiconductor opto-electronics. However, an appropriate engineering of the photonic environment is essential to achieve efficient extraction of the emitted photons from a high-index semiconductor matrix.
I will discuss how the integration of InAs QDs into hybrid circular Bragg Gratings [2] (CBGs) operating in the telecom O-band is a promising route to meet the challenging requirements for long-haul secure communication. Moreover, I will present a design optimization of hybrid CBGs operating in the telecom C-band and introduce a variation directly compatible with electric field control [3], which paves the way for the realization of efficient and electrically driven quantum light sources.

Semiconductor QDs are the only source of quantum light able to emit directly in the telecom O-band and C-band, therefore the integration with devices that can efficiently enhance their light output is essential for experiments based on important concepts, such as teleportation or entanglement swapping, and ultimately for the large-scale diffusion of quantum technologies.

References

[1] H.J. Kimble, Nature 453 (2008) 1023–1030.
[2] J. Liu et al., *Nat. Nanotechnol.* 14, 586–593 (2019).
[3] A. Barbiero et al., arXiv:2112.13028, 2021.

Figures

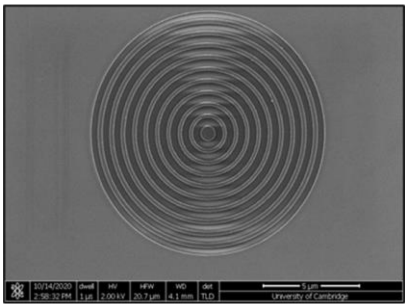

Figure 1: Example of hybrid CBG fabricated on a semiconductor slab.

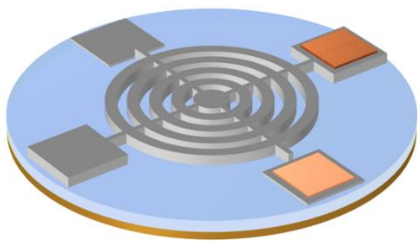

Figure 2: Modified CBG design compatible with electric field control.