Aluminium Gallium Arsenide Photonic Integrated Circuits for 780 nm Optical Delivery for Quantum Sensors

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An on-chip approach to optical delivery for portable quantum sensors is described. The optical design, epitaxy, nanofabrication and measurement of polarisation-maintaining, deep-etched aluminium gallium arsenide ($Al_xGa_{(1-x)}As$) waveguides for near-infra-red 780 nm light was achieved, in an analogous approach to earlier work at (1300-1550) nm wavelengths [1]. Material characterisation measurements inferred optical quality improvement and reduced intrinsic material optical loss for growth by Molecular Beam Epitaxy (MBE). High, continuous-wave optical intensities were guided with low polarisation noise and photonic waveguide performance was stable over time. The optical loss was measured to be below 4.3(±0.4) dB cm^{-1} corresponding to an attenuation coefficient, α, of 1.0 (±0.08) cm^{-1} for single mode waveguides and demonstrating improved performance data [2]. The polarisation extinction ratio was better than -19 (±1) dB for orthogonal polarisations. These novel components illustrate the feasibility of passive photonic integrated circuits for the 780 nm wavelength. Future work will investigate the optical switching properties of these structures. The ultimate aim of the work is the creation of waveguide-based photonic circuits for compact cold atom sensors based on the D_2 hyperfine transition of ^{87}Rb at 780.24 nm [3]. Further applications include free-space short-wave communications, hybrid quantum systems [4] and epitaxial structures transparent to shorter wavelengths for other cold atom species and trapped ions.

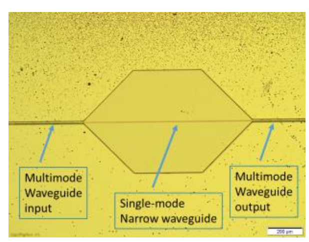

Figure 1: Optical microscopy semiconductor photonic waveguide single-mode and multi-mode regions

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