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Ring Quantum Cascade Lasers with Grating Phase Shifts

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A ring quantum cascade laser (ring QCL) is a semiconductor light source emitting in a wide range from the mid-infrared to the terahertz region of the electromagnetic spectrum. This makes such devices the ideal candidates for a large variety of applications like spectroscopy and chemical sensing. Compared to conventional Fabry-Pérot lasers, ring QCLs exhibit lower lasing thresholds and a higher optical output power due to the absence of facet losses. However, the rotational symmetry of the ring laser gives rise to an inherent intensity minimum in the center of the far field caused by destructive interference. By applying two abrupt grating pi-shifts, the electric field vector can be rotated by 180 degrees for half of the ring. This results in constructive interference and a linearly polarized central intensity maximum. The linear polarization feature can be extended to the whole far field with an on-chip polarizer fabricated onto the substrate of the device. We present an approach to suppress the undesired polarization directly in the waveguide instead of blocking the light with a polarizer. This approach is based on a continuous phase shift formed by a dual grating structure. It suppresses the light not only at a specific point but over a comparatively large area along the waveguide. In this way more light of the desired polarization is emitted by the ring QCL. Furthermore, the near field of the ring laser exhibits a small tilt, which can be linked to the exact location of the whispering gallery mode in the cavity.

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