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Room Temperature Lasing from InGaAs Quantum Well Nanowires on Silicon-On-Insulator Substrates

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Abstract : Quantum confinement can be used to increase efficiency and control the emitted spectra in lasers and LEDs. In semiconductor nanowires, quantum confinement can be achieved in the axial direction by stacking multiple quantum disks or in the radial direction by forming a core-shell structure. In this work we demonstrate room temperature lasing in topological photonic crystal nanowire array lasers by using the InGaAs radial quantum well as the gain material. The nanowires with the GaAs/ InGaAs/ InGaP quantum well structure are arranged in a deformed honeycomb lattice, forming a photonic crystal surface emitting laser (PCSEL) . Under optical pumping we show that the PCSEL lase at the wavelength of 1001 nm (undeformed pattern) and 966 nm (stretched pattern), with the lasing threshold of 103 μJ□/cm □^2. We compare the lasing wavelengths from devices with three different nanowire diameters for undeformed compressed and stretched devices, showing that the lasing wavelength increases as the nanowire diameter increases. The impact of deforming the honeycomb pattern is studied, where it was found out that the lasing wavelengths of undeformed devices are always larger than the corresponding stretched or compressed devices with the same nanowire diameter. Using photoluminescence results and numerical simulations on the field profile and the quality factors of the devices, we establish that the lasing of the device is from the radial quantum well structure.

Keywords : honeycomb PCSEL, nanowire laser, photonic crystal laser, quantum well laser
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