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Ge 量子ドットを有する導波路結合マイクロディスクの室温エレクトロルミネッセンス

Room-Temperature Electroluminescence from Waveguide-Coupled Microdisk with Ge Self-Assembled Quantum Dots

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Ge self-assembled quantum dots (QDs) grown on silicon are potential light emitting materials for monolithic silicon-based photonic integrated circuits. By embedding Ge QDs into optical cavities, the light emission efficiency can be enhanced due to the Purcell effect. We have demonstrated both optically and electrically injected light emitting devices based on photonic crystal cavities and microdisks. However, these devices are usually surface-emitting type, which are not suitable for planar integration with other waveguide components. In the paper, we demonstrated room-temperature electroluminescence (EL) extracted from planar waveguide coupled to microdisk.

The microdisk and bus waveguide were fabricated on SOI wafer containing three layers of Ge QDs grown by MBE. The total Si/Ge layer thickness is around 450 nm. A 100 nm thick slab was remaining as the electrical path after dry etching. A vertical PIN diode, with P+ region on the slab and N+ region on the microdisk, was fabricated to inject the carriers, as shown in the schematic diagram of Fig. 1(a). In order to measure the light emission from top by a confocal microscope photoluminescence (μPL) system, grating couplers were fabricated on the waveguide to convert the edge-emitting to surface-emitting. Fig. 1(a) shows the microscope image of a fabricated microdisk with radius of 3 μm. The EL spectra under different injected currents recorded from the grating coupler are shown in Fig. 1(b). Sharp resonant peaks were clearly observed in the EL spectra, with Q-factor around 1000-2000. Since the grating coupler only works around 1.5 μm wavelength and has a narrow optical bandwidth, we can only see the resonant peaks around 1.5 μm. In order to confirm the coupling between microdisk and bus waveguide, we also measured the optical transmission of the bus waveguide. Fig. 1(c) shows the comparison between the transmission and EL spectrum of the device. In our measurement range, three resonant notches are clearly seen, corresponding very well with the resonant peaks in the EL spectrum. These results verify that the light emission can be well extracted from the microdisk by a laterally coupled bus waveguide.

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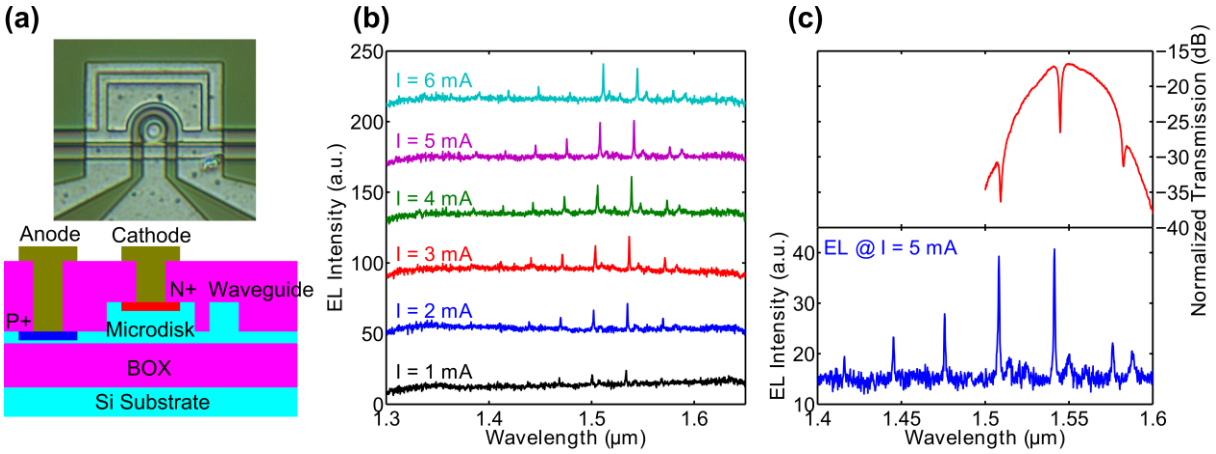

Fig. 1. (a) Microscope images of the waveguide-coupled microdisk current-injected LED; (b) EL spectra recorded from the grating coupler under different injected currents; (c) Comparison of the optical transmission and EL spectra of the LED.