Significantly enhanced performances of 1.3 µm InAs/GaAs quantum dot lasers by direct Si-doping

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Direct Si-doping into InAs/GaAs quantum dots (QDs) has shown dramatically enhanced photoluminescence of the QDs [1]. This Si-doping technology has been used to fabricate intermediate band QD solar cells and led to a markedly increased conversion efficiency of the cells from 11.3% to 17% [2]. In this work, we demonstrate significantly improved performances of 1.3 µm InAs/GaAs QD lasers using the direct Si-doing technology.

Two QD laser structures with the doping concentration of 1×10^{18} cm^{-3} and without any doing were grown by MBE. The active region of the two lasers consists of five stacked layers of InAs/GaAs QDs. Ridge waveguide lasers with a ridge width of 30 µm for the two laser structures were fabricated using standard wet etching and metallization techniques.

Figure 1 shows single-side CW power-current (P–I) curves of the two lasers with a cavity length of 2.5 mm, obtained at 20 ℃. It can be clearly seen from the figure that the threshold current of the doped QD laser is as low as 53.7 mA, which is much smaller than for the undoped one (125.5 mA). The corresponding threshold current density for the doped laser is only 71.6 A/cm^2 (14.3 A/cm^2 per QD layer), whereas it is 167.3 A/cm^2 (33.5 A/cm^2 per QD layer) for the undoped QD laser. In addition, the single-side slope efficiency is improved from 0.28 W/A for the undoped QD laser to 0.42 W/A for the doped QD laser.

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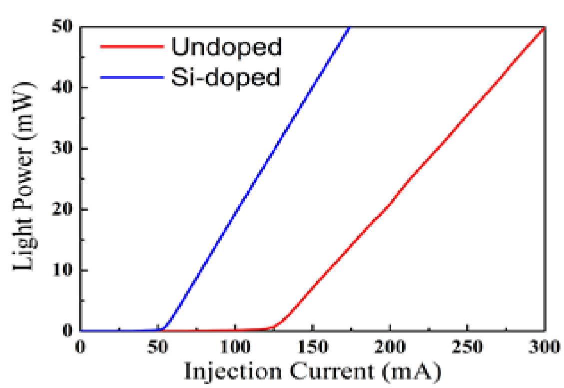

Figure 1 Single-side CW P–I curves of the two QD lasers

[1] T. Inoue et al., J. Appl. Phys. **108**, 063524 (2010).
[2] X. G. Yang et al., Sol. Energy Mater. & Sol. Cells **113**, 144 (2013).

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