

Effect of doping on the polarization characteristics of spin-injected quantum dot VCSEL

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Abstract: The polarization characteristics of doped spin-injected quantum dot vertical cavity surface emitting laser (QD-VCSEL) have been studied using multi-population spin-flip coupled rate equation model. The stability conditions of spin-injected VCSEL are also investigated for different device parameters. Our analysis reveals that QD-VCSEL emitting at high lasing energies, close to the first excited state energy, demonstrates high output ellipticity and high ellipticity gain compared to QD-VCSEL emitting at the ground state energy. Also, we find that increasing the p-type doping concentration of the quantum dots increases the output ellipticity gain of the device and significantly alters the stability conditions of the VCSEL. Large instability is observed when the VCSEL is emitting near 70meV above the ground state energy and when the quantum dots are doped with 4×10^{10} cm⁻² of p-type concentration. Moreover, we find that QD-VCSEL exhibits good stability when its emission energy is approximately 10-20meV higher than the ground state energy and when the dots are doped with more than 4×10^{10} cm⁻² of p-type concentration.