Electron-beam pumped blue (462 nm) VCSEL on MOVPE-grown ZnSSe/ZnMgSSe MQW structure

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E-beam pumped VCSEL emitting in blue spectral range is promising as an efficient light source for display technologies. To date, lasing at 484-493 nm (blue-green range) was achieved on basis MBE-grown ZnCdSe/ZnSe MQW structures. However to obtain pure blue (455-465 nm) lasing it is necessary to use compounds with wider band gap. ZnMgSSe with $E_g \approx 3.0$ eV is suitable material for barrier layers while ZnSSe or ZnSe may be used as QW material for blue range. Until ZnMgSSe solid solution was used only as cladding layers in II-VI laser diodes but not as barriers. Moreover typically MBE-grown ZnMgSSe with $E_g \leq 2.9$ eV was used for this purpose because an alloy instability problem occurs for this material with wider E_g. In this work we present the first results on growth of ZnSSe/ZnMgSSe MQW structures and realization of VCSEL with e-beam pumping on their basis.

55-period ZnSSe/ZnMgSSe QW structure was grown by MOVPE on GaAs substrates misoriented by 3^0 from (001) to (1$\underline{1}$0). The period was intended to be equal to $\lambda/2N$ where λ is the desired laser wavelength and N is the average refractive index along the period. The MQW part was grown on ZnSSe buffer with $3\lambda/2N$ thickness. ZnSSe and ZnMgSSe had lattice period close to one of GaAs substrate although not matched completely. The growth was carried out in home-made horizontal quartz reactor with optical window for *in situ* multiwavelength reflectrometry control of layer thickness. Growth run was carried out in hydrogen at atmospheric pressure using diethylzinc (Et_2Zn), bisethyl-cyclopentadienilmagnesium ($(EtCp)_2Mg$), diethylsulfide (Et_2S) and dimethylselenide (Me_2Se) as precursors. Substrate temperature was 450 ^{0}C. That is higher than growth temperature used before for ZnMgSSe making by both MOVPE and MBE. The GaAs substrate was removed by chemical etching and the structure was transformed into a microcavity with dielectric oxide mirrors.

Lasing at 462 nm with an output power of 0.6 W was achieved under scanning e-beam longitudinal pumping at room temperature. The threshold current at electron energy of 40 keV was 0.28 mA (about 50 A/cm^2 in current density).