Study on differences between high contrast grating reflectors for TM and TE polarizations and their impact on VCSEL designs

A theoretical study of differences in broadband high-index-contrast grating (HCG) reflectors for TM and TE polarizations is presented, covering various grating parameters and properties of HCGs. It is shown that the HCG reflectors for TM polarization (TM HCG reflectors) have much thicker grating thicknesses and smaller grating periods than the TE HCG reflectors. This difference is found to originate from the different boundary conditions met for the electric field of each polarization. Due to this difference, the TM HCG reflectors have much shorter evanescent extension of HCG modes into low-refractive-index media surrounding the HCG. This enables to achieve a very short effective cavity length for VCSELs, which is essential for ultrahigh speed VCSELs and MEMS-tunable VCSELs. The obtained understandings on polarization dependences will be able to serve as important design guidelines for various HCG-based devices.