# Reflectivity Spectra of DBR for IR Spectral Range: Carrier Concentration Dependency

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Distributed Bragg Reflectors (DBRs) represent crucial components extensively utilized in photonics applications. These structures are fabricated through epitaxial growth processes, comprising alternating layers of materials with distinct refractive indices. DBRs find widespread application as forming optical resonators in vertical emitting lasers [1]. Through strategic selection of materials and their respective thicknesses, precise control over the wavelength of the stimulated laser mode can be achieved. Particularly noteworthy is their utilization within the infrared spectral range, which is currently of significant interest in laser design as well as for boosting the extraction efficiency of non-classical light sources. Their versatility extends to various applications, including their integration into schemes for the detection of harmful gases, rendering DBRs an appealing domain for ongoing research endeavors. As a result of three primary phenomena - bandfilling, bandgap shrinkage, and free-carrier absorption - the refractive index, and consequently the reflectivity spectra, rely on the carrier concentration within the material [2]. This characteristics can be altered through doping, interaction with external fields, carrier injection, and other means which can be explored as basis for engineering of DBR reflectivity spectra.

In our study, we aim to calculate the reflectivity spectra of selected DBR materials suitable for IR range, but instead of alternating layers of two different materials the design is based on varying carrier concentration. The Transfer Matrix Method (TMM) is employed, which involves considering the electric field amplitudes during the propagation of an electromagnetic wave through the structure. This method encompasses propagation within materials characterized by specific refractive indices and thicknesses, as well as reflection and transmission at each interface. Light propagation throughout the entire structure can be represented using a 2D array known as a transfer matrix [3]. The TMM was implemented in Python and utilized to compute the reflectivity spectra of the DBR. To incorporate the variable containing information about carrier concentration, we leverage its strong association with refractive index [2]. By integrating this relation into our program, we can study the sensitivity of the reflectivity spectrum to this parameter.

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