

Simulations of reflectivity and of distribution of electric field in double, vertically coupled optical microcavities

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Semiconductor photonic micro- and nanostructures are typically produced by methods such as epitaxial growth that are time consuming and relatively expensive. Simulations of optical properties of such structures play an important role in their design and are a key step, which precedes the actual fabrication. Transfer Matrix Method (TMM) is a type of method that can be used to this end. In this work we present results of the TMM simulations,[1] by which we systematically analyze the impact of various structure parameters on the reflectivity as well as on a distribution of an electric field inside the photonic structures consisting of two vertically coupled, planar microcavities embedded in Distributed Bragg Reflectors (DBRs). Implementation of such structures offer such phenomena as Optical Parametric Oscillation.

In order to determine the strength of interaction between the optical mode of the microcavities, the following parameters of the structure are varied: number of DBR pairs between microcavities, contrast of refractive indices of the materials forming DBR layers, thickness of the DBR layers, and thickness of the microcavities.[2]

Simulations of evolution with time of reflectivity spectrum of the double microcavity in the full visible spectral range during the sample growth are also performed. They provide important information allowing one to control the process of epitaxial growth of the sample, if only the reflectivity is monitored in-situ, which often is the case (Fig. 1a)).

Moreover, one learns from the simulations that the distribution of the electric field for the coupled mode of the lowest energy is symmetric (antisymmetric) in the case of odd (even) number of DBR pairs. In turn, simulations of a propagation of the excitation laser inside the structure, in which the laser wavelength is tuned to the minimum of the structure reflectivity, show that the laser beam efficiently penetrates DBRs and that its intensity is the same in both microcavities. This information is valuable for photoluminescence studies of the structures.

The presented results provide an important insight to the designing, manufacturing, and the study of double coupled microcavities using spectroscopy methods.

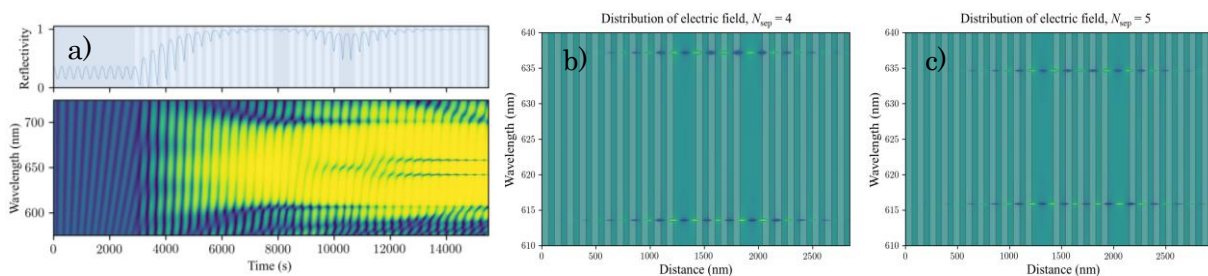


Fig. 1 a) Evolution of reflectivity spectrum during the epitaxial growth, b) and c) electric field distribution for the two lowest energy modes determined for four and five DBR pairs separating the coupled microcavities.

[1] C.B. Fu, C.S. Yang, M.C. Kuo, Y.J. Lai, J. Lee, J.L. Shen, W.C. Chou, S. Jeng, *Chin. J. Phys.* **41**, 535 (2003).

[2] M. Sciesiek, W. Pacuski, J-G. Rousset, M. Parlińska-Wojtan, A. Golnik, J. Suffczyński, *Cryst. Growth Des.* **17**, 7 (2017).