NONLINEAR OPTICAL PROPERTIES MODELLING OF QUANTUM RINGS HAVING RECTANGLE-SHAPED HOLES.

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Nonlinear optical properties modelling of quantum rings having rectangle-shaped holes.

Abstract

- Over recent years, the implementation of droplet epitaxy technique at high temperature regime has made possible the fabrication of semiconductor quantum rings having rectangle-shape holes (RQRs) [1]. This fact has motived to consider a single electron confined in a RQR under the presence of orthogonal electric and magnetic fields.
- To calculate the optical properties, the corresponding electron eigen-energies are obtained by solving Schrödinger wave equation within the effective mass approximation and using finite element computational procedure. From these data, we calculate the single electron nonlinear intraband optical absorption coefficient and relative refractive index changes as a function of incident photon energy.
- These calculations are made within the compact density-matrix formalism under steady state conditions. Taking into account that central rectangle hole and external circular contour of the quantum ring leads to an anisotropic width of the RQR, we analyze how this anisotropic structural behavior tends to affect the electron nonlinear optical properties since the widest areas have a great localizing power of the electronic cloud. [1]

Nonlinear optical properties modelling of quantum rings having rectangle-shaped holes.

REAL MODEL

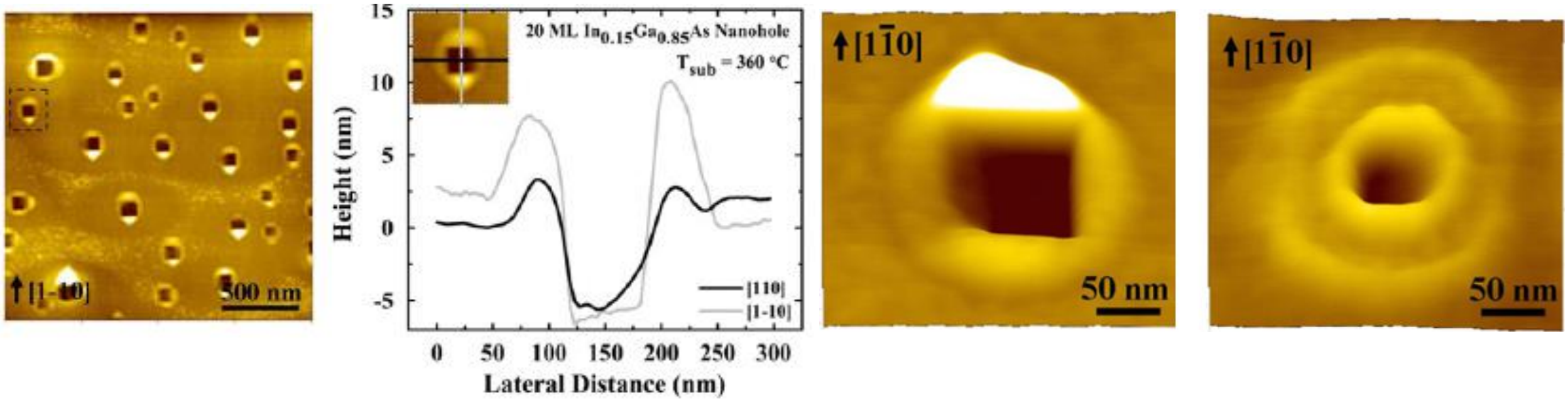


Fig1. Single quantum rings with square like nano holes on GaAs(001) by droplet epitaxy. **[1]**

Theoretical Model

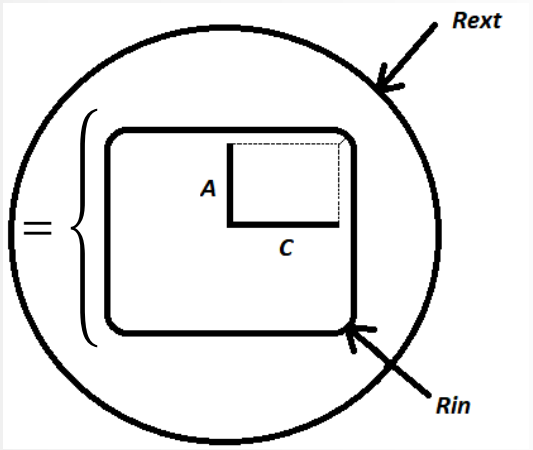
Dimensionless off-axis Donor Hamiltonian:

$$\frac{-\hbar^2}{2m_{eff}}\nabla^2 - \frac{ie\hbar B}{2m_{eff}}\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x}\right) + \frac{e^2B^2}{8m_{eff}}(x^2+y^2) + eFx + V_{conf}$$

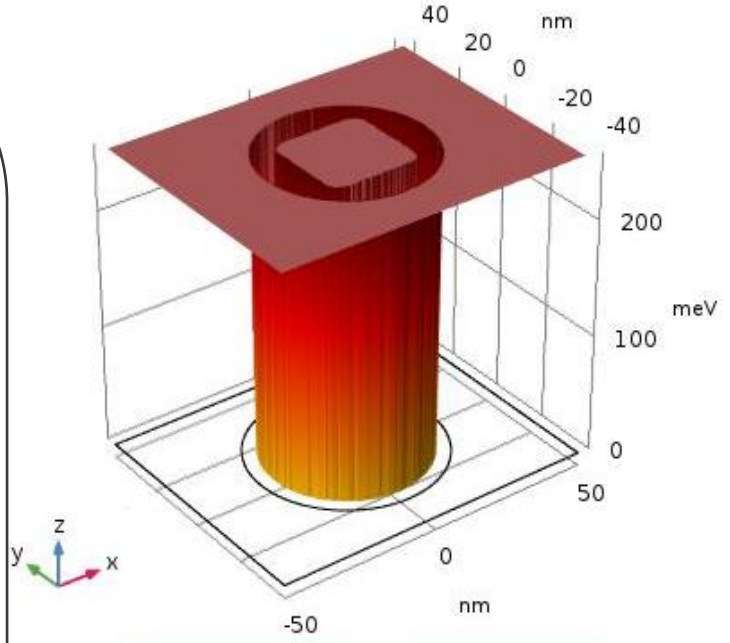
$$V_{Conf} = \begin{cases} 0 \ \ if\ V_{AC} \le R \le Rext \\ 256 \ \ if\ R \ge Rext\ or\ R \le V_{AC} \end{cases}$$

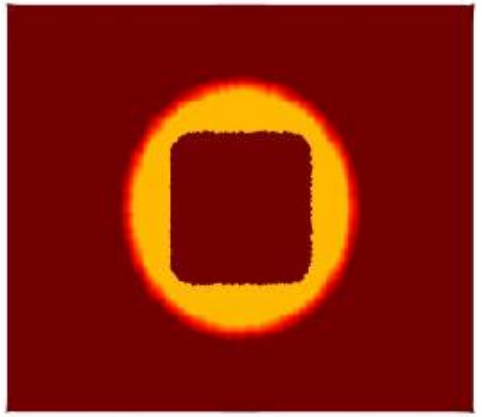
$$R = \sqrt{x^2+y^2}$$

V_{AC} =

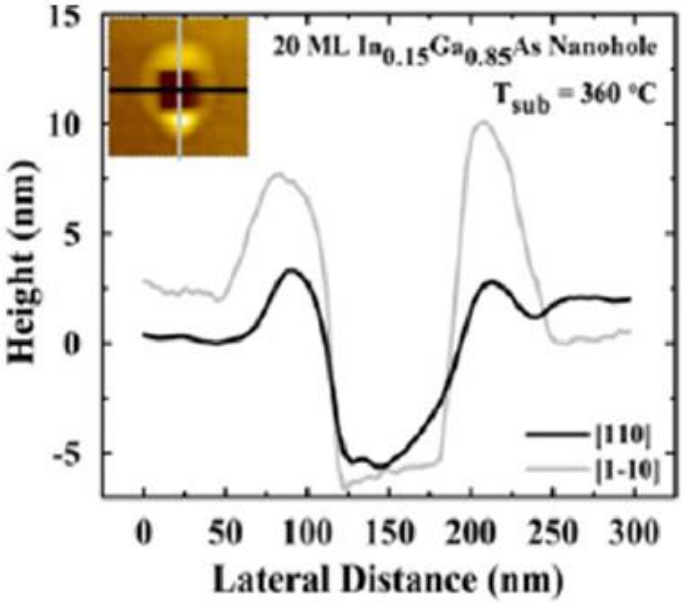


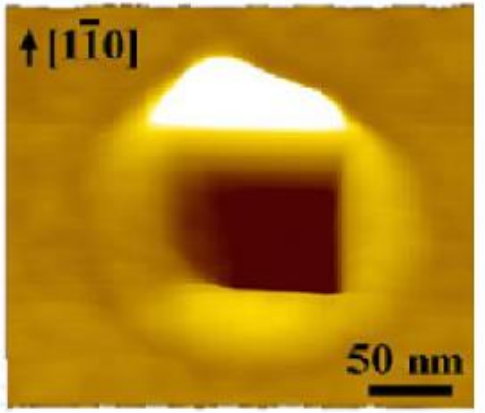
THEORETICAL MODEL





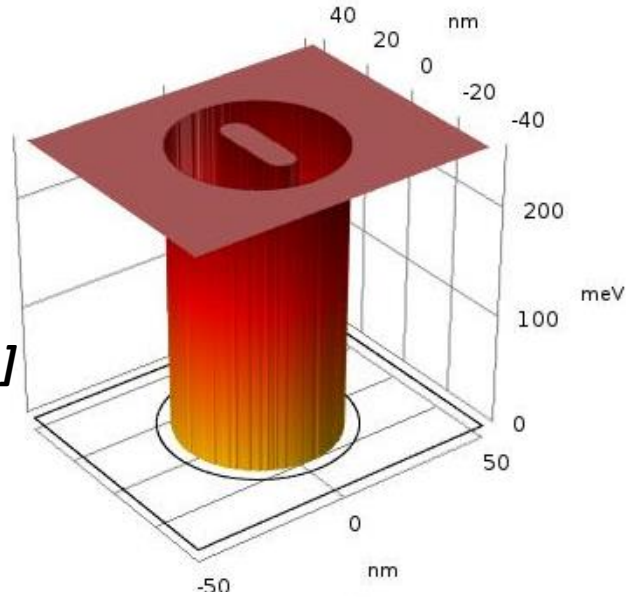
REAL MODEL

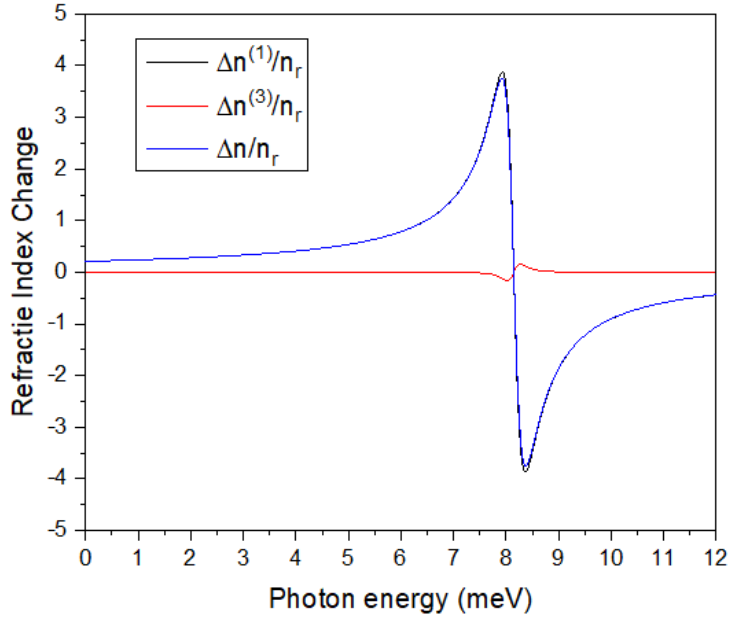


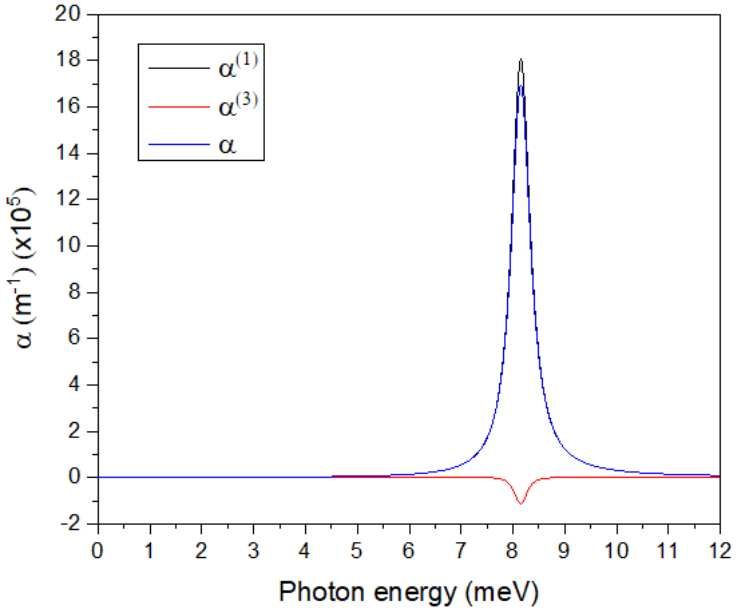


Refractive Index Relative Change And Optical Properties.

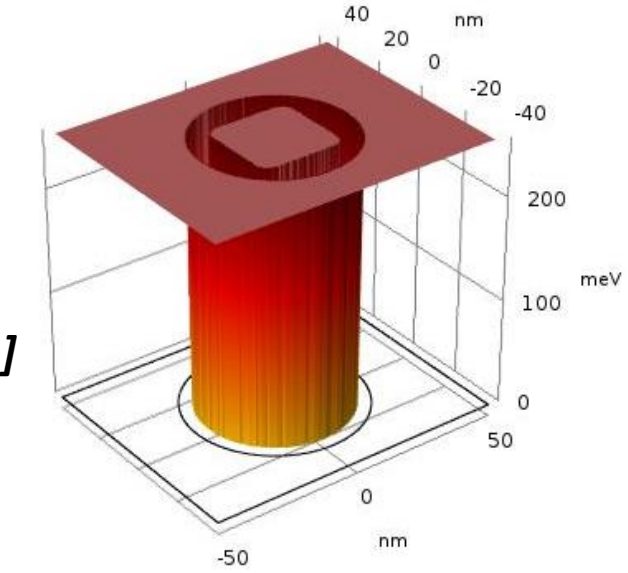
A=10[nm]
C=0[nm]
Rext=25[nm]
Rin=5[nm]

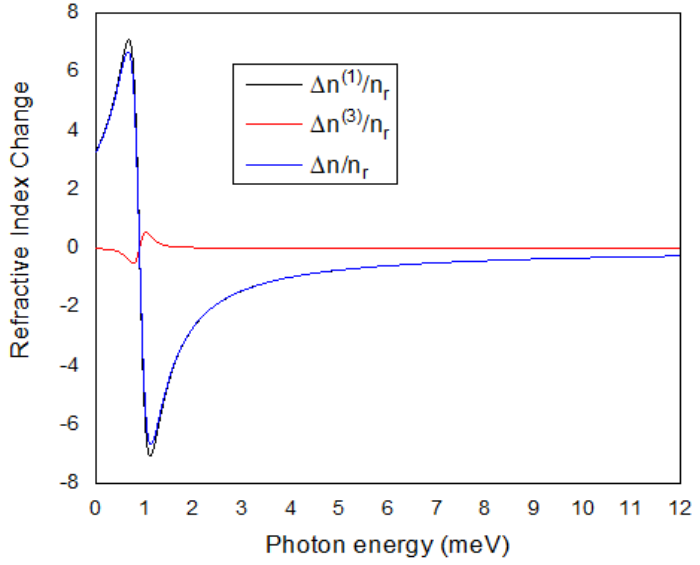


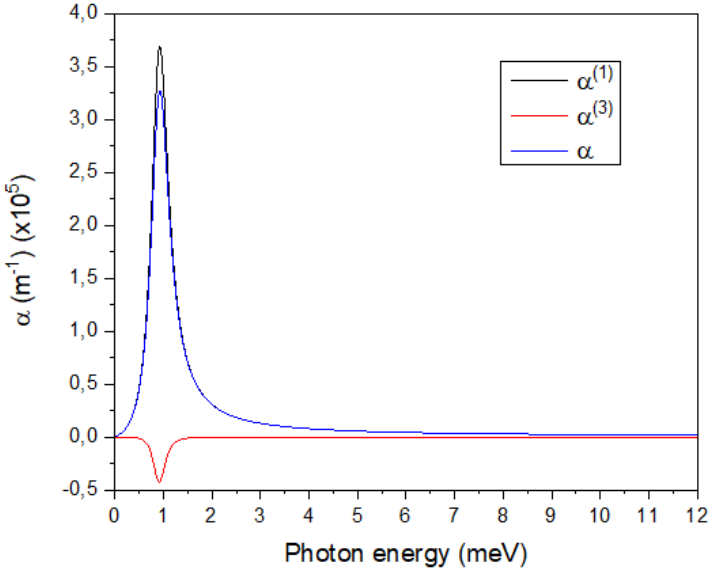




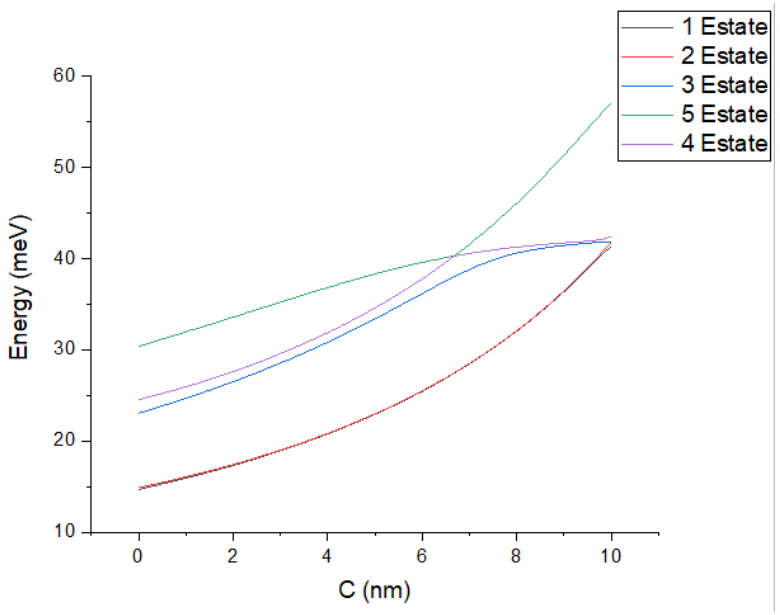
A=10[nm]
C=10[nm]
Rext=25[nm]
Rin=5[nm]

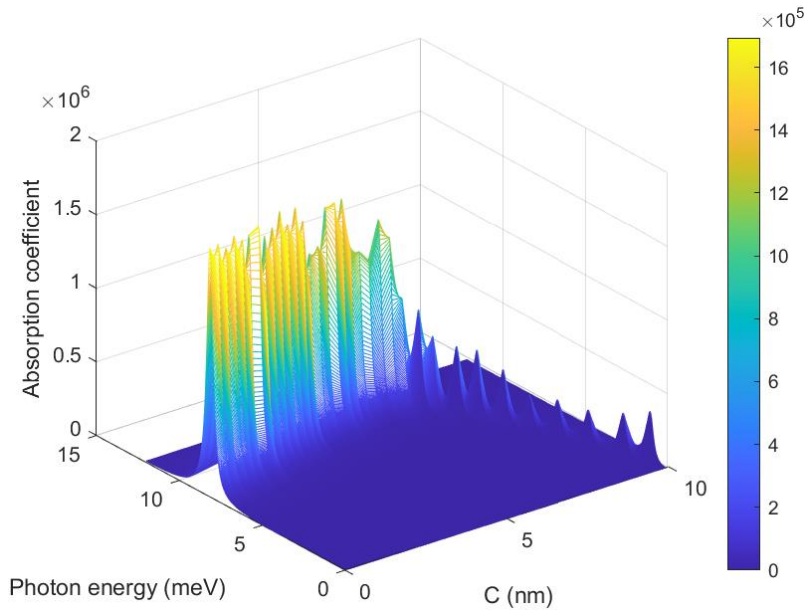


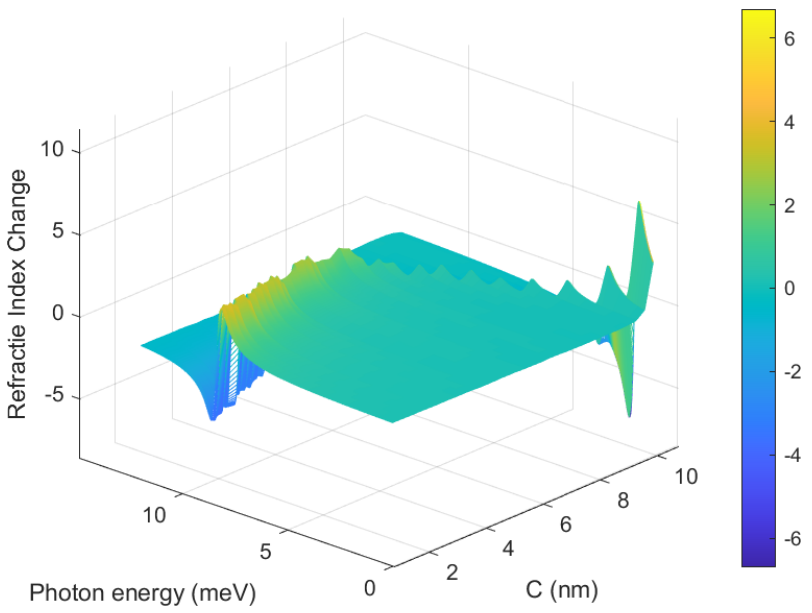




Refractive Index Relative Change and Optical Properties.







[1] *P. Boonpeng, W. Jevasuwan, S. Suraprapapich, S. Ratanathammaphan, S. Panyakeow, Quadra-quantum dots grown on quantum rings having square-shaped holes: Basic nanostructure for quantum dot cellular automata application, Microelectronic Engineering 86 (2009) 853–856.*