11th International Conference on Advanced Materials
ICAM2009
Rio de Janeiro Brazil
September 20 - 25

Aluminum concentration and magnetic field effects on the Landé g factor in a GaAs-(Ga,Al)As cylindrical pillbox

J. R. Mejía-Salazar(1)*, N. Porras-Montenegro(1)

(1) Departamento de Física, Universidad del Valle, Cali, Colombia, A.A. 25360.
* jrmejia3146@gmail.com

Abstract – We have performed a theoretical study of the aluminum concentration and axis-parallel applied magnetic field effects on the Landé g factor in a cylindrical GaAs-(Ga,Al)As quantum dot. The annisotropy and nonparabolicity effects on the conduction band was considered by mean of the Ogg-McCombe effective Hamiltonian, which includes terms up to fourth order. The present calculations are presented as a function of the strength of the applied magnetic field, aluminun concetration in the barrier material, radius and lengths of the cylindrical pillbox. Our results are in good agreement with previous theoretical and experimental results in the limit cases of a quantum wells and quantum well wires.

The electron Landé *g* factor dependence on the Aluminum concentration and magnetic field effects in cylindrical GaAs-(Ga,Al)As quantum pillbox has been studied within the effective-mass approximation. The annisotropy and nonparabolicity effects on the conduction band in each host material has been taked into account by mean of the Ogg-McCombe effective Hamiltonian, which include terms up to fourth order

$$\hat{H} = \frac{\hbar}{2}\hat{\vec{K}}\frac{1}{m(\rho,z)}\hat{\vec{K}} + \frac{1}{2}g(\rho,z)\mu_B B\sigma_z + a_1\hat{K}^4 + \frac{a_2}{l_2^4} + a_3\left(\left[\hat{K}_\rho^2,\hat{K}_\varphi^2\right]_+ + \left[\hat{K}_\varphi^2,\hat{K}_z^2\right]_+ + \left[\hat{K}_z^2,\hat{K}_\rho^2\right]_+\right)$$
$$+ a_4 B\hat{K}^2\sigma_z + a_5 B\left[\hat{\vec{\sigma}}.\hat{K}_\rho^2,\hat{K}_\varphi^2\right]_+ + a_6 B\hat{\sigma}_z\hat{K}_z^2 + V(\rho,z)$$

The quantum pillbox is assumed to consist of a finite length cylinder of GaAs material surrounded by $Ga_{1-x}Al_xAs$ material. The calculations have been performed by using the Kummer confluent hypergeometric functions. In this way we can study the *g* factor not only in cylindrical quantum pillbox, but also in the limit geometry of a quantum well and a cylindrical quantum well wire. Our results are in very good agreement with previous experimental [1,2] and theoretical [3,4] data.

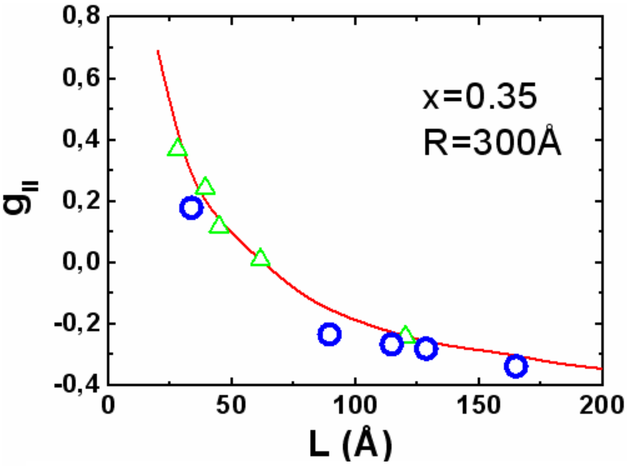

Figure 1: g factor as a function of the length of the cylindrical quantum pillbox for a very large radius. Our results are compared with previous experimental measurements [1,2] in the limit geometry of a quantum well for x=0.35.

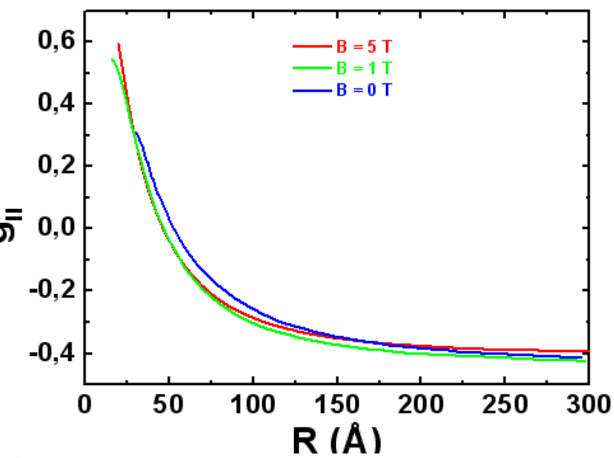

Figure 2: g factor as a function of the radius for a very large length of the cylindrical pillbox, B=5T and x=0.35. Our results are compared with previous theoretical results in the limit geometry of a quantum well wire for B=0T [3], and for B=1T [4].

[1] P. Le Jeune, D. Robart, X. Marie, T. Amand, M. Brosseau, J. Barrau, V. Kalevich, and D. Rodichev, Semicond. Sci. Technol. **12**, 380 (1997).
[2] A. Malinowski and R. T. Harley, Phys. Rev. B **62**, 2051 (2000)
[3] A. A. Kiselev, Ivchenko, Rössler, PRB **58**, 16353 (1998).
[4] F. E. López, B. A. Rodríguez, E. Reyes-Gómez, and L. E. Oliveira, private communication.