Intensity-dependent nonlinear optical properties in an asymmetric Gaussian potential quantum well modulated by external fields

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Abstract

In this paper, the effects of external electric, magnetic and non-resonant intense laser fields on the nonlinear optical rectification (NOR), second-harmonic (SH), and third-harmonic (TH) generation in a GaAs quantum well with asymmetrical Gaussian potential are theoretically investigated. Firstly, the energy eigenvalues and eigenfunctions of a single electron confined in the structure are obtained by using the diagonalization method within the framework of the effective-mass and parabolic band approaches. Then, using these energy eigenvalues and eigenfunctions, expressions derived within the compact density matrix approximation has been employed to calculate the coefficients of the nonlinear optical response in the structure. The obtained simulation results show that the influence of the external fields leads to significant changes in the coefficients of nonlinear optical rectification, second and third harmonic generation in the system. As a result, it has been seen that the amplitude and position of the peaks of nonlinear optical rectification, second and third harmonic coefficients can be controlled by changing the applied external fields.

Full Text

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Figures

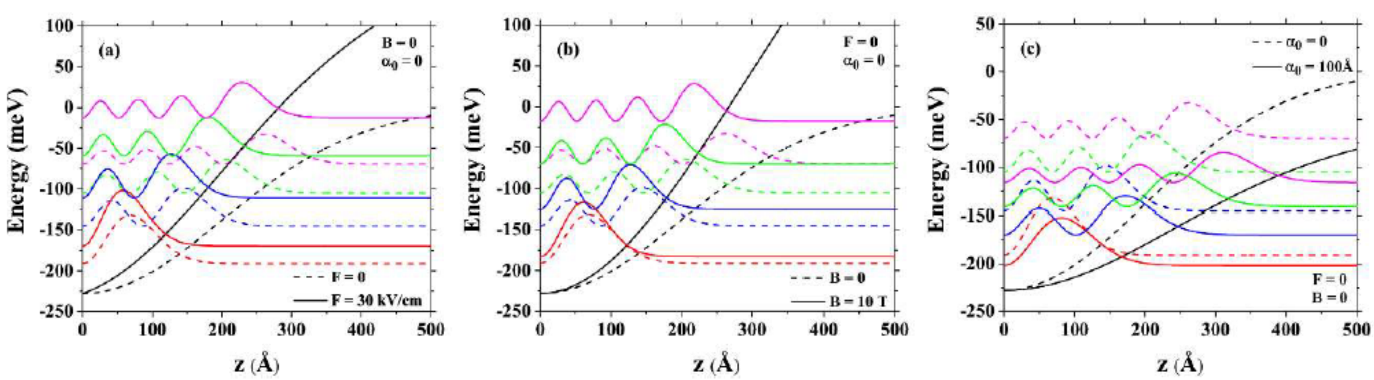

Figure 1

Representation of asymmetrical Gaussian potential profile at different external fields (a) B=0, α0=0, F=30kV/cm (b) F=0, α0=0, B=10T (c) F=0, B=0, α0=100Å. Dashed lines stand for the potential profile and corresponding wave functions in absence of any external field.

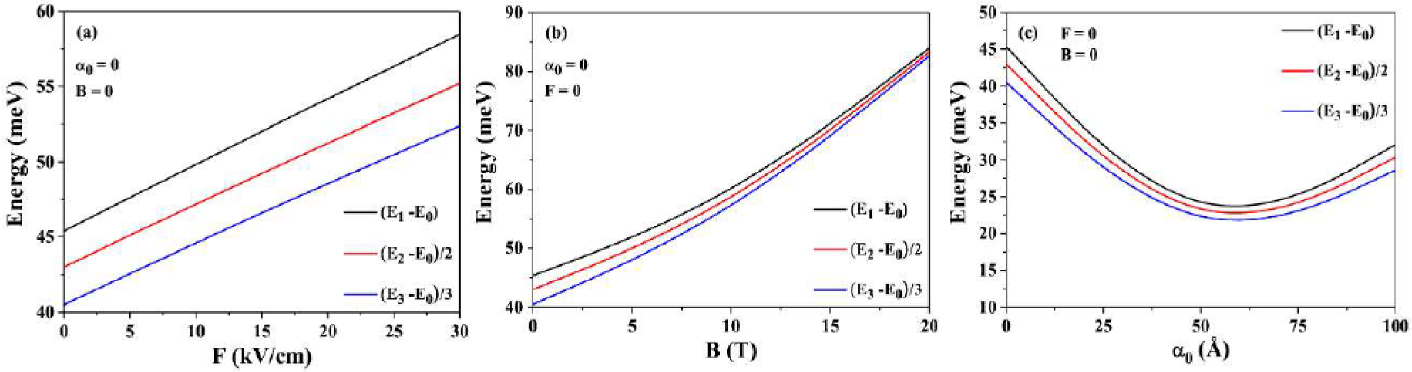

Figure 2

The energy difference between the ground state (E0) and the first (E1), second (E2), and third (E3) excited states as a function of the external (a) electric field (b) magnetic field (c) ILF.

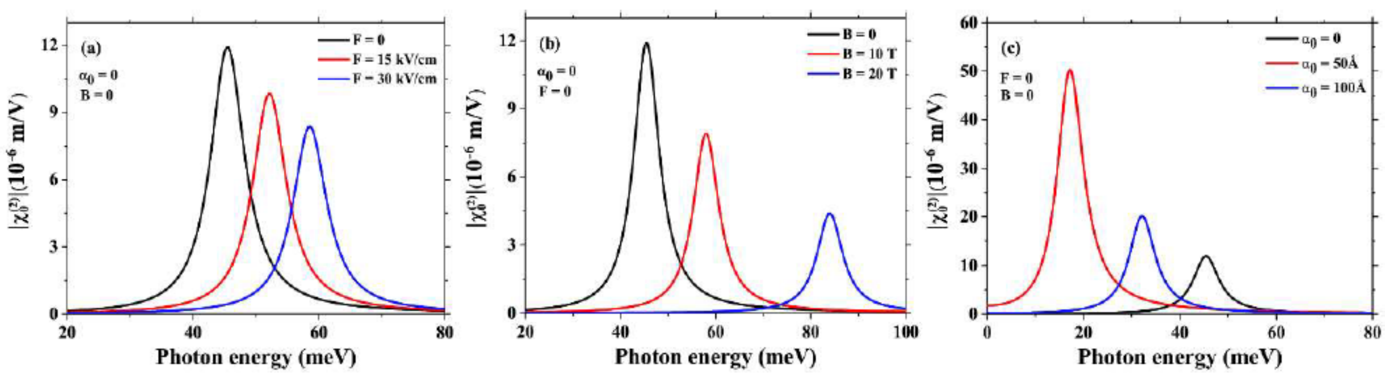

Figure 3

NOR coefficients as a function of incident photon energy for three different external fields. (a) α0=0 and B=0, black line is for F=0, red line is for F=15kV/cm, and blue line is for 30kV/cm. (b) α0=0 and F=0. B is set to 0, 10 and 20T for black line, red line and blue line. (c) F=0 and B=0, intense laser field (α0) chances for 0, 50 and 100Å.

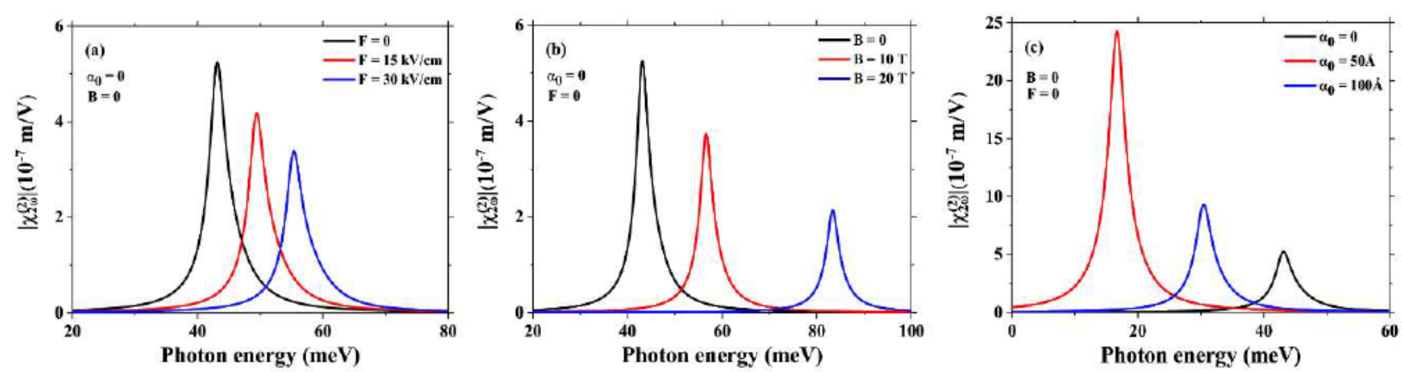

Figure 4

SHG coefficients as a function of incident photon energy. (a) α0=0 and B=0, black line is for F=0, red line is for F=15kV/cm, and blue line is for F=30kV/cm. (b) α0=0 and F=0, black line is for B=0, red line is for B=10, and blue line is B=20T. (c) F=0 and B=0, black line is for α0=0, red line is for α0=50 Å, and blue line is α0=100 Å.

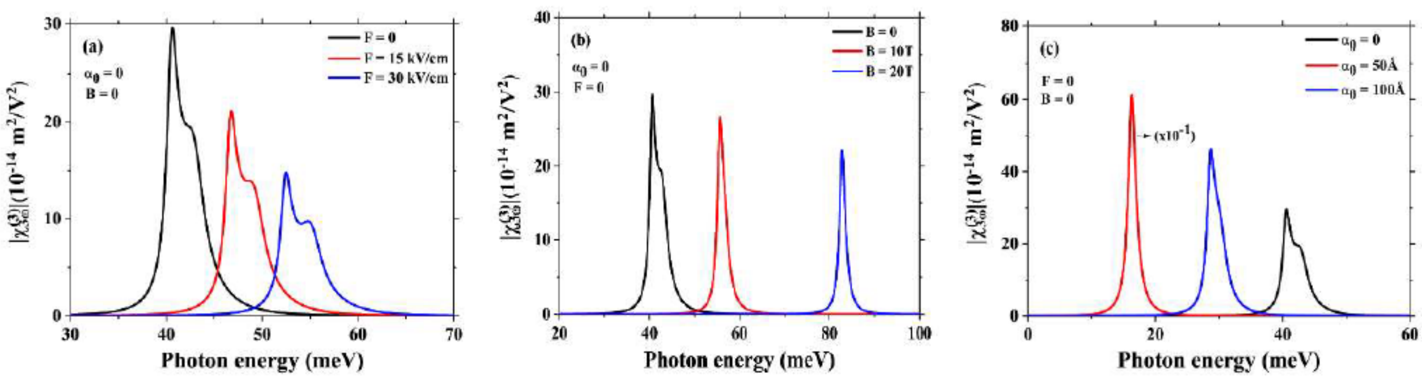

Figure 5

SHG coefficients as a function of incident photon energy. (a) α0=0 and B=0, black line is for F=0, red line is for F=15kV/cm, and blue line is for 30kV/cm. (b) α0=0 and F=0. B is set to 0, 10 and 20 T for black line, red line and blue line. (c) F=0 and B=0, α0 chance for 0, 50 and 100Å. (x10-1) corresponds signal decrease as a factor of 10 for visual comparison.