ELECTRONIC STATES AND ELECTRON RAMAN SCATTERING IN ASYMMETRICAL MULTIPLE QUANTUM WELLS

R. Riera, R. Betancourt-Riera, J.L Marín and R. Rosas
Departamento de Investigación en Física. Universidad de Sonora
Apdo. Postal 5-88, C. P. 83190, Hermosillo, Sonora, México
E-mail: rriera@cajeme.cifus.uson.mx

In recent years there has been considerable interest in asymmetrical multiple quantum wells systems because new devices could be developed based on inter-subband transitions. This feature could fulfill the necessity for efficient sources of coherent mid-infrared radiation for the applications in several branches of the science of the communications, radars, etc. For example, the inter-subband Raman laser can be built with a three-levels system [1-4] in such a way that the required space between the levels could be obtained by using double or triple asymmetrical quantum wells. These devices are fabricated of $GaAs/Al_xGa_{1-x}As$ grown epitaxially, where x commonly is of the order of 0.35, and *InGaAs/AlInAs* [5]. The system consists of two or three asymmetric *GaAs* coupled wells separated by an intermediate $GaAs/Al_xGa_{1-x}As$ barrier [6].

It is important to study this type of systems to determine their characteristics and predict their behavior. The Raman scattering is an ideal technique for their precision. The electronic structure of nanostructures can be studied through the Raman scattering processes considering different polarizations of incident and emitted radiation [7,8]. This is the reason why the Raman scattering experiments constitutes a powerful tool for the investigation of semiconductor nanostructures.

In this work, optical and electronic properties of asymmetrical multiple quantum wells for the construction of the quantum cascade lasers are calculated. Analytic expressions for the electronic states of two and three asymmetrical quantum wells are presented. The gain and differential cross-section for an electron Raman scattering are calculated too. The emission spectra for different scattering configurations are discussed. The corresponding selection rules for the processes involved are also studied. An interpretation of the singularities found in the spectra is done. The electron Raman scattering here studied can be used to provide direct information about the efficiency of the lasers and band structure used.

In Figure 1a and 1b, the electronic band structures for the double or triple asymmetrical quantum well are presented: *a*) $d_1 = 60\text{Å}$, $d_2 = 30\text{Å}$ and $b = 10\text{Å}$; *b*) $d_1 = 50\text{Å}$, $d_2 = 20\text{Å}$, $d_2 = 40\text{Å}$ and $b_1 = b_2 = 10\text{Å}$.

On the other hand, the laser gain for the double or triple asymmetrical quantum well is presented in Figure 2a and 2b. While the corresponding laser Raman cross sections are shown in Figure 3.

References

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Figures

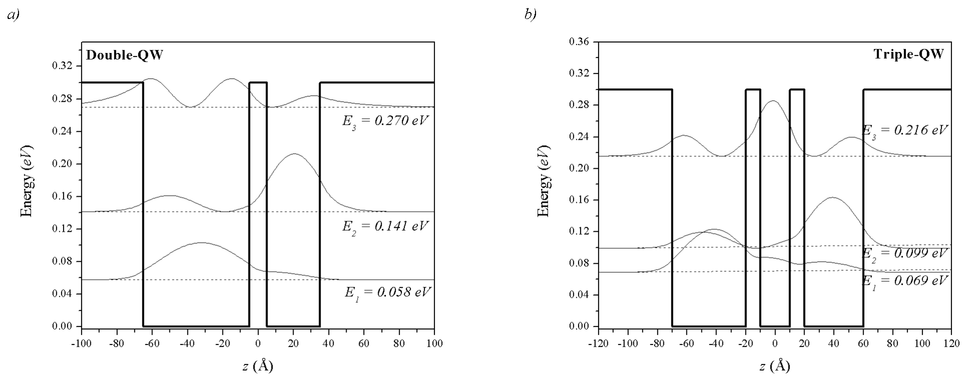

Figure 1

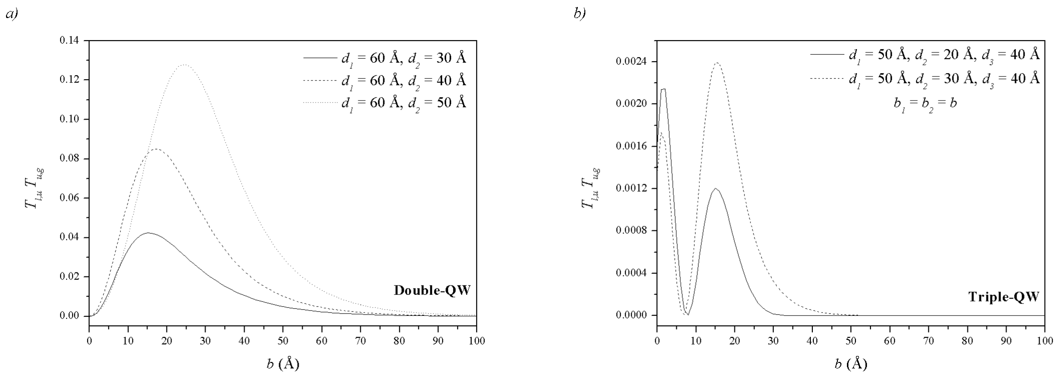

Figure 2

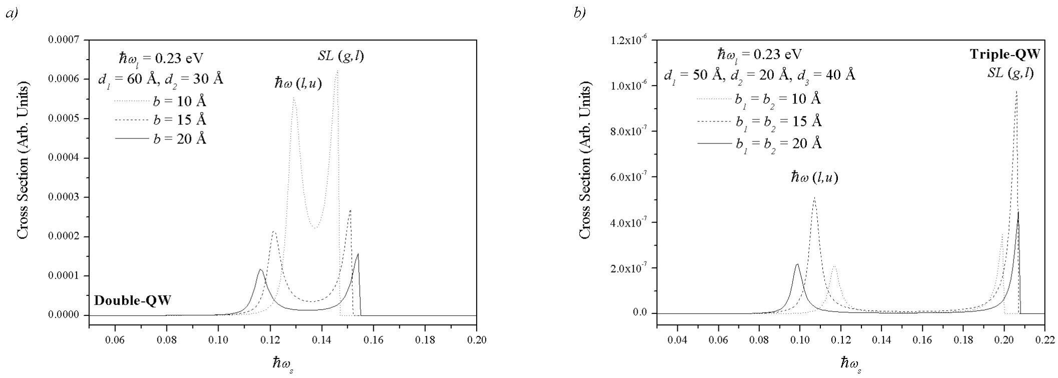

Figure 3