



QUANTUM CONFINED STARK EFFECT IN SOME NANOSTRUCTURES (QWs- QUANTUM WELLS)

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MODELLING STRUCTURAL, ELECTRONIC AND OPTICAL PROPERTIES OF SEMICONDUCTOR NANOSTRUCTURES AND NANOSTRUCTURED DEVICES WITH NUMERICAL SEMI-EMPIRICAL TIGHT-BINDING METHOD.

THE ELECTRIC FIELD EFFECTS (HEREAFTER TERMED STARK EFFECTS) ON DIFFERENT QW STRUCTURES ARE VERY IMPORTANT FOR SEVERAL REASONS:

- DUE TO THE POSSIBILITY OF MAKING VARIOUS FAST ELECTRO-OPTICAL DEVICES;
- MANY SEMICONDUCTOR DEVICES BASED ON QWS WORK UNDER AN APPLIED ELECTRIC FIELD;
- IN ANY REAL TRANSPORT EXPERIMENT, EXTERNAL ELECTRIC FIELDS ARE APPLIED TO THE SYSTEM.

AS A RESULT OF SUCH CALCULATIONS IT IS POSSIBLE TO STUDY THE STARK SHIFTS OF THE QW ELECTRONIC STATES AND THEIR SPATIAL DISTRIBUTIONS. WITH THIS ESSENTIAL AND NEW INFORMATION WE CAN LOOK FOR A POTENTIAL PROFILE THAT PROVIDES GOOD STARK EFFECT CHARACTERISTICS OF A GIVEN QW. THIS WILL FACILITATE THE SEARCH FOR NEW MATERIALS POSSESSING UNIQUE ELECTRON AND OPTICAL PROPERTIES

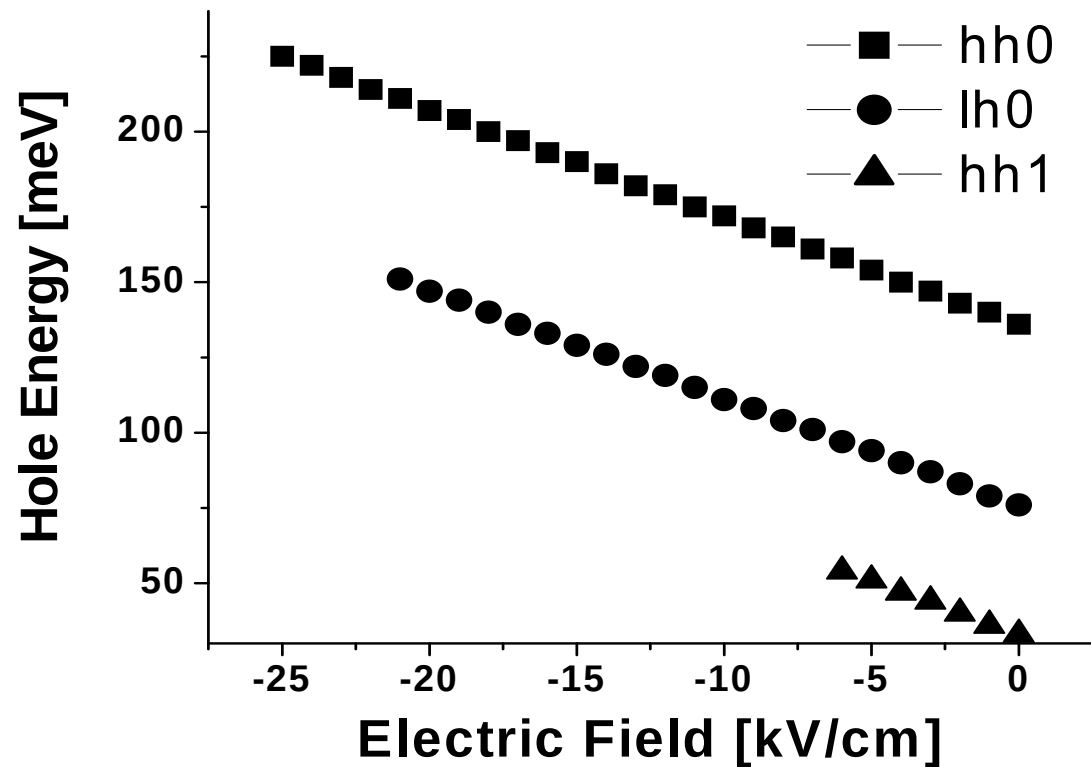


Figure 1. The dependence of the hole energy (hh0, lh0 and hh1) on the applied electric field intensity as a function of the acceptor concentration $p2D$, for a p-type Be δ -doped GaAs QW. The impurity concentration $p2D$ is $50.10^{12} \text{ cm}^{-2}$. (a) – first heavy hole energy level – hh0 (rectangles), (b) - first light hole energy level – lh0 (circles), (c) – second heavy hole energy level – hh1 (triangles).

We can say that the obtained results from such TB calculations would help to study more profoundly the physics of the doping at different impurity densities and at different electric field intensities. Such investigations that make possible to study in detail the Stark shifts of the hole energy states and their spatial distributions, and consequently the hole subband spectra and intersubband transitions, are very promising in looking for δ -doped structures for potential device applications, namely the devices based on the hole intersubband and intrasubband transitions (e.g. photodetectors and optical modulators).

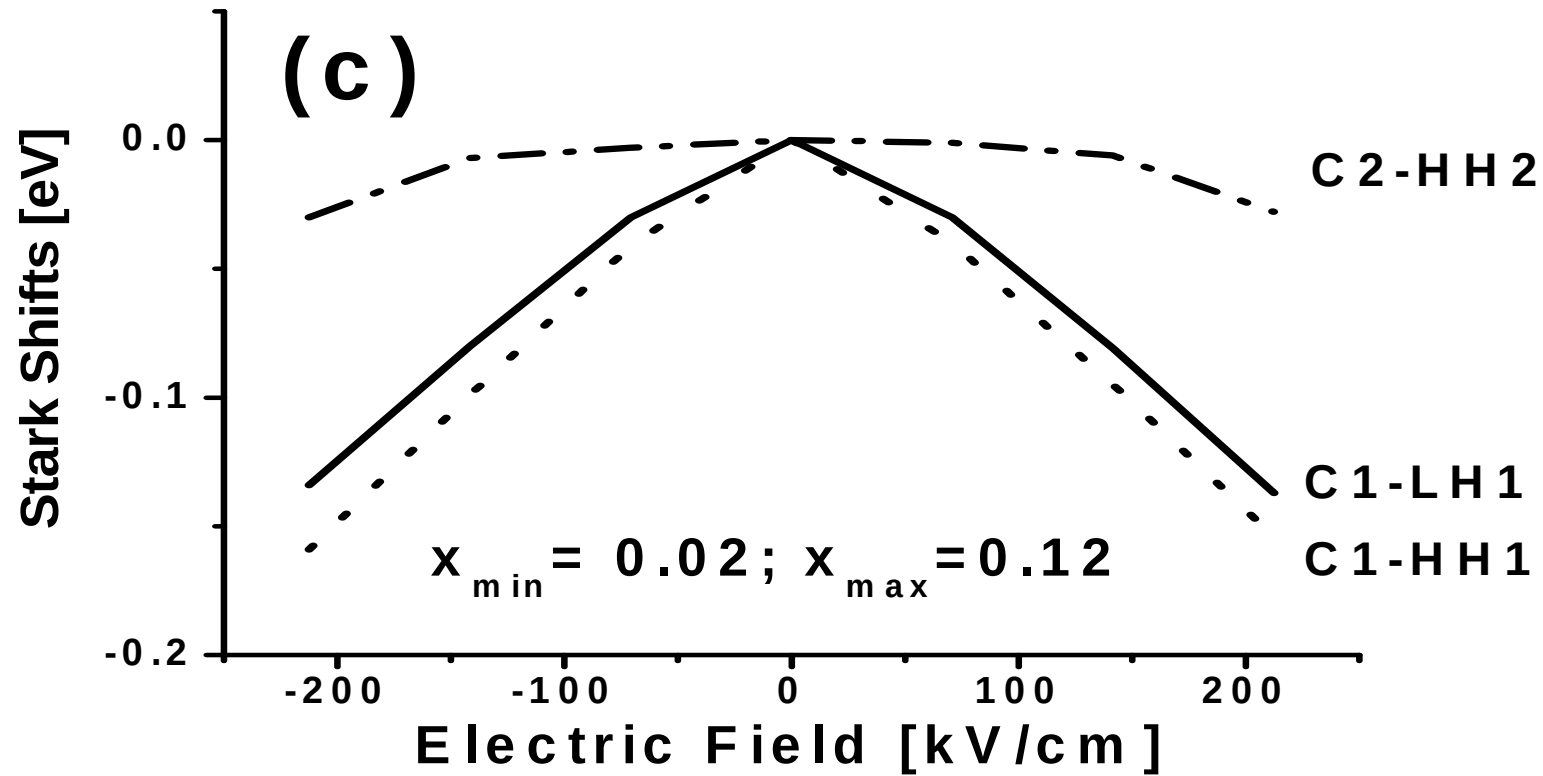


Figure 2. The dependence of the Stark shifts of the main optical transition energies $E(\text{C1-HH1})$, $E(\text{C1-LH1})$ and $E(\text{C2-HH2})$ for the PQW (Parabolic Quantum Well) on applied electric field. Al concentration is x . In the PQWs x varies parabolically from $x_{\min} = 0.02$ at the barriers to $x_{\max}$ in the middle of the well. The growth direction is [100]. The Al concentration x in the barriers for all parabolic QWs (PQWs) is $x=0.36$.

We present the TB calculations of the quantum confined Stark effect in PQWs with parabolic potential and with QW width of 44 MLs. We can say that the results from the TB calculations, such in this work, help to study the physics of the electric field effects at different concentrations and electric field intensities. Such investigations that make possible to study in details the Stark shifts of the electronic states and their spatial distributions, are very promising in looking for PQW structures that provides good Stark effect characteristics for potential device applications. Such investigation will help us to find a QW potential profile with better Stark effect characteristics for application in QW-based devices.