Effect of wells thickness disorder on the quantum magneto-transport properties in GaAs/AlGaAs multi-quantum wells for near wavelength infrared applications

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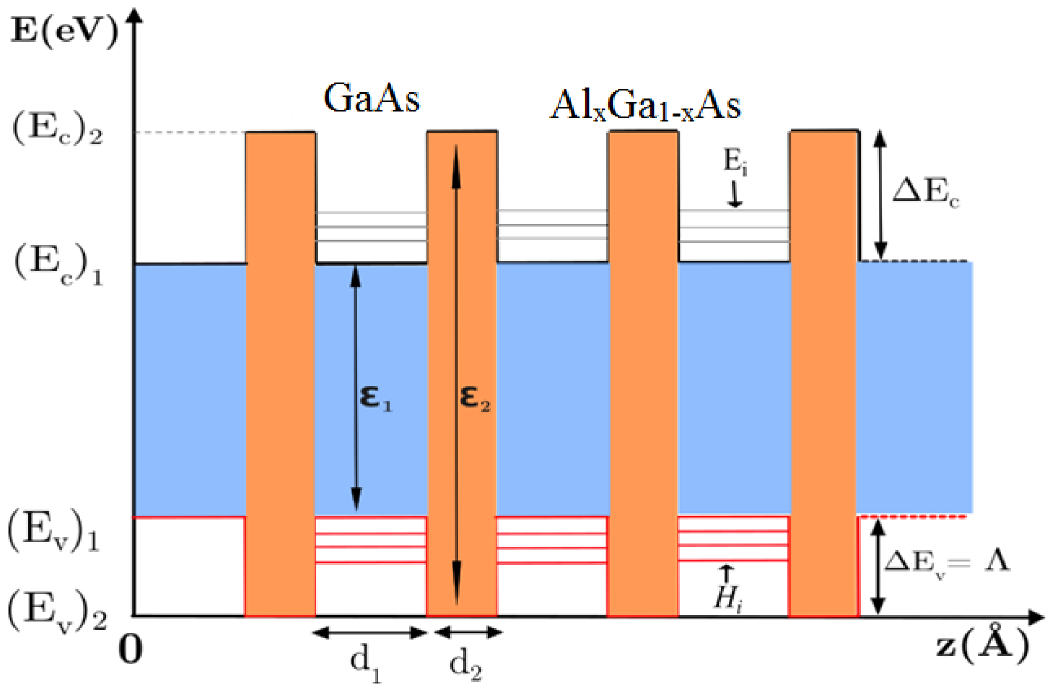

Fig.1: Our purpose is to calculate the band structure of GaAs/$Al_{0.18}Ga_{0.82}As$ multi-quantum well (MQW), with a width of the wells (GaAs) fixed at d_1=184 Å, but at different thickness d_2 of barrier ($Al_{0.18}Ga_{0.82}As$), in ordered to theoretically study the influence of interlayer tunneling on the quantum Hall effect measurements, in the multilayer structure. The effect of well thickness disorder strengths will be also treated. The origin of the energies has been chosen at the top of $Al_{0.18}Ga_{0.82}As$ valence band as shown in this Figure.

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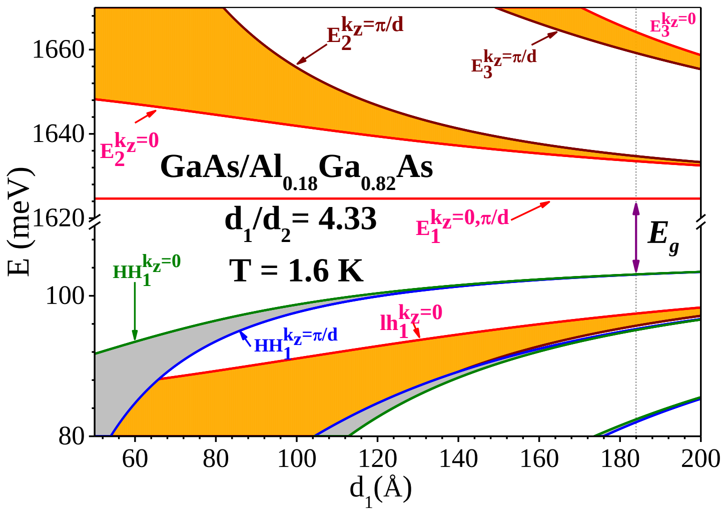

Fig.2: Energy levels as function of d_1

* In this case E_1 don't change with increasing d_1

* E_g, decreases with increasing the d_2.

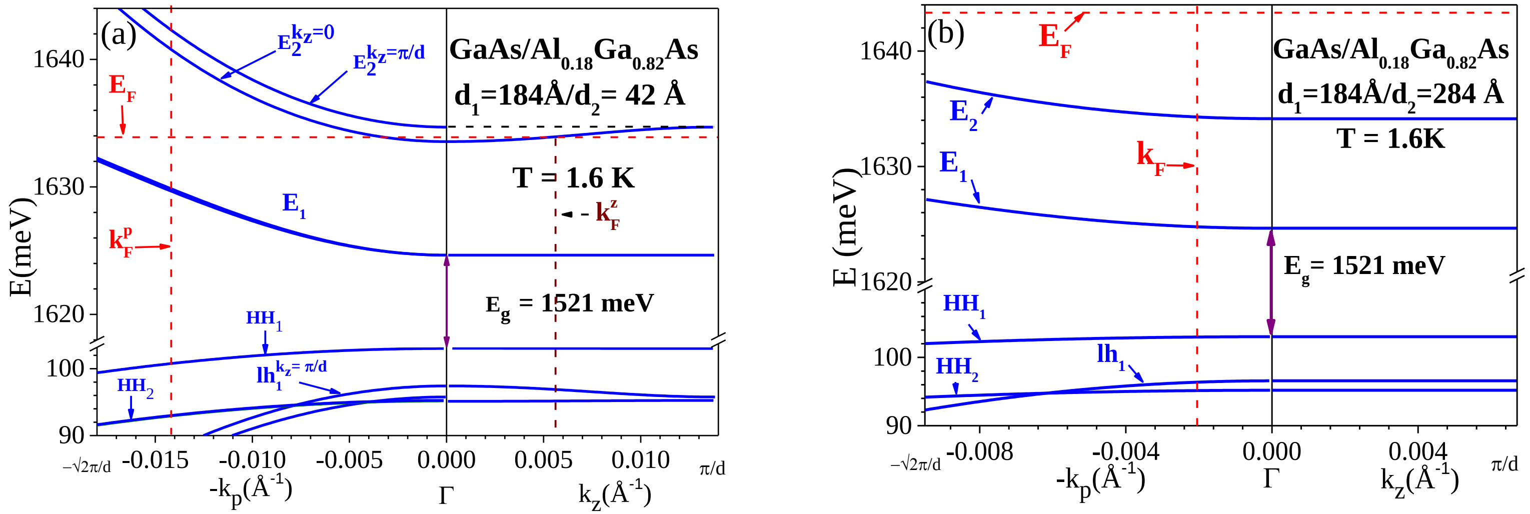

Fig.3: Band structures of the investigated two samples.

* The same value of E_g in bout cases.

* E_g = 1521 meV in agreement with that found by B. G. M. Tavares et al.

* λ_c=0,815 µm (Near Infrared detectors).

* In (a) case, the band width $\Delta E_2 \neq 0$ wherease $\Delta E_2 = 0$ in (b).

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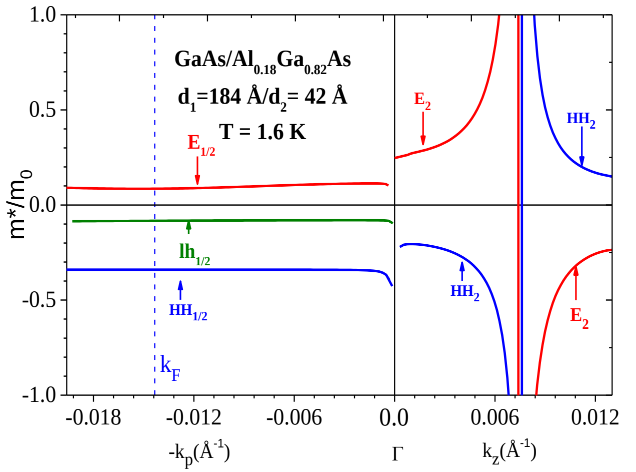

Fig.4: Calculated carriers effective mass, from Fig.3 by

$$\left(\frac{1}{m^*}\right)_{ij} = \frac{1}{\hbar^2}\frac{\partial^2 E_{k_{ij}}}{\partial k_i \partial k_j}$$

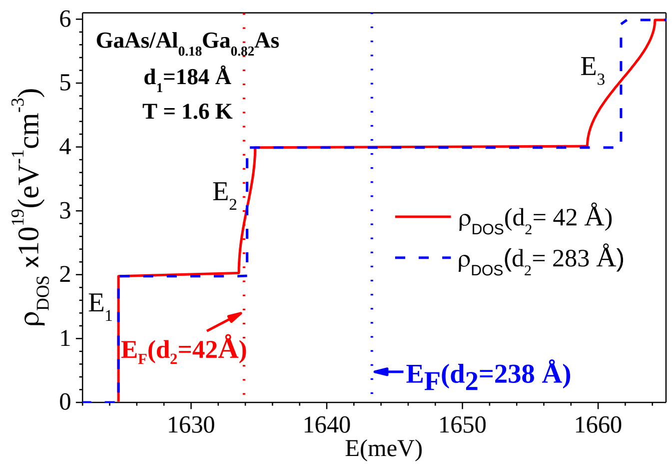

Fig.5: Density of states.

***First and second conduction bands are completely occupied in MQW(d_2=283 Å).**

***Quasi-two-dimensional conductivity in MQW with d_2 = 42 Å**

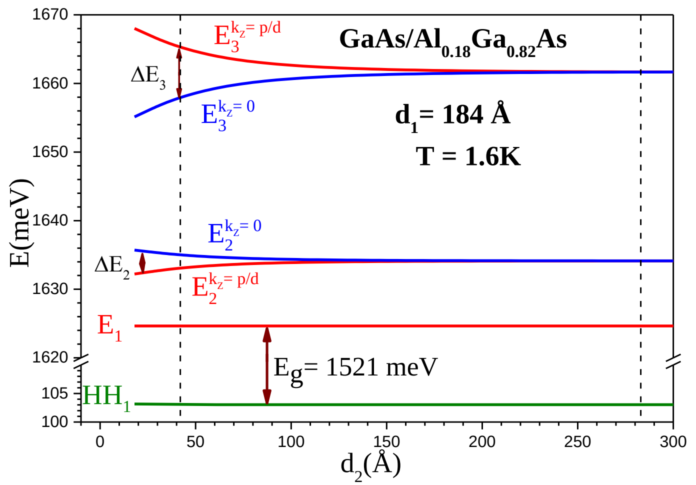

Fig.6: The effect of barrier thickness on bands width.

***ΔE_2 and ΔE_3 increase with decreasing d_2**

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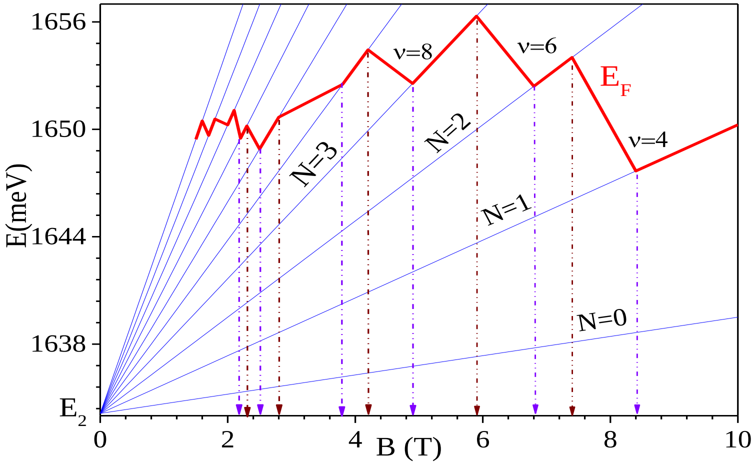

$B_{Min(théo)}$ (T)	$B_{Min(exp)}$ (T)	$B_{Max(théo)}$ (T)	$B_{Max(exp)}$ (T)
8.43	8.97	7.44	7.95
6.84	7.37	5.95	6.50
4.98	5.35	4.27	4.68
3.85	4.11	3.42	3.61
3.16	3.28	2.85	3.02

Fig.7: Energy of second conduction Landau mini-band and Fermi level as function of magnetic field in GaAs/$Al_{0.18}Ga_{0.82}As$ MQWs with d_2 = 283 Å. B_{min} and B_{max} are in agreement with those of the Subnickov Hass Effect measured in magnetoresistance by B. G. M. Tavares et al [3] (as seen in the table).

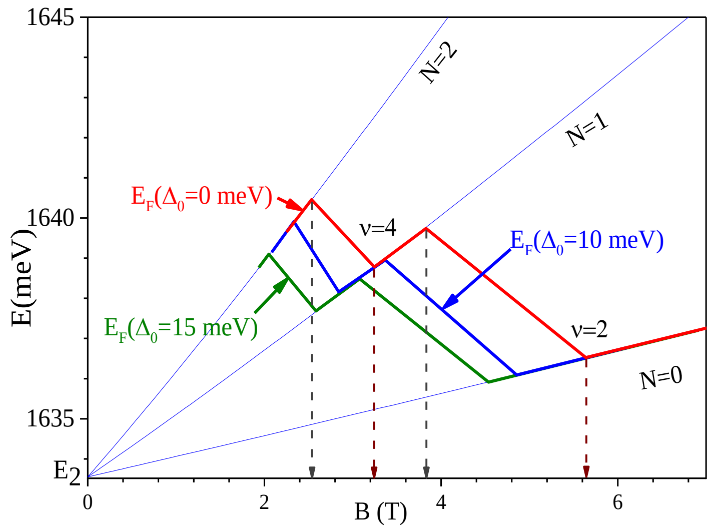

Fig.8: Energy of E2…for d_2 = 42 Å.

***We can't observe the high-index felling factor minimums.**

*** For B=cte, E_F decreases with increasing well thickness d1 disorder Δ_0.**

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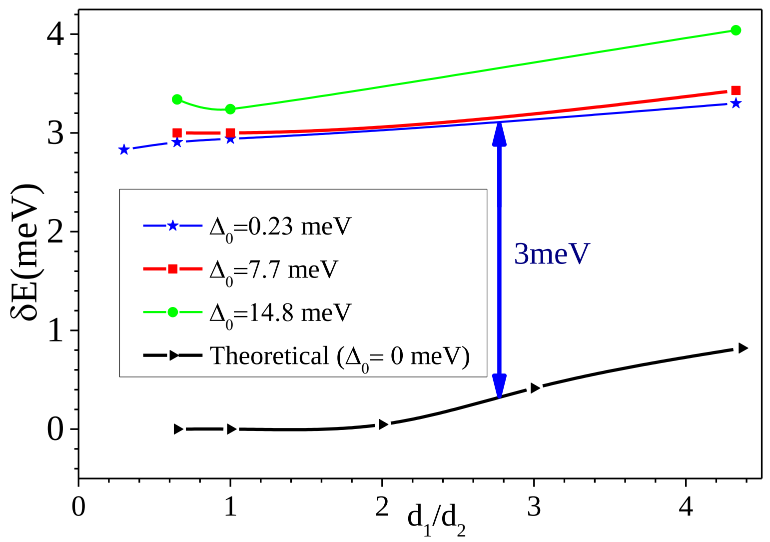

Fig.9: Theoretical calculated inter-plateau Quantum Hall effect widths δE and experimental δE measured [3] in $GaAs/Al_{0.18}Ga_{0.82}As$ periodic multilayer, with different disorder strengths Δ_0 as a function of the ratio d1/d2.

* δE increases with d1/d2.
* For example, the origin of the 3meV(Δ_0=0,23 meV) disaccord between our theoretical and experimental [3] results is du to the contribution of Tunnel effect between wells to δE.
* For a given d1/d2, δE increases with Δ_0 (d1 disorder)

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