فحص البنى النانوية لأشباه الموصلات.

أنموذج حسابي خاص بتقنية التألق المهبطي

Monte Carlo model of cathodoluminescence microscopy.
Application to semiconductor nanostructure.

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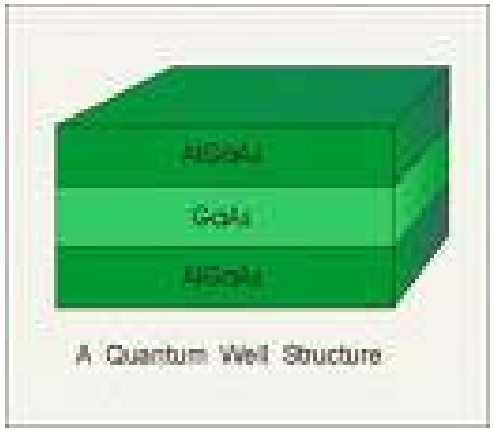
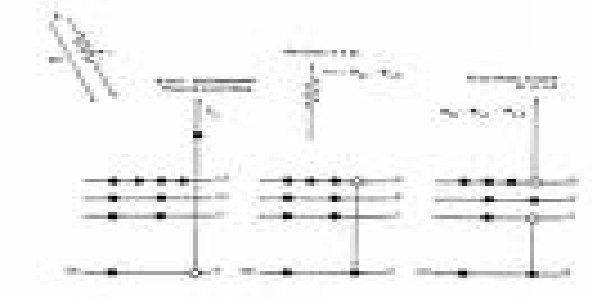
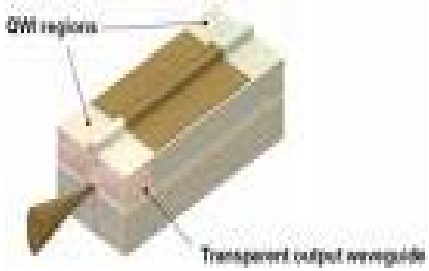


البئر الكوانتي

Quantum well



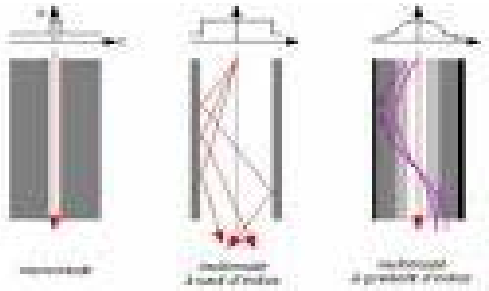


صمام الليزر

Laser diode

الألياف البصرية

Optic fibers



تقنية التألق المهبطي

Cathodoluminescence

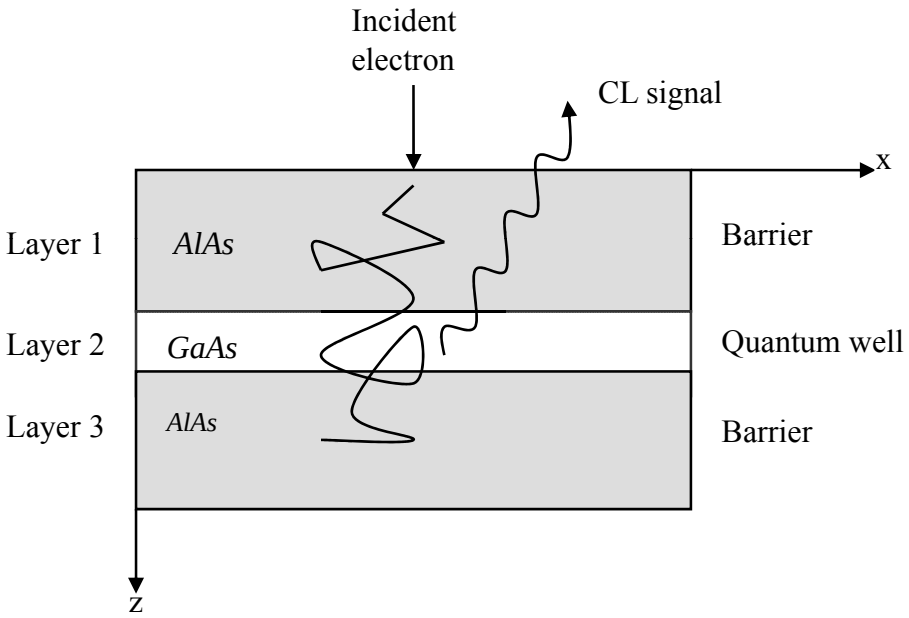
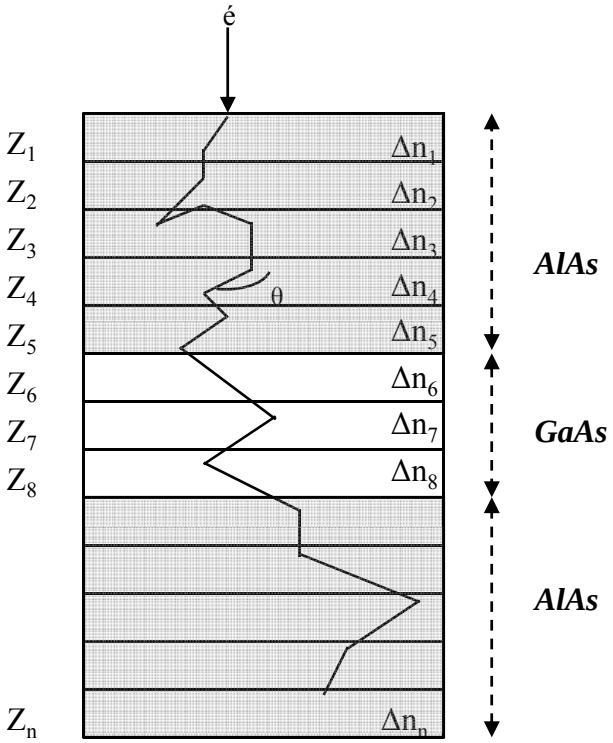


Fig.1 Schematic representation of AlAs/GaAs/AlAs nanostructure under an electron beam used in cathodoluminescence microscopy.

الأنموذج الحسابي

Calculation model



$$E = E_0(1-\gamma)$$

E_0 طاقة تسريع الإلكترون

γ نسبة الإلكترونات المرتدة عند السطح

$$S = -\lambda.\ln(R)$$

S المسافة بين اصطدامين متتاليين

λ نسبة الإلكترونات المرتدة عند السطح

R عدد عشوائي محصور بين 0 و 1

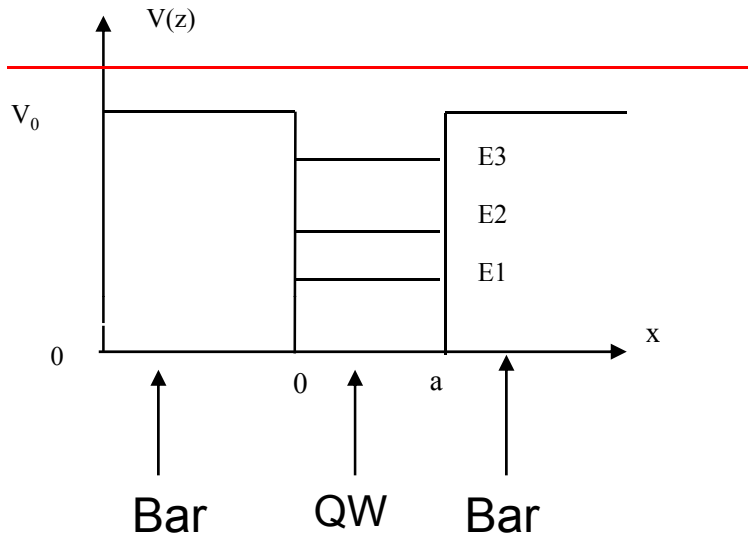
$$0 < \theta < 360^0$$

θ زاوية الاتجاه بعد كل اصطدام

$\Delta\, n\,(\,z\,)$ حاملات الشحنة الناتجة بدلالة العمق

الأنموذج الحسابي

Calculation model



$$\frac{d^2\psi}{dx^2} - \frac{2m}{\hbar^2}(V_0 - E)\psi = 0$$

$$T = \frac{4E(E-V_0)}{4E(E-V_0)+V_0^2 \sin^2(\frac{a}{\hbar}\sqrt{2m(E-V_0)})} \quad (E>V_0)$$

$$T = \frac{4E(V_0-E)}{4E(V_0-E)+V_0^2 sh^2(\frac{a}{\hbar}\sqrt{2m(V_0-E)})} \quad (E<V_0)$$

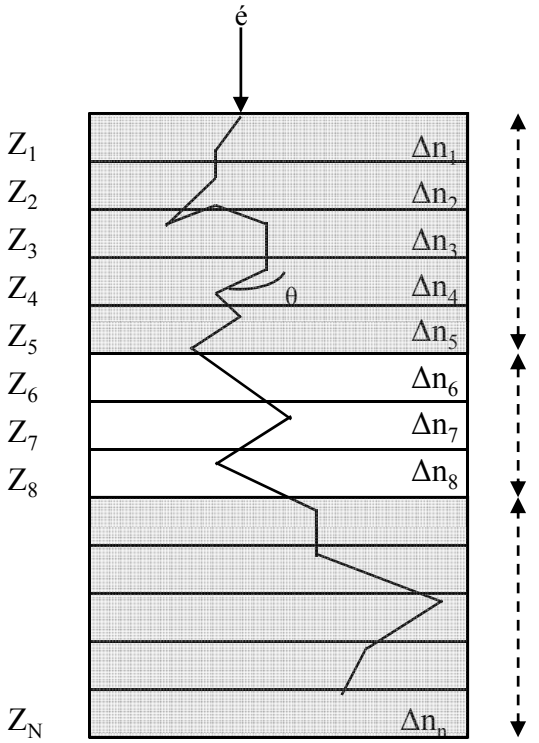
$$T = \frac{\hbar^2}{\hbar^2 + 2ma^2V_0} \quad (E=V_0)$$

$$P \propto e^{-\frac{x}{Ln}}$$

R=1-T

الأنموذج الحسابي

Calculation model



$$\Delta n_{(QW)} = \Delta n_{(Bar)} e^{-\frac{z_i}{Ln}}$$

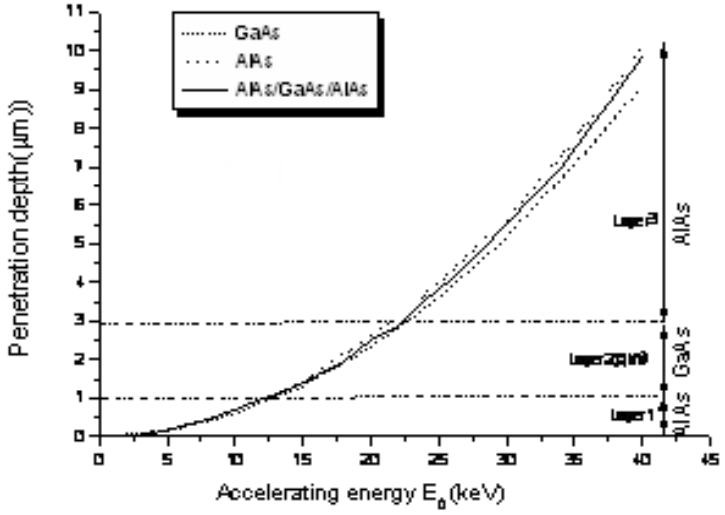
$$I_{CL} = \sum_{i=1}^{N} \Delta n_i e^{-\alpha . z_i}$$

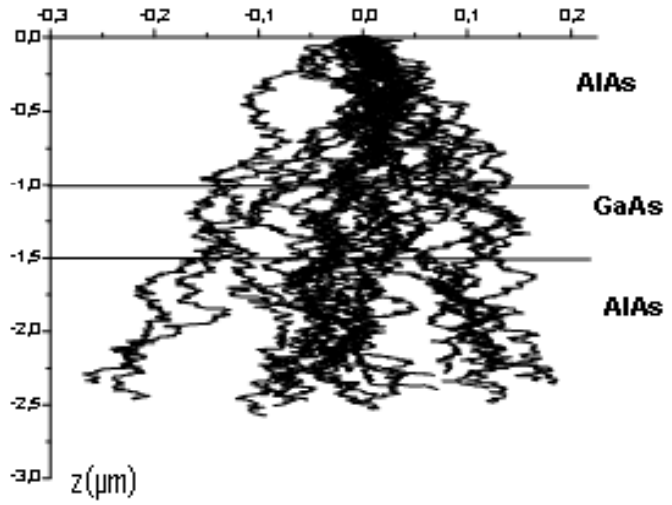
$$I_{CL} = \Delta n_1 e^{-\alpha . z_1} + \Delta n_2 e^{-\alpha . z_2} + \ldots + \Delta n_N e^{-\alpha . z_N}$$

$$R_e = \frac{\sum_{i=1}^{nel} r_{\max\ i}}{n_{el}}$$

النتائج

Results

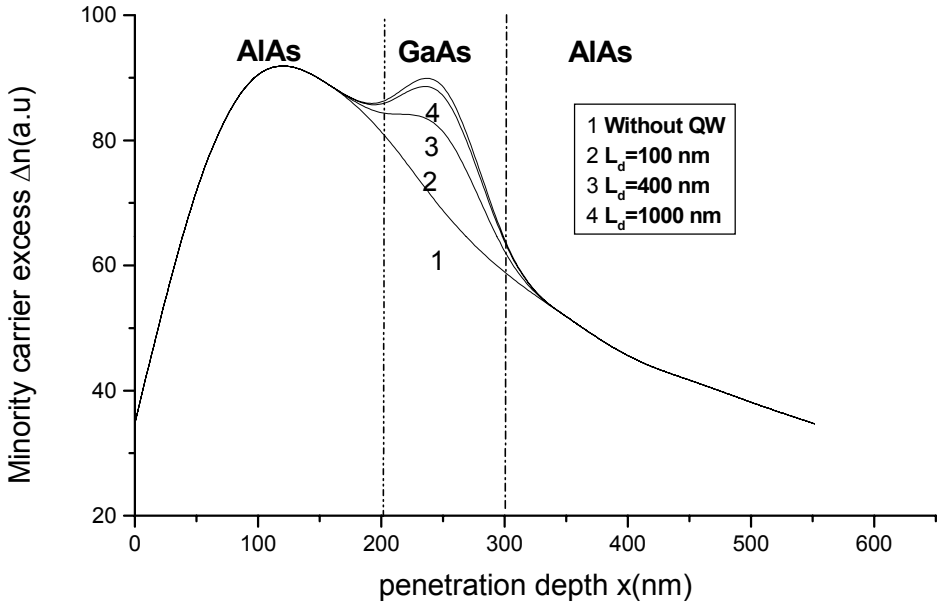




penetration depth

النتائج

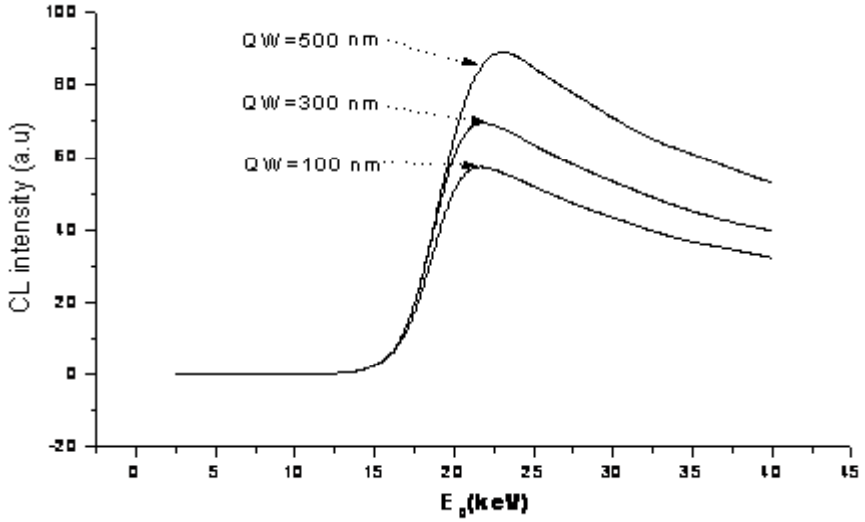
Results



minority carrier excess

النتائج

Results

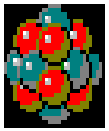


Cathodoluminescence signal

الخلاصة

Conclusion

Uncomplicated numerical model of cathodoluminescence (CL) technique is developed using the Monte Carlo method. This model describes the electron-matter interaction phenomena with the nanostructure devices like AlAs/GaAs/AlAs. According to the proposed model, the CL signal is produced by the radiative recombination of the minority carrier confined inside the quantum well (GaAs layer). Some physical parameters like diffusion length and size of the quantum well can influence on CL curves and CL intensity



MC_Nouiri.exe