A cathodoluminescence study on the diffusion length in InGaAlP/InGaP/GaAs heterostructures

Shabnam Dadgostar, Cantia Belloso Casuso, Oscar Martínez, and Juan Jiménez

GdS-Optronlab group, Dept. Física de la Materia Condensada, Universidad de Valladolid, Paseo de Belén, 19, 47011 Valladolid, Spain

shabnam.dadgostar@uva.es

Manuel Hinojosa and Iván García

Instituto de Energía Solar, ETSI de Telecomunicación, Universidad Politécnica de Madrid, 28040 Madrid, Spain

DRIP XVIII

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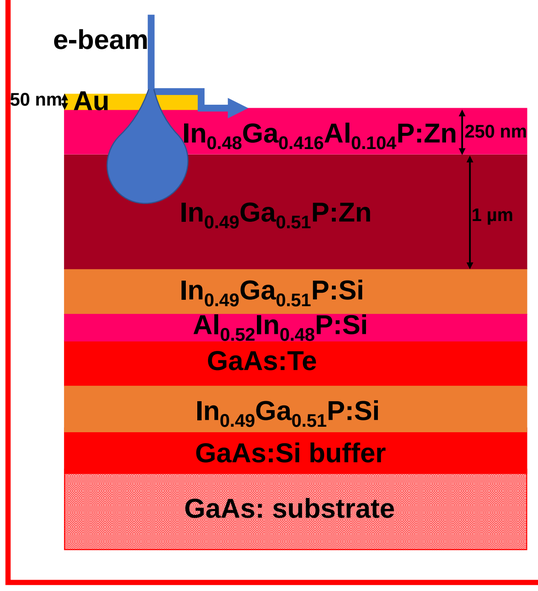
- **Carrier recombination is critical for the operation of many devices, e.g. solar cells, light emitting diodes, and laser diodes.**
- **The diffusion length depends on the band structure of the material, the crystal quality, alloy scattering, doping, and the presence of defects.**

Studied Structure



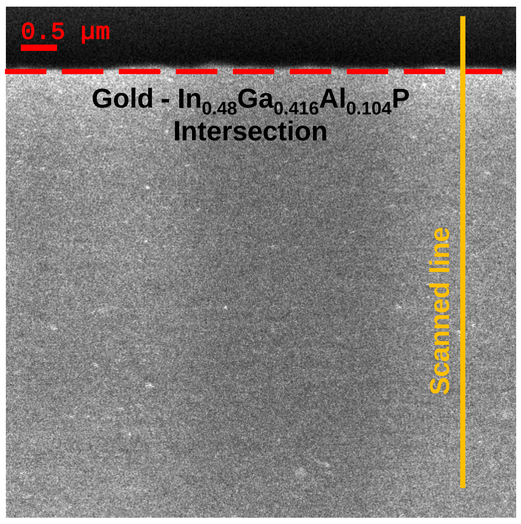
Scanning was done normal to:

(a) Gold - $In_{0.48}Ga_{0.416}Al_{0.104}P$ intersection

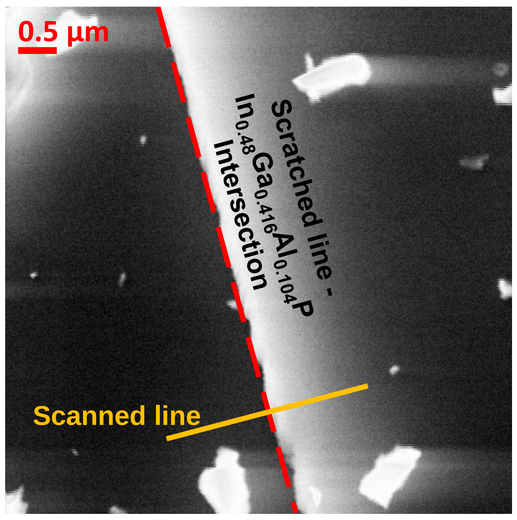
(b) Scratched line on $In_{0.48}Ga_{0.416}Al_{0.104}P$

- **Scratched line was deliberately made on the surface of the studied structure to investigate the impacts of defects on diffusion length.**

(a)

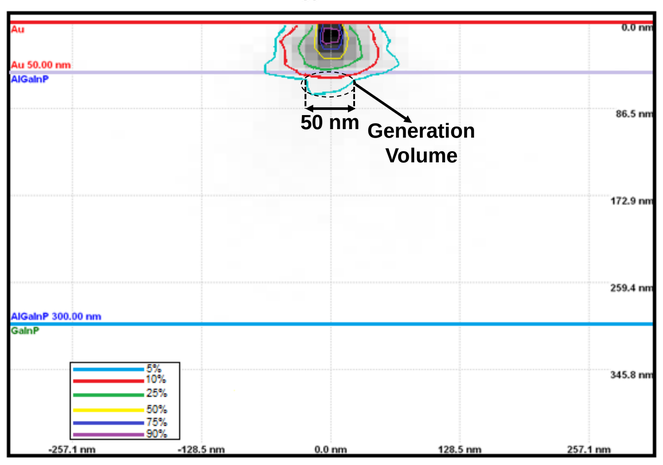


(b)

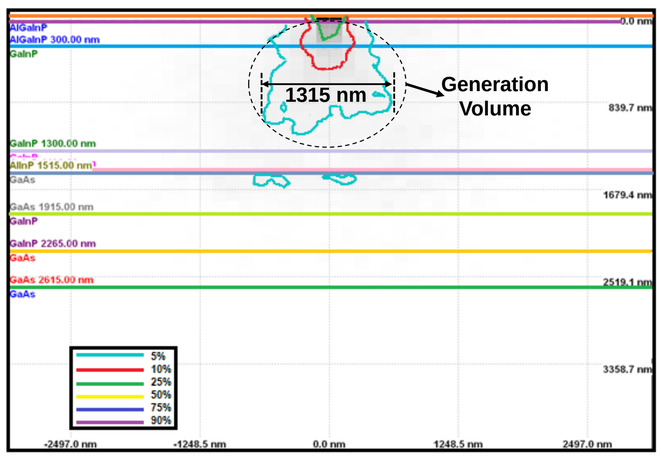


Monte Carlo Simulations for two different e-beam energies

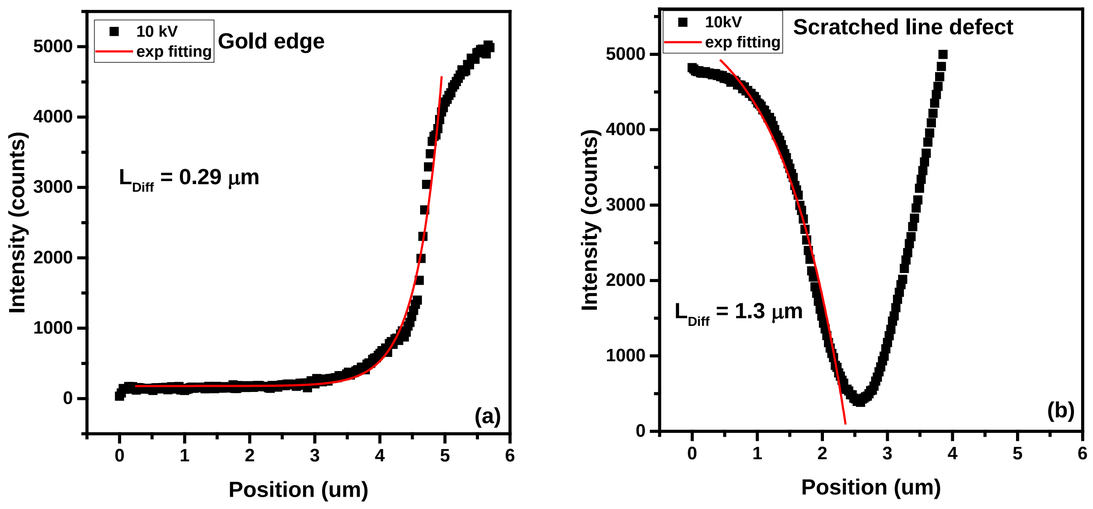
e-beam energy= 7 keV



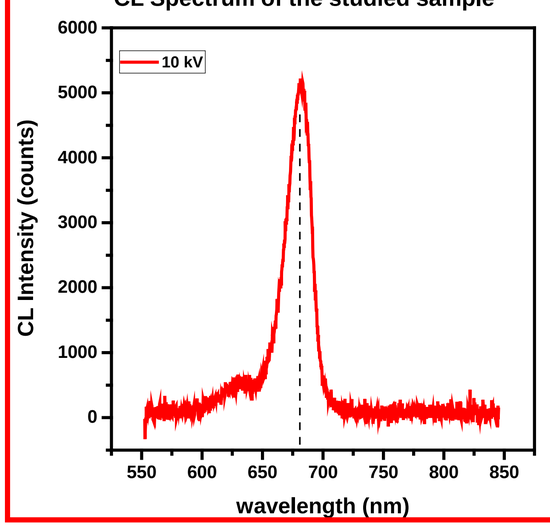
e-beam energy = 20 keV



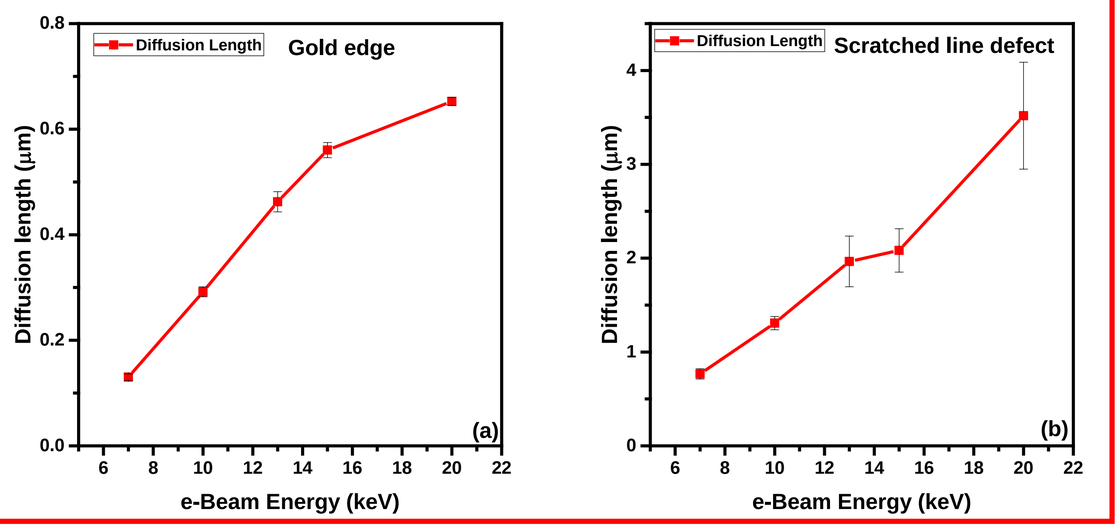
CL Intensity vs position on scanned line



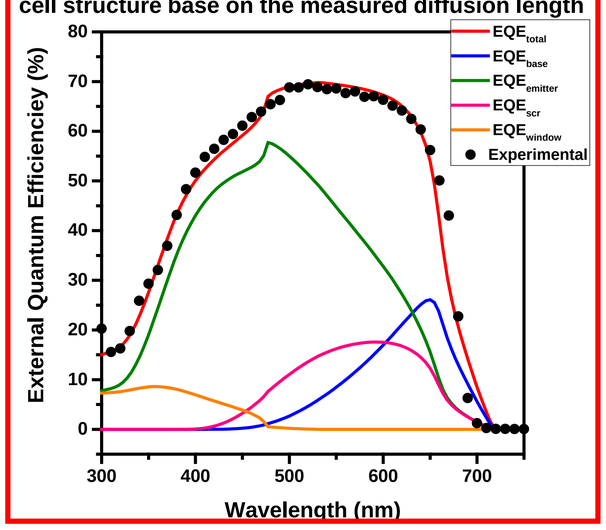
CL Spectrum of the studied sample



Diffusion length



Simulated external quantum efficiency of the solar cell structure base on the measured diffusion length



- **The measured diffusion length depends on the generation volume, which is determined by the e-beam energy. For low e-beam energy (7 keV) the generation volume is small (≈ 30 nm radius), while it is ≈ 600 nm radius for higher energy (20 keV), this difference can partially account for the dependence of the diffusion length with the e-beam energy. On the other hand, for low energy the generation volume is close to the Au/p-InGaP interface, and one should take account of the surface recombination, which reduces the diffusion length; this effect is minimized for high energy e-beam, for which the bulk generation is dominant.**
- **The effective diffusion length for the scratched line defect is significantly longer than the one estimated in the pristine sample, and it can be associated with the lateral extension of the damage induced by the scratch. In fact, one measures the recombination distribution around the scratch. In general, one can argue that the diffusion length cannot be estimated around a defect because of the extension of the perturbed recombination region around it.**
- **The External Quantum Efficiency of Solar Cells is strongly affected by the diffusion length of charge carriers, which in turn, can be measured accurately by CL.**

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