Dynamics of charge storage in quantum dot devices

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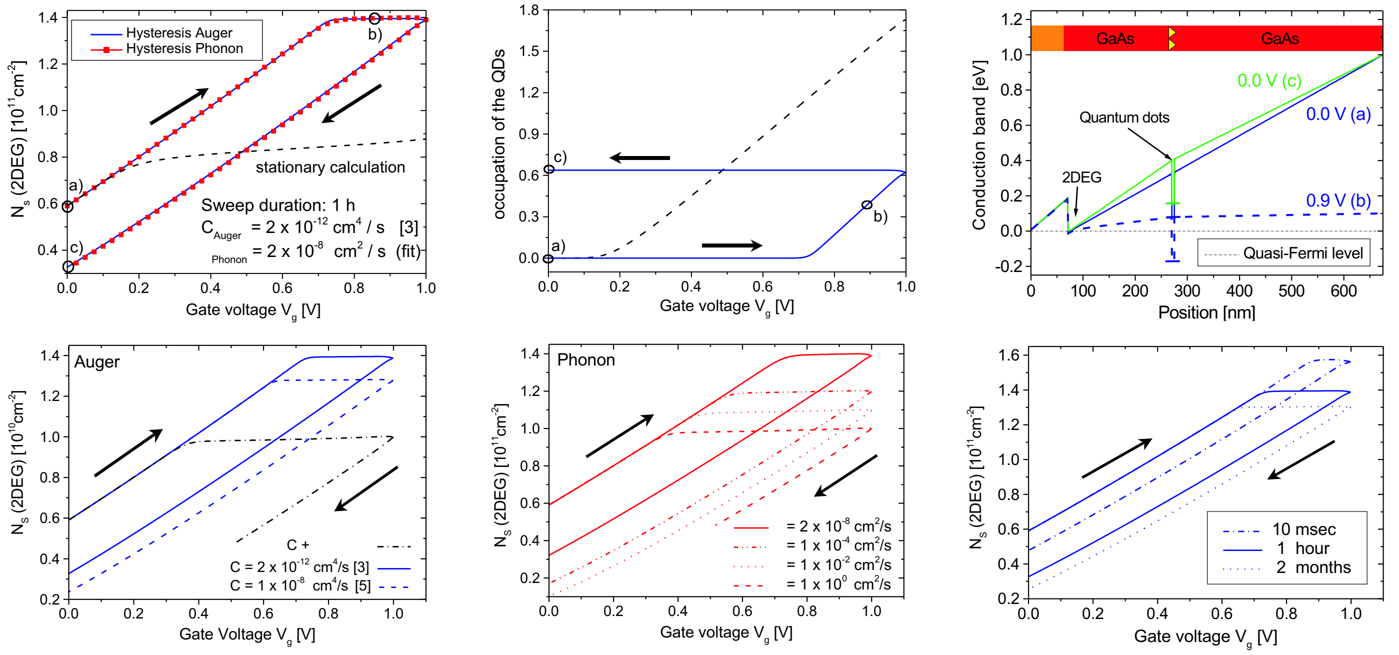
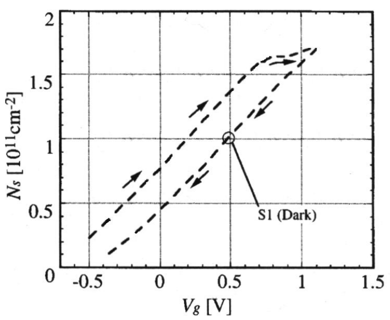
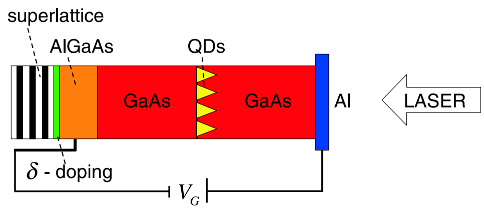


Experiment



GaAs/*n*-AlGaAs field effect transistor



77 K, dark, 1 h sweep duration

Model

Poisson equation

$$\ldots \, (z) \ldots (z) \ldots (z)$$
$$(z) \quad e \; N_D(z) \quad n^{3d}(z) \quad n_{QD}^{3D}(z)$$

Continuity equation

$$0 \quad {}_t n(z) \quad \frac{1}{e} \quad {}_z j(z) \quad f\; n(z), n_{QD}^{2D}(z,t)$$

Electron capture and emission rate (QD)

$${}_t n_{QD}^{2D}(z,t) \quad f\; n(z), n_{QD}^{2D}(z,t)$$
$$(C \;\; n^{2D} \quad) \;\; (n^{2D} \quad p_{QD}^{2D} \quad n_1^{2D} \quad n_{QD}^{2D})$$

Conclusion

- Auger vs. Phonon -

- Auger process [3] exactly reproduces necessary electron emission and caputure rates, suitable for fast and for slow dynamics
- experimental data yields fast dynamics for high charge densities and slow dynamics for low densities. As the Auger process depends quadratically on those densities it suits both - slow and fast dynamics - while the phonon processes depend linearly on the densities and therefore only can explain slow *or* fast dynamics [4]
- numerial simulations in perfect agreement with experimental results
- in order to reproduce the experiment with phonon processes one has to use an extremely small capture rate (10^{4} cm^2/s)

[1] G. Yusa and H. Sakaki, Appl. Phy. Lett. 70, 345 (1997)
[2] A. Rack et al., Phys. Rev. B 66, 165429 (2002)
[3] A. V. Uskov et al., Appl. Phy. Lett. 72, 58 (1998)
[4] R. Heitz et al., Phys. Rev. B 56, 19435 (1997)
[5] S. Raymond et al., Phys. Rev. B 61, 16331 (2000)