

Two-Dimensional Gunn Effect

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Abstract. Current self-oscillations in semiconductors with a region of negative differential resistivity in their current-field characteristic are known since J. B. Gunn's early experiments on n-GaAs samples in 1963. Most studied are Gunn self-oscillations in one-dimensional spatial configurations which appear when planar contacts are placed in bulk semiconductor samples: during each period of the current oscillation, a charge dipole wave is triggered at the injecting contact, moves and is annihilated at the receiving contact. Dynamics of planar dipole waves can be surprisingly rich for systems with one-dimensional geometry: besides periodic self-oscillations, under *dc* voltage bias there may appear period doubling, frequency blocking and intermittency routes to (low-dimensional) chaos.

We study by numerical and asymptotic methods the solutions of a widely used drift-diffusion model of the Gunn effect in a circular geometry (Corbino disks: a circular disk with one contact on its circumference and a point contact at its center). The result is that axisymmetric pulses of the electric field are periodically shed by an inner circular cathode for a dc voltage bias above a certain onset. These waves decay during their journey to the outer anode, which they may not reach. Meanwhile the current continuously increases and then abruptly decreases when a new wave is shed, in agreement with existing experimental results of Willing and Maan [1]. Depending on the bias, more complex patterns with multiple shedding of pulses at the cathode are possible [2].

References

1. B. Willing and J. C. Maan, Phys. Rev. B **49**, 13995 (1994).
B. Willing, Ph.D. Thesis, University of Nijmegen (1994).
2. L. L. Bonilla, R. Escobedo, F. J. Higuera (preprint 1999).