GaN distributed transferred electron device based THz oscillator modeling

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The realization of useful solid state THz power sources is still today a challenge. Among the possible electronic and optic solutions is the gallium nitride (GaN) transferred electron device. Some theoretical and experimental research works have concerned vertical lumped structures but none distributed ones which structure is similar to a microstrip line or a N^+NN^+ multilayer parallel waveguide in the case of a bidimensional (2D) theoretical approach (figure 1). Its RF operation is based on the interaction between an electromagnetic wave propagating along the device epitaxial layers and electrons moving perpendicularly which RF operation is the accumulation layer and transit time mode. The wave amplification is obtained in the N active zone behaving as a negative resistance medium. The oscillator complex RF operation is modelled by means of a 2D time-domain physical simulator based on the self-consistent solution of both the Maxwell and energy-momentum macroscopic electron transport equations. Thus, space-time physical and functional quantity analysis can be performed following electromagnetic and quasi-electrostatic approaches [1]. The semiconductor structure is preliminary optimized to operate at 1 THz.

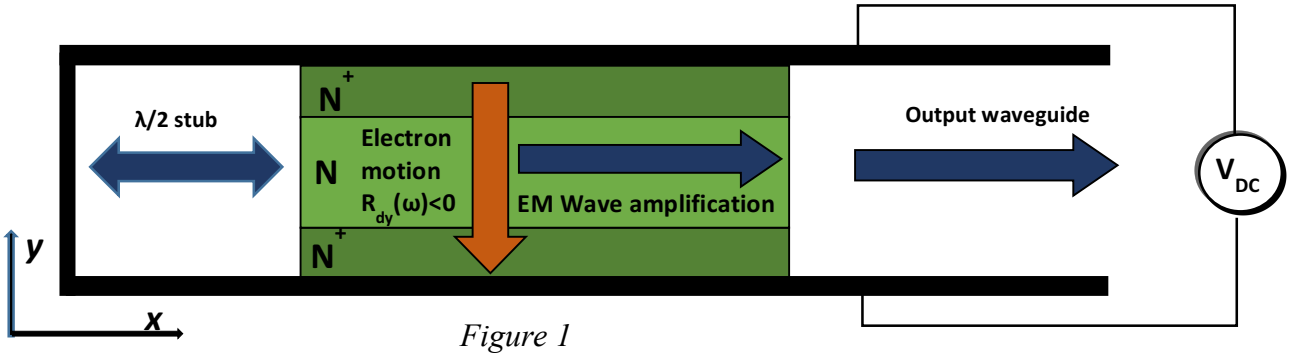

Figure 1

Simulations start from a DC solution and described the transient and continous wave operation. Figure 2, as an exemple, illustrates the transient evolution of the terms constituting the energy conservation equation. Figure 3 shows the frequency spectrum of the net electromagnetic (EM) power under CW operation. The main line is 1 THz. This result is consistent with the expected oscillator DC and RF operation and semiconductor structure design.

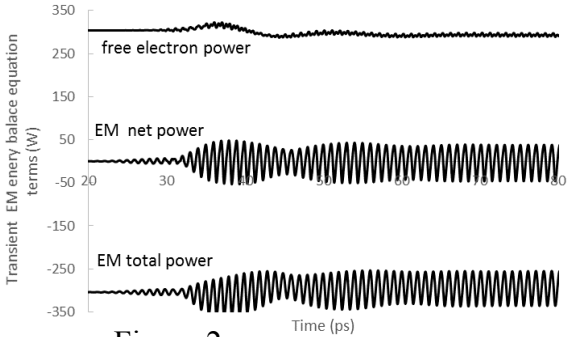

Figure 2

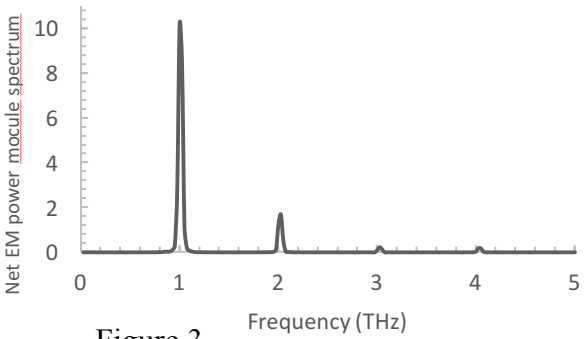

Figure 3

References

[1] C. Dalle," 2D Time-domain numerical Maxwell/transport modeling for THz distributed Gallium Nitride Transferred Electron Device*", International Journal of Numerical Modeling,* 2017