# Scalability of graphene transistors supported on h-BN substrates targeting RF applications

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Hexagonal boron nitride (h-BN) has been demonstrated to be an appropriate substrate for graphene devices, which has led to a huge increase in graphene device quality [1]. In this paper we have investigated to which extent such an increment in quality could be exploited in transistors to get competitive radio frequency (RF) performances. For such a purpose, we have applied multi-scale physics based techniques to assess the scalability of the transistor RF performance via reduction of the channel length. To capture the specific physics of graphene supported on hBN the carrier density dependent mobility and saturation velocity were obtained from an ensemble Monte Carlo simulator that deals with the relevant scattering mechanisms, such as intrinsic phonons, scattering with impurities and defects, surface polar phonons with the substrate and gate dielectric, and electron-electron interaction [2,3]. This information is fed into a self-consistent simulator, which solves the drift-diffusion equation coupled with the 2D Poisson's equation, so we can take full account of short channel effects [4]. That way we get the DC characteristics, which have been benchmarked against experimental data from our own GFET devices. From the DC response we have developed a charge-conserving small-signal model, which allows an accurate estimate of the transistor RF figures of merit (see Fig. 1). Next, we have applied microwave-engineering techniques to assess the device stability when it is operated as an amplifier. We have found that scaling the device down to ~200 nm could be sufficient to get a maximum oscillation frequency in the THz region. However, severe device unstability might happen if the bias point is not properly selected. We have also quantified the negative impact of the gate series resistance on the RF performance.

## References

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## Figures

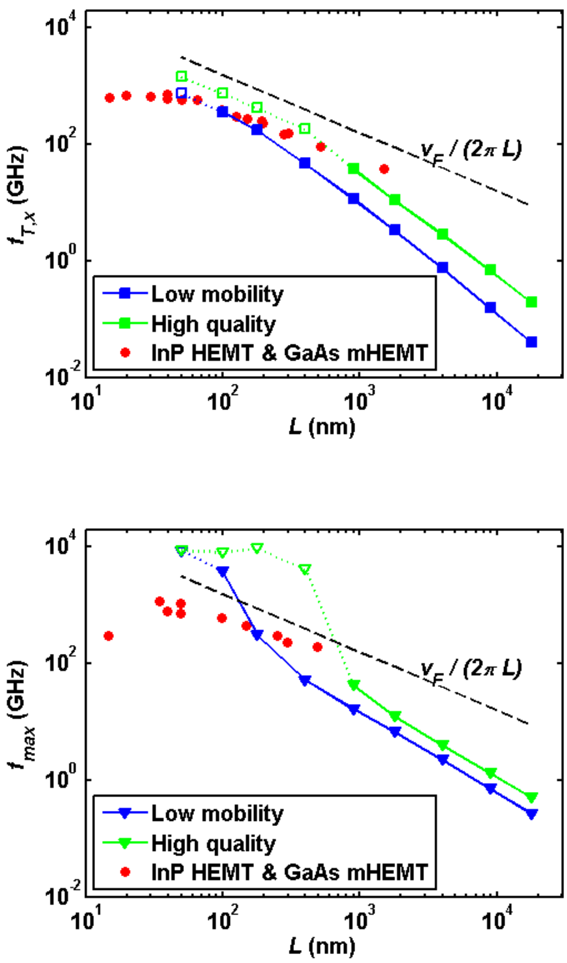


**Figure 1:** Scaling of the extrinsici cutoff (fT,x) and maximum oscillation frequency (fmax) of GFETs supported on h-BN. Two different graphene qualities scenarios have been considered. We have compared the expected performance with state-of-the-art III-V technology. Closed and open symbols correspond to stable and unstable devices, respectively. Unstability implies that the GFET amplifier is unusable at this particular bias point. The dashed line corresponds to the physical limit of the fT,x. This frequency limit comes out from the minimum possible transient time in a graphene. The bias point was considered to be Vgs – $V_D$ = 2 V and $V_{ds}$ = 0.6 V.