GRAPHENE FLAGSHIP

Drain current saturation in graphene field-effect transistors at high fields

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Development of competitive high frequency graphene field-effect transistors (GFETs) is hindered, first of all, by a zero-bandgap phenomenon in monolayer graphene, which prevents the drain current saturation and limits significantly the GFET power gain. An approach has been proposed to realise the drain current saturation in GFETs without a bandgap formation, but via velocity saturation of the charge carriers at high fields [1]. In this work, we report on the performance of GFETs fabricated using high quality CVD monolayer graphene and modified technology, which reduce the concentration of traps generating the charge carriers at high fields [2]. Fig. 1 shows typical output characteristics of GFETs with gate length of 0.5 µm. The drain current clearly reveals the saturation trends at high fields, which we associate with the saturation of the carrier velocity, see inset to Fig. 2 [2]. Fig. 2 shows typical measured (extrinsic) transit frequency (f_T) and the maximum frequency of oscillation (f_{max}), which are characteristics of the current and power gain, respectively. Since f_T and f_{max} are proportional to the carrier velocity, they reveal similar saturation behaviour. We analyse the saturation effects by applying the Fermi-Dirac carrier statistics. The f_T and f_{max} are up to 34 GHz and 37 GHz, respectively, which are highest among those reported so far for the GFETs with similar gate length and comparable with those reported for Si MOSFETs [3].

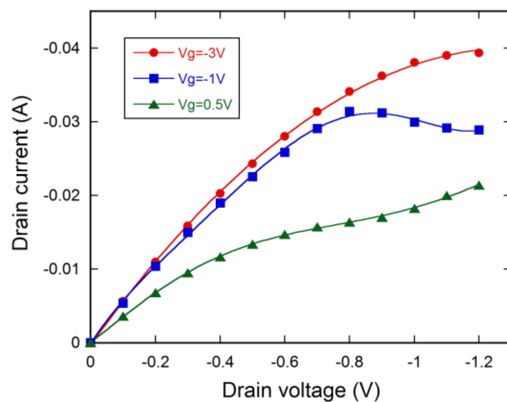

Fig. 1. Output characteristics of GFETs at different gate voltages: -3 V (circles), -1 V (squares) and 0.5 V (triangles). The lines are polynomial fitting curves. The kinks signify the presence of an ambipolar channel.

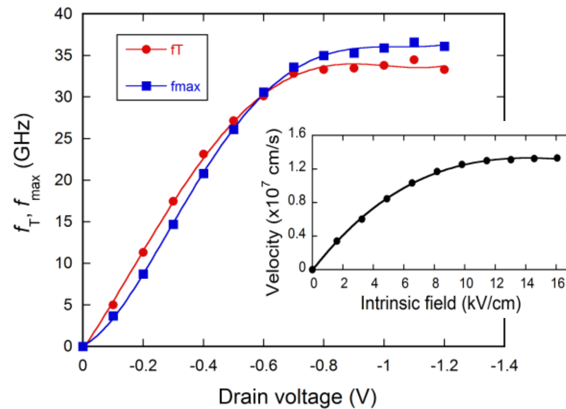

Fig. 2. Extrinsic transit frequency, f_T, (circles) and the maximum frequency of oscillation, f_{max}, (squares) of GFETs vs drain voltage. The lines are polynomial fitting curves. Inset shows a typical dependence of the velocity of charge carriers on the intrinsic field [2].

References

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