Graphene field-effect transistors for high frequency applications

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Realization of competitive high frequency graphene field-effect transistors (GFETs) is hindered, in particular, by extrinsic scattering of charge carriers and relatively high contact resistance of the graphene-metal contacts, which are both defined by the quality of the corresponding graphene top interfaces [1]. In this work, we report on improved performance of GFETs fabricated using high quality chemical vapour deposition (CVD) graphene and modified technology steps. The modified processing flow starts with formation of the gate dielectric, which allows for preserving the high velocity of charge carriers, and, simultaneously, providing very low contact resistance. The transfer line method (TLM) analysis and fitting the GFET transfer characteristics (Fig. 1) both reveal very low specific width contact resistivity of the top contacts, down to 95 Ω·µm. Fitting shows also that the field-effect mobility in the GFETs can be up to 5000 $cm^2/(V{\cdot}s)$. The measured (extrinsic) transit frequency (f_T) and the maximum frequency of oscillation (f_{max}) are up to 35 GHz and 40 GHz, respectively, for GFETs with gate length L_g=0.5 µm (Fig. 2), which are highest among those reported so far for the GFETs with similar gate length and comparable with those of Si MOSFETs [2,3]. The dependencies of the f_T and f_{max} on the gate length indicate that these GFETs are very promising for the scaling down and in particular for the development of power amplifiers operating in the mm-wave frequency range.

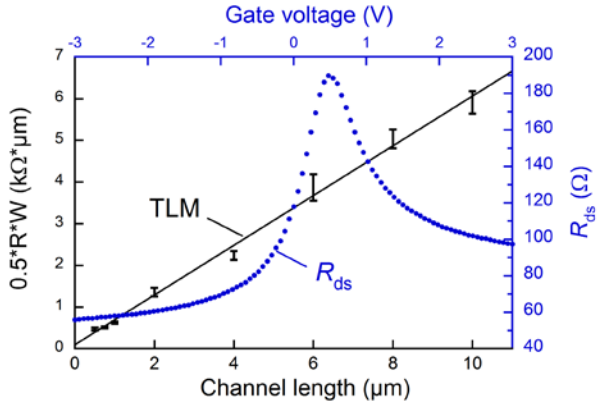

Fig. 1. Electrical characteristic of the TLM structures, where R and W are the channel resistance and width, respectively, vs channel length and the drain resistance of a GFET with L_g=0.5 µm (R_{ds}) vs gate voltage. The line is a linear mean fit. The error bars indicate standard error.

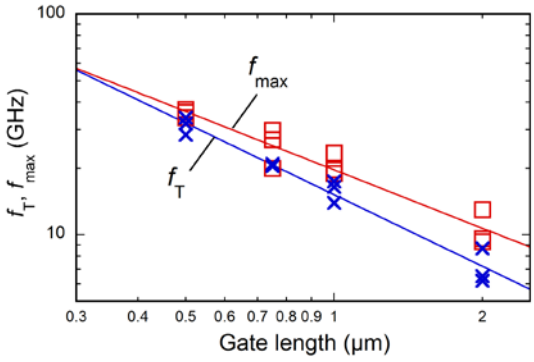

Fig. 2. The measured (extrinsic) transit frequency (crosses) and the maximum frequency of oscillation (squares) of GFETs vs gate length. The lines are mean value power fitting curves.

References

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