Plasmon guiding in graphene demonstrated by time-resolved electrical measurements

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Plasmons, which are collective charge oscillations, in graphene have attracted recent interest owing to tunable properties by chemical or electrostatic doping. Here, we demonstrate gate-controlled plasmon guiding in graphene by time-resolved electrical measurements. The guiding is based on local tuning of the carrier density, through which transport properties of the system can be changed.

The sample used was fabricated from graphene grown on SiC. It has three separated top gates; the side two gates (guiding gates) and the center gate (channel gate) serve to define the channel for the plasmon transport and change the properties of guided plasmons, respectively (Fig. 1**a**). All measurements were performed at 1.5 K. For the time-resolved electrical measurement [1], pulsed plasmons at gigahertz frequencies are generated in graphene by applying a voltage step to the injection gate. The plasmons are detected as the time-dependent current through three detector Ohmic contacts: D1 is connected to the channel, while D2 and D3 are separated from the channel by a guiding gate. When the guiding gate bias ($|V_{gg} - V_{CNP}|$: V_{CNP} is the bias at the charge neutrality point) is large, largest signal appears in the detector D2, which is closest to the injector (dashed line in Figs. 1**b** and **c**). As $|V_{gg} - V_{CNP}|$ is decreased, the plasmon signal through D1 increases, while that through D2 decreases and almost disappears at $V_{gg} = V_{CNP}$ (solid line in Figs. 1**b** and **c**). This indicates that plasmons are guided in the channel; 84% of injected plasmons are transmitted to D1 when $V_{gg} = V_{CNP}$ (Fig. 1**d**).

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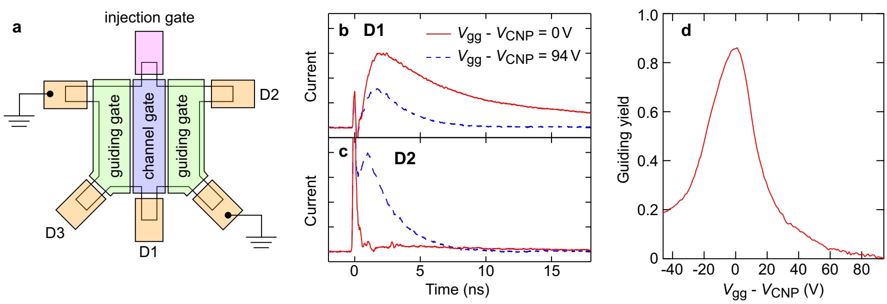

Figure 1: **a**, Schematic illustration of the sample structure with side guiding gates and a center channel gate. The width of the channel gate is 50 μm. **b** and **c**, Current as a function of time detected through the Ohmic contacts D1 and D2, respectively, for the guiding gate bias $V_{gg} - V_{CNP} = 94$ V (solid line) and 0 V (dashed line). The sharp peak at $t = 0$ is due to crosstalk, while the broad peak with time delay is plasmon signal. The channel gate bias is fixed at $V_{cg} - V_{CNP} = 94$ V. **d** Guiding yield as a function of $V_{gg} - V_{CNP}$.