Zero-bias operation of CVD graphene photodetector with asymmetric metal-contacts

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Raman spectrum of graphene and SEM image of device

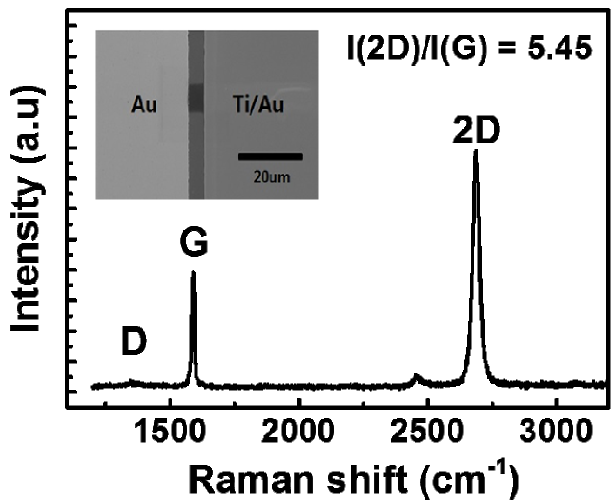

Figure S1: Raman spectrum of graphene channel and SEM image of device.

Raman spectrum of the graphene channel: The D-peak is low, and I(2D)/I(G) = 5.45 indicates a single layer of graphene is transferred on the Si/SiO_2 (90 nm) substrate. Inset figure presents a scanning electron microscopy image of an asymmetric metal contact graphene photodetector using Au, Ti/Au metal as the source and drain metal. (L_{ch} = 4 µm, W_{ch} = 5 µm)

Total resistance fitting with experimental data

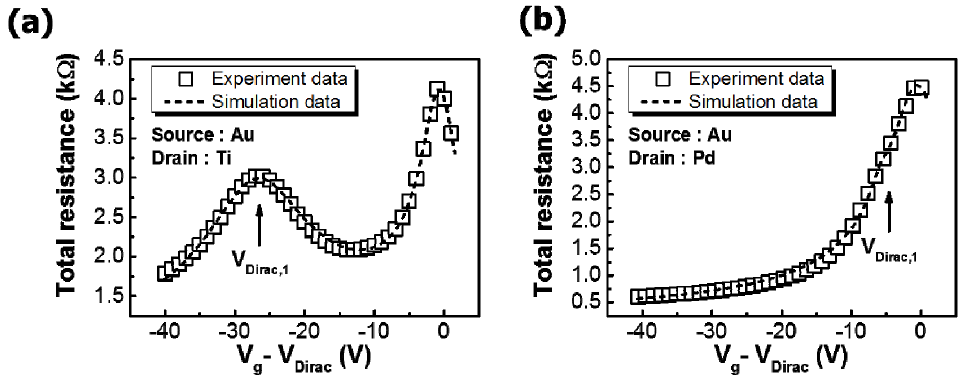

Figure S2: I_d-V_g curve fitting using the modified constant mobility method: (a) Au and Ti metal contact, (b) Au and Pd metal contact graphene photodetector.

In an asymmetric metal contact structure, two metals are contacted at each side of the source and drain. Thus, the Fermi level of each side of the graphene is shifted depending on the work function of the contacted metal, and two Dirac points appear on the I_d-V_g curve by the graphene doping asymmetry. To extract the Dirac point for calculating the internal potential of the asymmetric geometry, two metal contacts are postulated as variable resistors, and the experimental data are fit by calculating the total resistance of each metal contact graphene photodetector by[1]

$$R_{tot} = R_c + R_0 + R_1 = R_c + \frac{L_0}{eW\mu_0\sqrt{n_0^2 + n_0[V_g^*]^2}} + \frac{L_1}{eW\mu_1\sqrt{n_1^2 + n_1[V_g^*]^2}}$$

where R_c is the contact resistance, and R_0 and R_1 are the resistance of each metal contact of the asymmetric metal structure, and L and W are the channel length and width. μ is the mobility of the CVD graphene in this experiment. As a consequence of this equation, the Dirac voltage for each metal contact can be extracted.

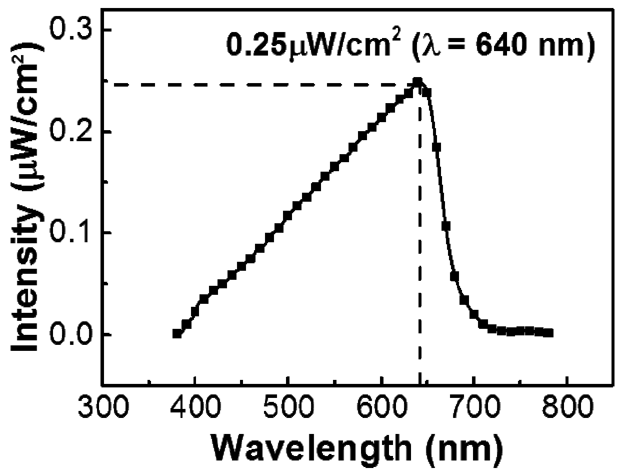

Figure S3: Characteristics of the light source used in this experiment.

The light source used in this experiment was a halogen lamp for which variable wavelength is mixed. We measured from 380 ~ 780 nm to calculate the photoresponsivity of the fabricated graphene device. Maximum power was 0.25 μA/cm^2 at 640 nm.

REFERENCE

1. Kim YJ, Kim S-Y, Noh J, *et al.* Demonstration of Complementary Ternary Graphene Field-Effect Transistors. *Sci. Rep.* 6, 39353 (2016).