Highlights

Other Materials —2017

Hybrid graphene/silicon Schottky photodiode with intrinsic gating effect

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We propose a hybrid device consisting of a graphene/silicon (Gr/Si) Schottky diode in parallel with a Gr/SiO_2/Si capacitor for high-performance photodetection. The device, fabricated by transfer of commercial graphene on low-doped n-type Si substrate, achieves a photoresponse as high as 3 AW^{-1} and a normalized detectivity higher than 3.5×10^{12} $cmHz^{1/2}$ W^{-1} in the visible range. It exhibits a photocurrent exceeding the forward current because photo-generated minority carriers, accumulated at Si/SiO_2 interface of the Gr/SiO_2/Si capacitor, diffuse to the Gr/Si junction. We show that the same mechanism, when due to thermally generated carriers, although usually neglected or disregarded, causes the increased leakage often measured in Gr/Si heterojunctions. We perform extensive I–V and C-V characterization at different temperatures and we measure a zero-bias Schottky barrier height of 0.52 eV at room temperature, as well as an effective Richardson constant $A^{**} = 4\times10^{-5}$ A cm^{-2} K^{-2} and an ideality factor n≈3.6, explained by a thin (<1 nm) oxide layer at the Gr/Si interface.

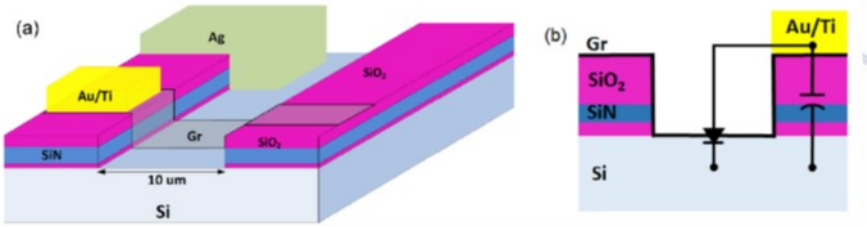

Fig.1: (a) 3D schematic view and (b) cross-section of Gr/Si diode in parallel with a Gr/SiO_2–Si_3N_4–SiO_2/Si MOS capacitor.

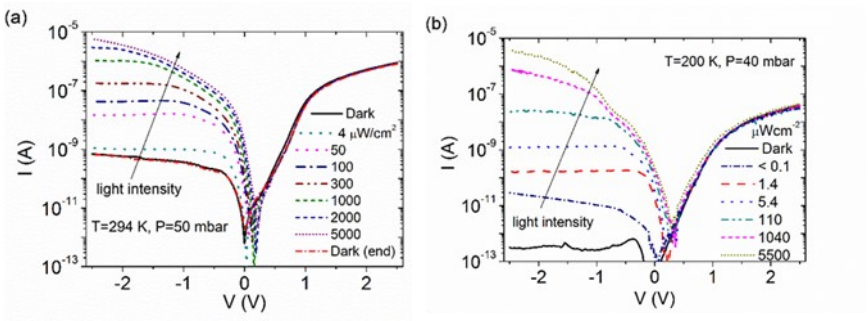

Fig.2: I-V characteristics of the Gr/Si junction for different illumination levels at T=294 K, P=50 mbar (a) and at T=200 K, P=40 mbar (b) after 5 days vacuum anneal.