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Room-temperature mid-infrared photodetector in all-carbon graphene nanoribbon-C_{60} hybrid nanostructure: supplementary material

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MATERIALS AND METHODS

Sample Preparation. Highly ordered pyrolytic graphite (HOPG) was purchased from SPI supplies. Monolayer graphene was fabricated by a 3M tape-based mechanical exfoliation on SiO_2/Si wafer with 285 nm thermal-oxidized SiO2 layer. Heavily p-doped silicon substrate was employed as a bottom gate electrode. Monolayer graphene was identified by the optical microscope and Raman spectroscopy.[1] The single Lorenz 2D peak (~2700 cm^{-1}), I2D/IG>2 and absence of D peak (~1350 cm^{-1}) demonstrated the quality of the single layer graphene.

Electron Beam Lithography (EBL) Process. Monolayer graphene sheet with lateral sizes of ~11.2 μm was contacted with Ti/Au (20/80 nm) metal electrodes fabricated by e-beam evaporation after photolithography. Consequently, the graphene channel was patterned into nanoribbons by electron beam lithography (EBL) process. First, hydrogen silsesquioxane (HSQ) was spin-coated on the whole wafer, and the thickness was ~30 nm by using the spin speed of 5000 rpm. Second, the HSQ covered sample was exposed by electron beam with a designed nanoribbon pattern.[2] Third, the exposed sample was developed by NaOH/NaCl salty solution, and the un-exposed HSQ was washed away. Next, the sample was put in the RIE chamber and etched by O_2 plasma, the graphene area with HSQ covering was retained while the other uncovered grahenene parts will be etched away by the O_2 plasma. Last, HSQ resist was washed away by immersing in HF solution (~2%) for 30 seconds.

Electrical and Photoresponse Measurements. Electrical characteristics were conducted by a semiconductor device analyzer (Agilent B1500A). Photoresponsivity measurement was performed in a digital deep level transient spectroscopy (DLTS, BIORAD) combined with a four-probe stations. The light source is a tunable quantum cascade laser (QCL) from 9.75 μm to 10.48 μm, during the optoelectronic measurement we control the wavelength to be 10 μm. The laser was aligned by optical lens and the power densities of the lasers were assumed to be uniform. All the measurements were conducted at room temperature.

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