Supporting Information

High-Quality InSb Nanocrystals: Synthesis and Application in Hybrid Graphene Based Near-Infrared Photodetector

Kun Zhang,[1,2] Yilun Wang,[1] Weifeng Jin,[1] Xin Fang,[1] Yi Wan,[1,2] Yinfeng Zhang,[1] Jingzhi Han[1] and Lun Dai[1,2,a)]

[1]*State Key Lab for Mesoscopic Physics and School of Physics, Peking University, Beijing 100871, China*

[2]*Collaborative Innovation Center of Quantum Matter, Beijing 100871, China*

[a)] Author to whom correspondence should be addressed. Email: lundai@pku.edu.cn

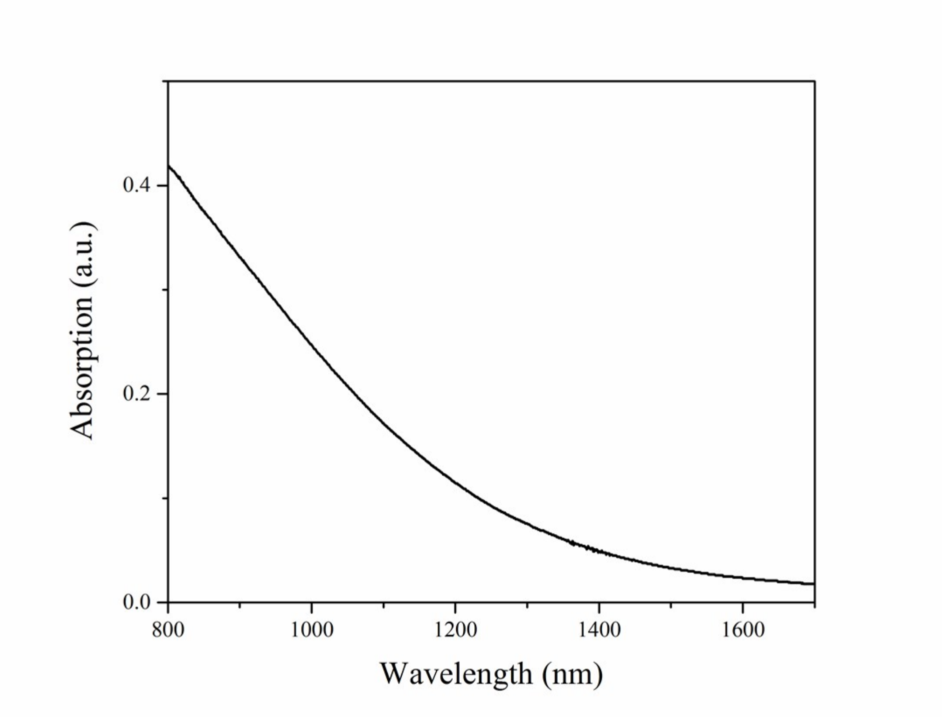

Figure S1 Absorption spectrum of the NCs with average diameter of about 182 nm. (The measurement was performed on UV-3600Plus UV-VIS-NIR spectrophotometer. The NCs were directly grown on silica substrates for the measurement.)

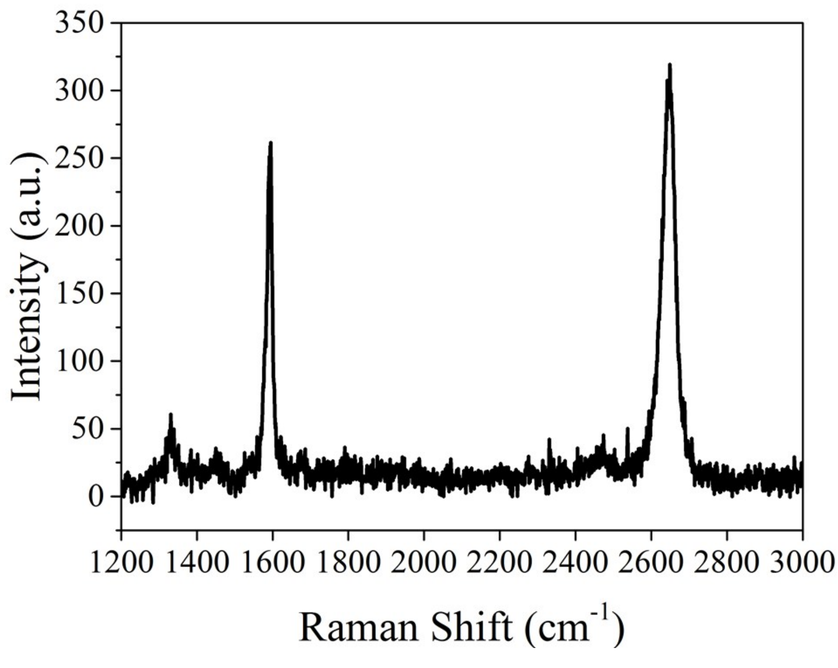

Figure S2 Raman spectrum of the transferred graphene on a 300 nm SiO_2 /Si substrate under 633nm excitation. The I_{2D}/I_G is close to 1. The FWHM of the 2D peak is about 46 cm^{-1}. These results indicate the formation of bilayer graphene.[1]

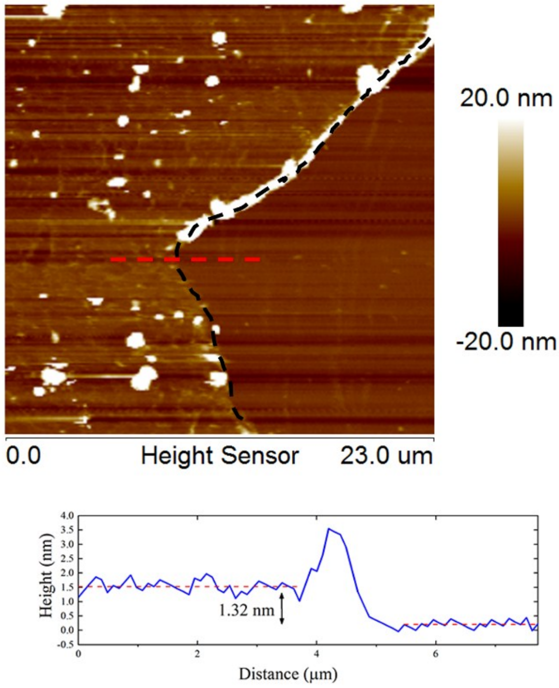

Figure S3 (a) AFM image of the transferred graphene on SiO_2/Si. Black dashed line: graphene edge. (b) The height profile measured along the red dashed line in (a). The height profile shows that the height of graphene is 1.32 nm, in accord with the height of transferred bilayer graphene.[2,3]

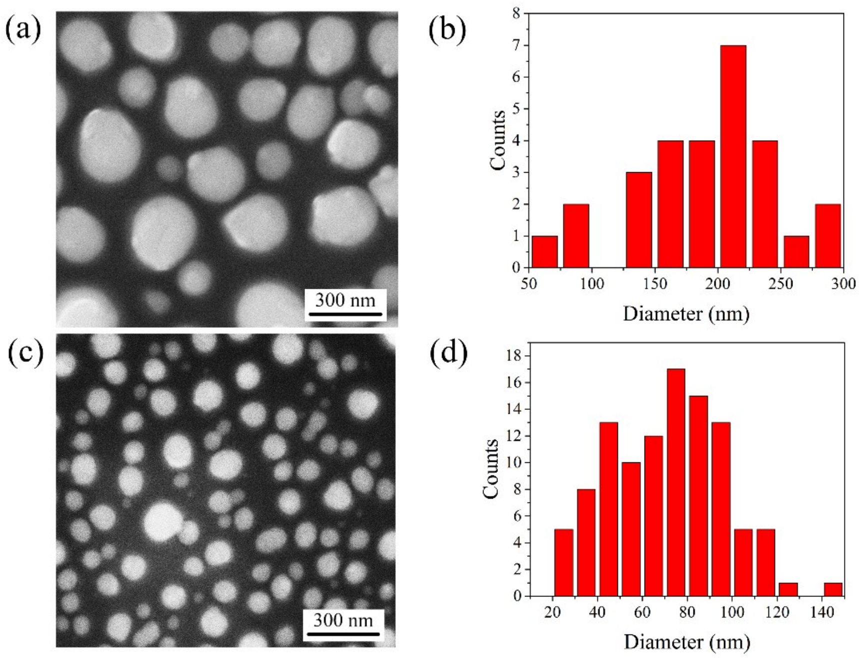

Figure S4 (a) FESEM image of the bigger InSb NCs on graphene/SiO_2/Si. (b) Size distribution histogram of the NCs in (a). Coverage: 46%, average diameter: 199 nm. (c) FESEM image of the smaller InSb NCs on graphene/SiO_2/Si. (d) Size distribution histogram of the NCs in (c). Coverage: 26%, average diameter: 76 nm.

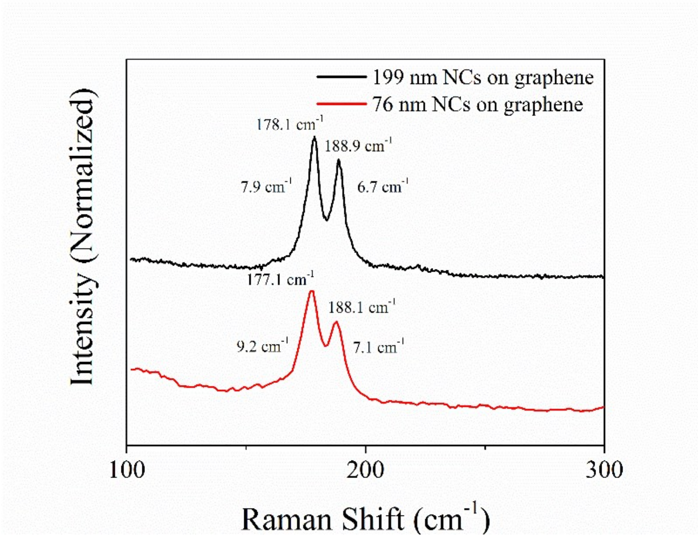

Figure S5 Raman spectra of InSb NCs on graphene/SiO_2/Si.

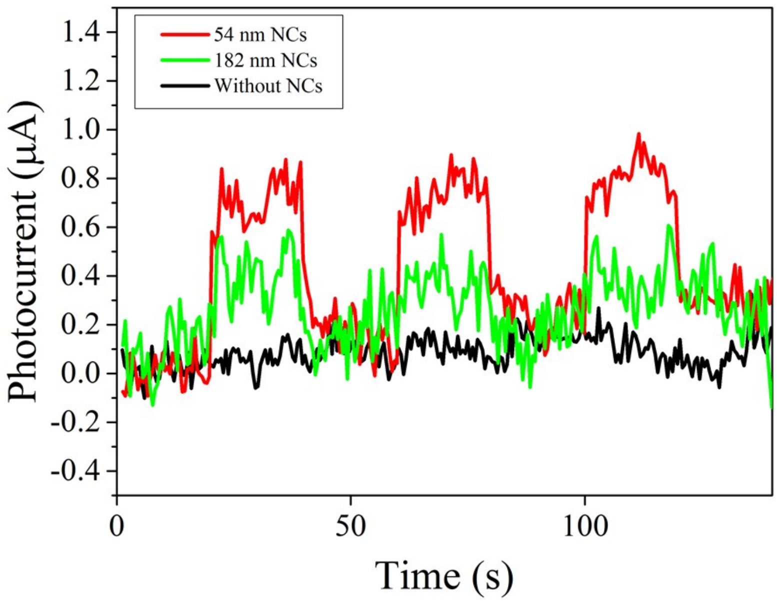

Figure S6 Photoresponses of the devices with smaller NCs (red), bigger NCs (green) and bare graphene (black) under 1550 nm laser illumination (318 mW cm^{-2}). The source-drain bias (V_{DS}) is 0.5 V. The photoresponse of the device with bigger NCs (green line) is weaker compared to the device with smaller NCs (red line).

Sample	Mobility (cm^2/Vs)
Transferred graphene	673
Smaller NCs/graphene	411
Bigger NCs/graphene	288

Table S1 Mobility measurement results on transferred bare graphene, smaller NCs/graphene, and bigger NCs/graphene.

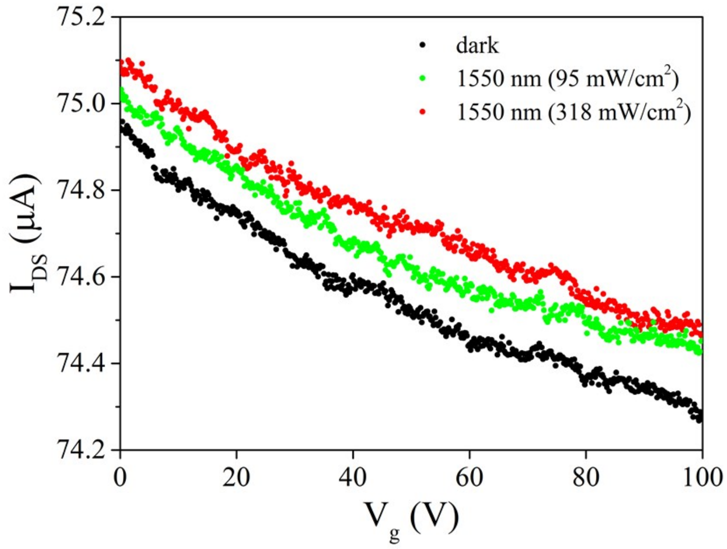

Figure S7 I_{DS}-V_g relation of the device illuminated by 1550 nm laser of different intensities. The V_{DS} is 0.5 V.

Estimation of Fermi level in the bilayer graphene

The position of the Fermi level in the bilayer graphene is estimated by the relation: $E_F=-\hbar^2\pi n/2m^*$, where $\hbar$ is Planck's constant divided by 2π, n is the carrier density, $m^*=0.033m_e$ is the effective mass of carrier in bilayer graphene relative to the bare electron mass m_e.[4, 5]

The carrier concentration was measured by Hall effect measurement (Accent HL 5500). Four Au electrodes were fabricated on the transferred graphene (0.5 cm × 0.5 cm). The result indicates that the graphene is *p*-type-doped with hole density to be about 8.8×10^{12} cm^{-2}. Therefore, the Fermi energy level shift with respect to the Dirac point is estimated to be about -0.31 eV. Using the intrinsic work function of undoped bilayer graphene (~4.69 eV),[4] we can obtain the work function of the transferred bilayer graphene in our case to be about 5.0 eV.

Reference

1 Z. Peng, Z. Yan, Z. Sun, J. M. Tour, *ACS Nano* 2011, *5*, 8241.

2 L. Liu, H. Zhou, R. Cheng, W. J. Yu, Y. Liu, Y. Chen, J. Shaw, X. Zhong, Y. Huang and X. Duan, ACS Nano, 2012, 6, 8241-8249.

3 A. Reina, X. Jia, J. Ho, D. Nezich, H. Son, V. Bulovic, M. S. Dresselhaus and J. Kong, Nano Letters, 2009, 9, 30-35.

4 Y.-J. Yu, Y. Zhao, S. Ryu, L. E. Brus, K. S. Kim, P. Kim, *Nano Letters* 2009, *9*, 3430.

5 D. Ziegler, P. Gava, J. Güttinger, F. Molitor, L. Wirtz, M. Lazzeri, A. M. Saitta, A. Stemmer, F. Mauri, C. Stampfer, *Physical Review B* 2011, *83*.