Photoresponse in Graphene–based Heterojunctions

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Abstract

Due to the long relaxation time, high carrier mobility and broadband photoresponse, graphene is a promising material for high-performance photodetection. However, there are several key challenges toward real applications, such as low absorption of single atom layer, lack of bandgap, and difficulty in integration with high-quality infrared materials. In this talk, we will share our recent progress in which we try to alleviate these problems above. Firstly, with in-situ grown graphene nanowalls as the electrodes of Schottky heterojunction, a visible-infrared photodetector with ideal Schottky barrier and high responsivity could be obtained, according to the improved absorption by nanowalls, while the response wavelength could be further expanded to mid-infrared as well as THz. Secondly, through barrier engineering and using graphene as the absorption material, the photogating effects in graphene-silicon heterojunction would be enhanced, and an infrared photodetector with high responsivity could therefore be realized. Finally, to improve the performance of graphene-based hybrid photoconductors, single-oriented PbSe nanoplates could be grown on graphene using electrochemical atomic layer epitaxy method, with improved crystal orientation as well as better graphene-PbSe interface. As prepared graphene PbSe heterojunction demonstrated excellent photoresponse in 2.7 micrometre at room temperature.

References

[1] Liu X., Zhou Q., Luo S., Du H., Cao Z., Peng X., Feng W., Shen J. & Wei D. Infrared Photodetector Based on the Photothermionic Effect of Graphene-Nanowall/Silicon Heterojunction. (2019) ACS Appl. Mater. Interfaces, http://dx.doi.org/10.1021/acsami.9b0329.

[2] Zhou, Q., Liu, X. Z., Luo, W., Shen, J., Wang, Y. F. & Wei, D. P. The interface modification for GNWs/Si Schottky junction with PEI/PEIE interlayers. (2018) Mater. Res. Express, 5, 8.

[3] Shen, J., Liu, X., Song, X., Li, X., Wang, J., Zhou, Q., Luo, S., Feng, W., Wei, X., Lu, S., Feng, S., Du, C., Wang, Y., Shi, H. & Wei, D. High-performance Schottky heterojunction photodetector with directly grown graphene nanowalls as electrodes. (2017) Nanoscale, 9, 6020-6025.

[4] Zhou Q., Shen J., Liu X., Li Z., Jiang H., Feng S., Feng W., Wang Y. & Wei D. Hybrid graphene heterojunction photodetector with high infrared responsivity through barrier tailoring. Nanotechnology, 30 (2018) 195202.

[5] Yang C., Feng S., Wei X. & Shi H., (Unpublished).

Figures

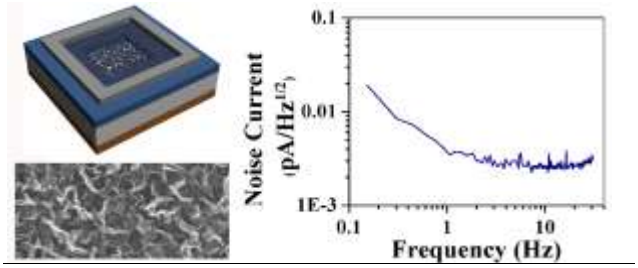

Figure 1: Photoresponse with Schottky barrier based on in-situ grown graphene nanowalls.

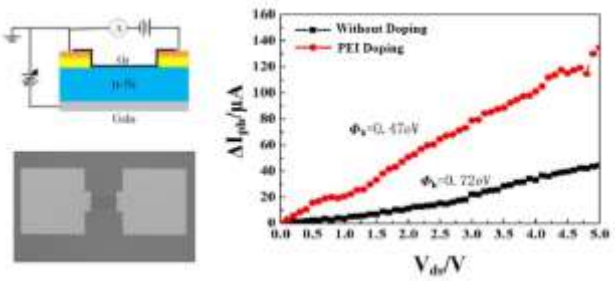

Figure 2: Enhanced infrared photoresponse of graphene-silicon heterojunction resulting from barrier engineering.