

## Fabrication of Chemical Graphene Nanoribbons via Edge-selective Covalent Modification

Qin Xie, Lei Liao, Zhongfan Liu

Center for Nanochemistry, Academy for Advanced Interdisciplinary Studies, Peking University,  
Beijing 100871, P. R. China

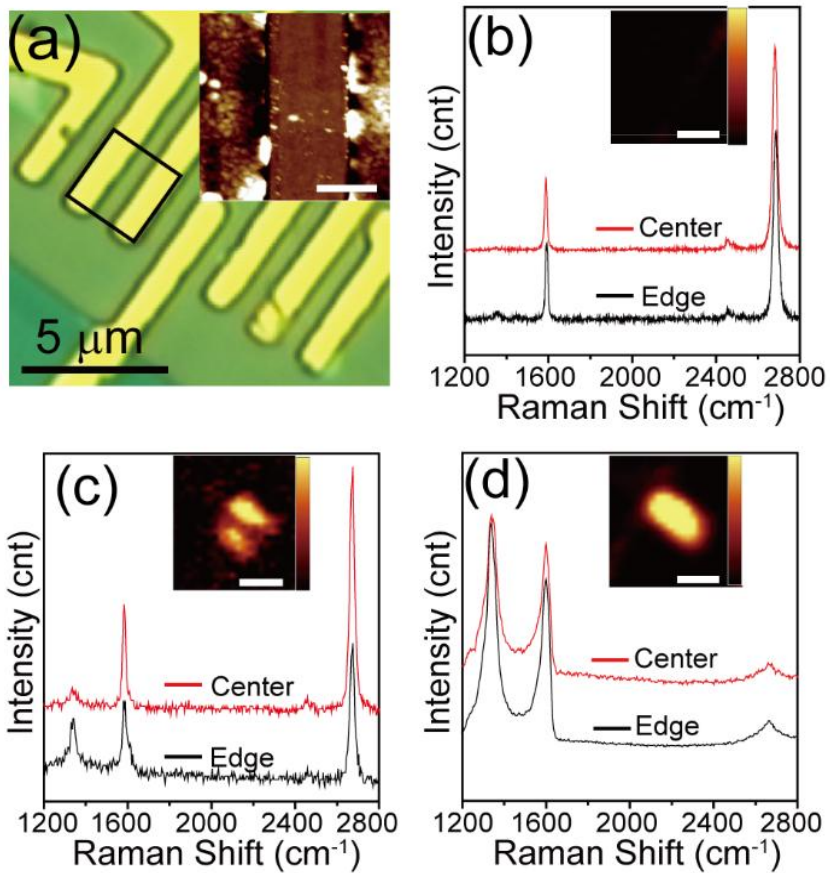
E-mail: [xieqin-cnc@pku.edu.cn](mailto:xieqin-cnc@pku.edu.cn)

### Abstract

Graphene, an ideal two-dimensional crystal, presents a series of novel physical properties. Because of its zero band gap, it is key for graphene application in silicon-based conductive channel to open a band gap. Chemical modification of graphene offers an exciting direction to modulate its surface, electronic properties and prepare new carbon materials. This work focused on developing a novel route for chemical functionalization of graphene and modification of its electronic property. We fabricated the chemical graphene nanoribbons by the edge-selective reaction between graphene and di-tert-butyl peroxide, which was a new type of quantum-confined graphene nanostructure having tunable electrical conduction channels and bandgaps. The transport measurements and variable-temperature electrical measurements proved that such kind of chemical graphene nanoribbons exhibited semiconducting behavior. By altering the reaction time, the on/off ratios could be tuned in the range from a few hundreds to ~10<sup>4</sup>, which was much higher than those obtained from conventional top-down etching techniques. The present approach may extend the potential of CGNRs to be an alternative material in the development of high-performance electronic devices.

### References

- [1] L Liao, Q Xie, ZF Liu, XF Guo, *Adv. Mater.*, 27(2015), 4093.
- [2] S Ghosh, I Calizo, D. Teweldebrhan, EP Pokatilov, DL Nika, AA Balandin, W Bao, F Miao, CN Lau, *Appl. Phys. Lett.* 92 (2008), 151911.
- [3] L Liao, ZH Song, Y Zhou, H Wang, Q Xie, HL Peng, ZF Liu, *Small* 9(2013),1348.
- [4] YW Son, ML Cohen, SG Louie, *Phys. Rev. Lett.* 97(2006), 216803.
- [5] HY Han, B Ozyilmaz, YB Zhang, P Kim, *Phys. Rev. Lett.* 98(2007), 206805.
- [6] DV Kosynkin, AL Higinbotham, A Sinitskii, JR Lomeda, A Dimiev, BK Price, JM Tour *Nature* 458(2009), 872.
- [7] AK Singh, BI Yakobson *Nano Lett.* 9(2009), 1540.
- [8] X Wang, H Dai *Nat. Chem.* 2(2010), 661.



a) Optical microscope images of a WGR-based device. The inset is the AFM image of the area in the black square, and the scale bar is 500 nm. Raman spectra of WGR's edge and center b) before reaction, c) after 5-min reaction, and d) after another 5-min reaction. The inset images are the D band mapping results, and the scale bar is 300 nm.