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Water-based Graphene Patterning under Ultraviolet Irradiation

Abstract: Magnetic-assisted UV ozonation has been proposed to be an alternative cost-effective method for patterning microscale graphene microstructures, immune to organic contamination and substrate damage [1,2]. However, the low oxidizing intensity and lateral diffusion of the instable intermediate of ozone molecule appear detrimental to the quality of graphene patterning. Herein, we propose to pattern chemical vapor deposition grown graphene film through a stencil mask using a stronger oxidant of paramagnetic $\mathrm{OH}\ (\mathrm{X}^2\,\Pi)$ radicals photodissociated from water ($\mathrm{H_2O}$) molecules under ultraviolet (UV) irradiation [3]. The $\mathrm{OH}\ (\mathrm{X}^2\,\Pi)$ radicals move directionally toward graphene surface in an inhomogeneous vertical magnetic field ($\mathrm{B_Z} = 0.51\ \mathrm{T}$, $\nabla \mathrm{B_Z} = 160\ \mathrm{T \cdot m^{-1}}$), strongly enhancing the oxidation intensity. Another photodissociated product of paramagnetic $\mathrm{H}\ (1^2S)$ radicals together with the stable water molecule explain the improved lateral under-oxidation. The water-based graphene patterning under UV irradiation is applicable to graphene-based electronic and optoelectronic devices.

References

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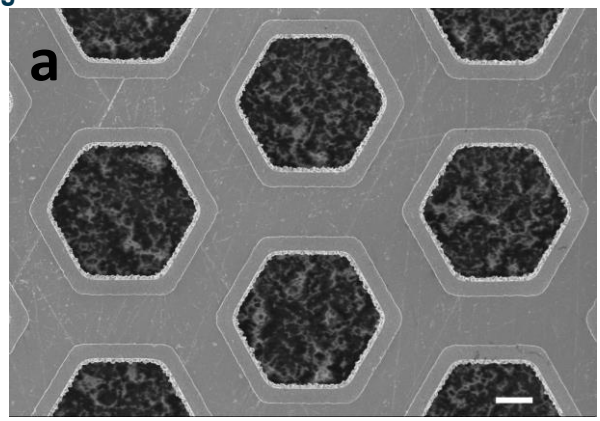
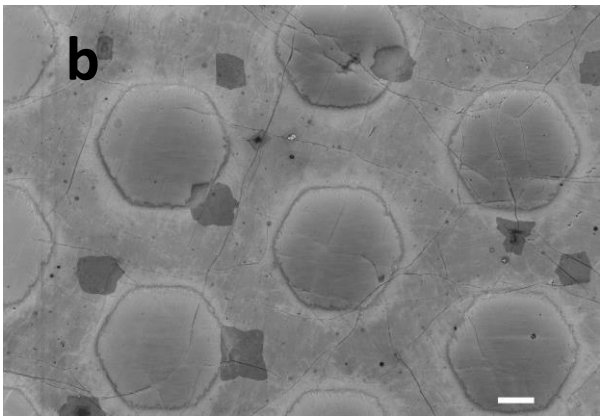
[2] H. Yue, H. Tao, Y. Wu, S. Su, H. Li, Z. Ni, X. Chen. Phys. Chem. Chem. Phys. 19 (2017), 27353.
[3] K. H. Welge, and F. Stuhl. J. Chem. Phys. 46(1967), 2440.

Figures





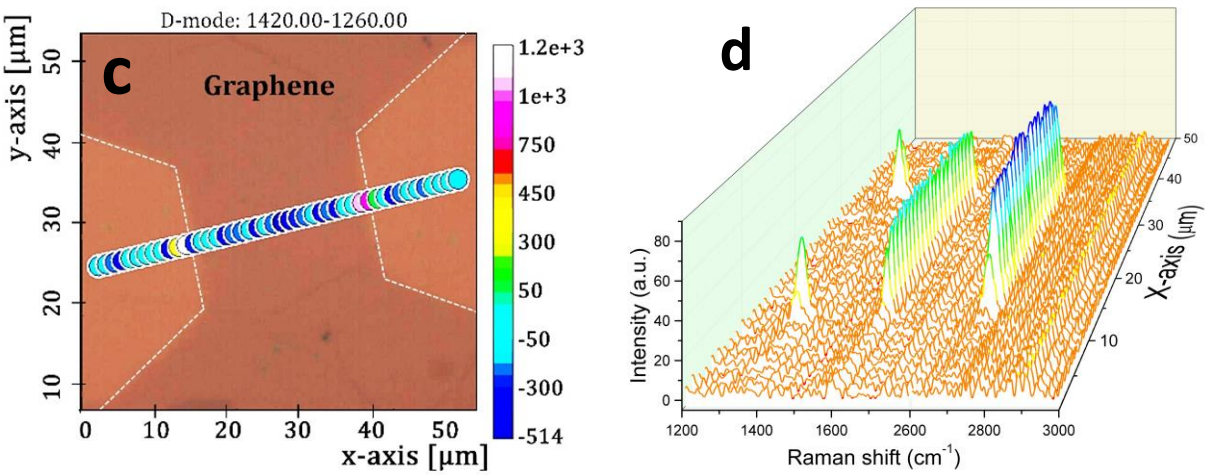


Figure 1: Water-based graphene patterning under UV irradiation through a copper mask. SEM topographical images of (a) the copper mask and (b) the corresponding microstructural graphene pattern; (c) Its optical topographical image with a line representing the defect mode (D band), and (d) the detailed Raman spectrum evolution. Both scale bars are 10 µm.