

Effects of number of layer and supporting substrate on local oxidation and reduction of graphene

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Abstract (Century Gothic 11)

Single layered (SLG) or few layered graphene (FLG) can be oxidized and later reduced back to pristine like graphene. The oxidation and reduction dynamics of SLG had been fully explored by micro-Raman (μ -RS) and micro-X-ray photoelectron (μ -XPS) spectroscopies. Qualitative difference can be found for the above processes when number of layers of graphene and its supporting substrate are changed. Compared to its single layered counterpart, the detailed mechanism of oxidation and reduction on FLG is still not well explored. In this work, we address the above issues by locally oxidizing a chemical vapor deposition grown graphene sheet at regions with one to four layers through scanning probe lithography (SPL). Through μ -RS and μ -XPS, it is found that only the top first layer graphene is oxidized, while the underneath graphene layers remain intact, under the same SPL condition. With prolonged irradiation by focused X-ray, the C-O related bonds are found to diminish and the oxidation patterns are reduced back to pristine like graphene. By analyzing the time evolution of C-O related bond areas, we found fastest reduction rate in four-layered graphene, due to promoted level of photoelectrons emitted from the underneath graphene. The above observation suggest the X-ray induced reduction mechanism is predominantly determined by photoelectron current emitted from the underneath substrate. Post-X-ray reduction measurement of μ -RS reveals no significant difference in structural reconstruction on the hexagonal lattice graphene as compared to amorphous SiO_2 , indicating the structural

reconstruction process is not affected by the crystallinity order of supporting substrate.

References

- [1] Hung-Chieh Tsai, 2D Mater., 2 (2015) 031003
- [2] Hsiao-Mei Chien, Carbon, 80 (2014), 318-324

Figures

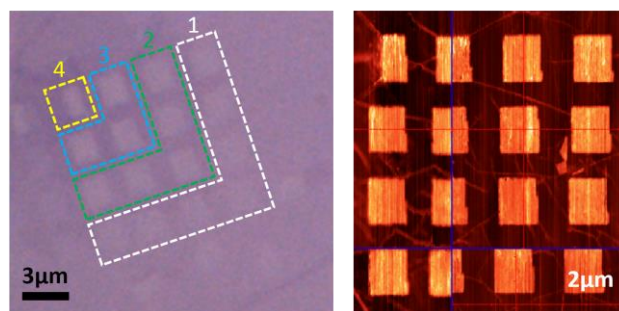


Figure 1: After oxidizing by scanning probe lithography, the oxidation patterns are identified by optical microscopy and atomic force microscopy.

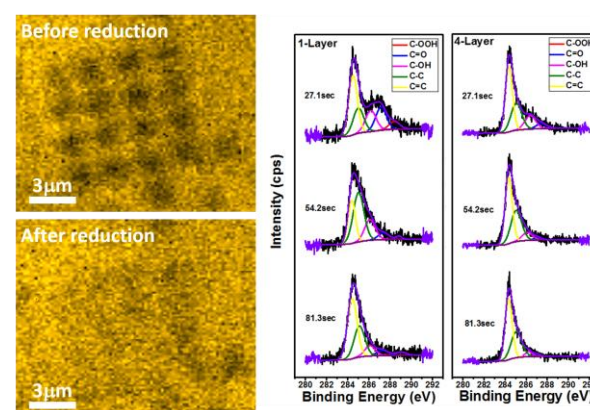


Figure 2: After measuring by focused X-ray, the C-O related bonds are reduced along with the duration of irradiation. The dark area (C-O related bonds) becomes bright one (C-C related bonds) at C 1s channel.