Electronic Supplementary Information (ESI) for Chemical Communications

This journal is © The Royal Society of Chemistry 2013

Supplementary Information

Tuning of magnetization in vertical graphenes by plasma-enabled chemical conversion of organic precursors with different oxygen content

Donghan Seo, Zengji Yue, Xiaolin Wang, Igor Levchenko, Shailesh Kumar, Shixue Dou, and Kostya (Ken) Ostrikov

Table of Contents

Electronic Supplementary Information (ESI) for Chemical Communications

This journal is © The Royal Society of Chemistry 2013

1. Experimental Details

Growth of vertical graphenes from organic precursors

The deposition process for VGs was carried out in a magnetron-sputtering-unit assisted inductively-coupled plasma chemical vapour deposition (ICP-CVD) system (13.56 MHz, RF power 1.0 kW max). Cleaned P-type Si wafers with thermally oxidized SiO_2 coating of 500 nm thickness was used as substrates for the deposition. For the fabrication of vertical graphenes from honey 0.03 g of honey was pasted evenly on the wafer and for vertical graphenes from butter and milk, 0.02 g of butter and 0.03 g of condensed milk was evenly pasted for the 1 cm^2 substrate. After loading the substrates into the reactor chamber, the chamber was pumped down to 4.8 x 10^{-4} Pa. Then a gas mixture of 10 sccm Ar and 10 sccm H_2 was fed into it to produce vertical graphenes from both honey, butter and milk. Plasma was ignited 4 cm away from the substrate at a chamber pressure and rf power of 2.5 Pa and 1000 W was maintianed during the 9 minutes of the processes. Additional information on natural precursor conversion is described in elsewhere.[1-3]

Magnetic measurements

The magnetization analysis of the vertical graphene films has been performed with vibrating sample magnetometer (VSM) in Physical Property Measurement System (PPMS). To exclude the influences of SiO_2/Si, the vertical graphenes were cleaved from the substrate before VSM measurements. Firstly, the sample holder and plastic tapes which were used to carry samples were measured and display absolute diamagnetism, then the magnetic hysteresis loops of the vertical graphenes were measured at temperatures 5, 50 and 300 K,

Additional characterizations

The microstructure of vertical graphenes were investigated by a field-emission scanning electron microscopy (FE-SEM; Zeiss Auriga) operated at an electron acceleration voltage of 20 kV and a working distance of 8 mm. The Raman spectra were collected by Renishaw *InVia* confocal Raman microscope system with a 50× objective lens. Samples were excited with 514 nm laser at power of ~ 1.5 mW and a spot diameter of ~ 1 μm^2. Energy dispersive Xray-spectrum was performed using (FE-SEM; Zeiss Auriga) operated at an electron acceleration voltage of 20 keV.

Electronic Supplementary Information (ESI) for Chemical Communications

This journal is © The Royal Society of Chemistry 2013

Section 2: Schematic of the inductively coupled plasma-enhanced CVD reactor

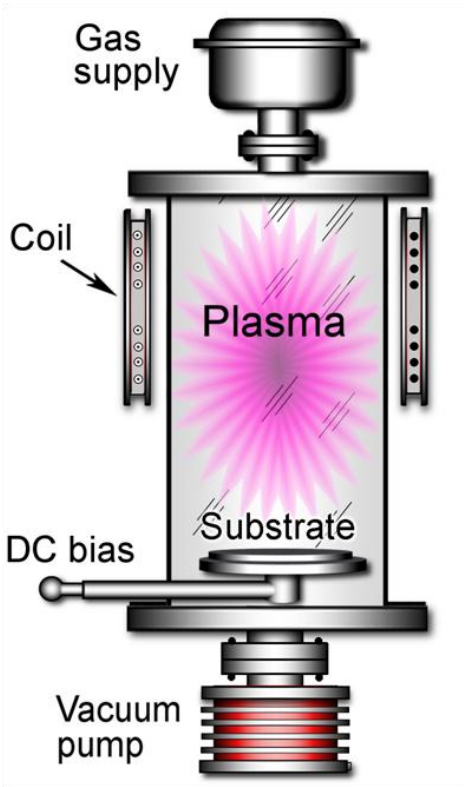

Fig. S1. Schematic of the inductively coupled plasma-enhanced CVD reactor.

Electronic Supplementary Information (ESI) for Chemical Communications

This journal is © The Royal Society of Chemistry 2013

Section 3: Vertical graphene film formation from natural precursors using plasmas

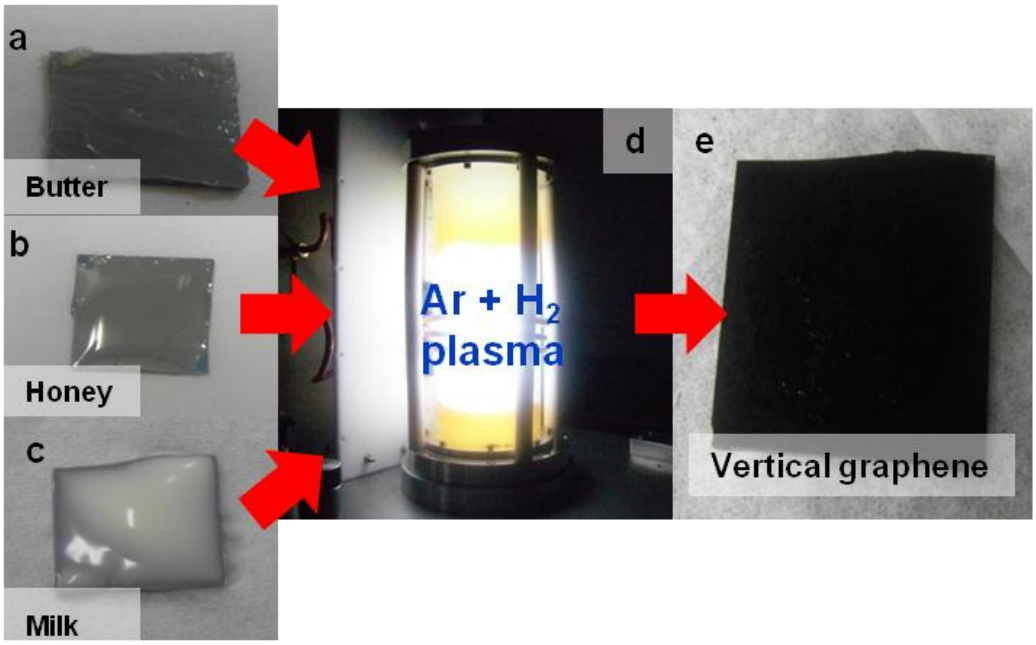

Fig. S2. Photograph of natural precursors such as (a) butter and (b) honey (c) milk is being converted to (e) vertical graphenes using (d) Argon and hydrogen plasmas.

Electronic Supplementary Information (ESI) for Chemical Communications

This journal is © The Royal Society of Chemistry 2013

Section 4: Elemental composition of vertical graphenes

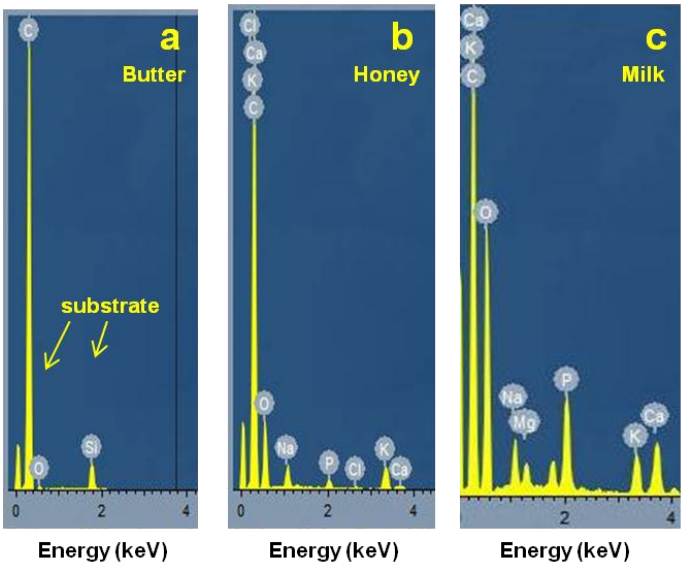

Fig. S3. EDX spectrum of vertical graphenes from (a) butter, (b) honey and (c) milk.

Section 5: Diamagnetization background of sample holder

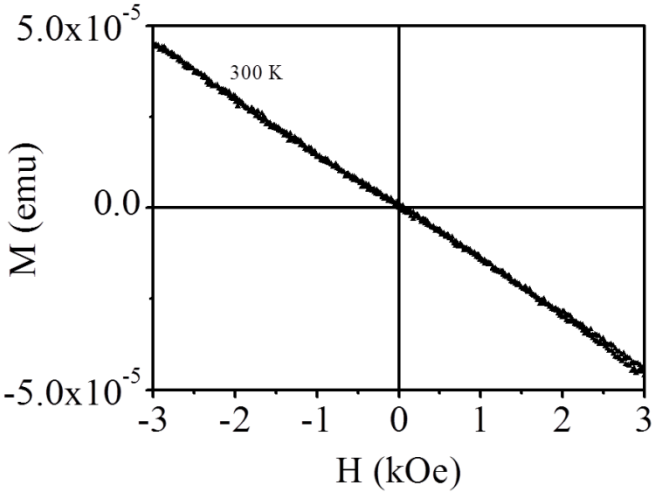

Fig. S4. Diamagnetization background of sample holder

Electronic Supplementary Information (ESI) for Chemical Communications

This journal is © The Royal Society of Chemistry 2013

Section 6: Schematic of structural states in vertical graphenes.

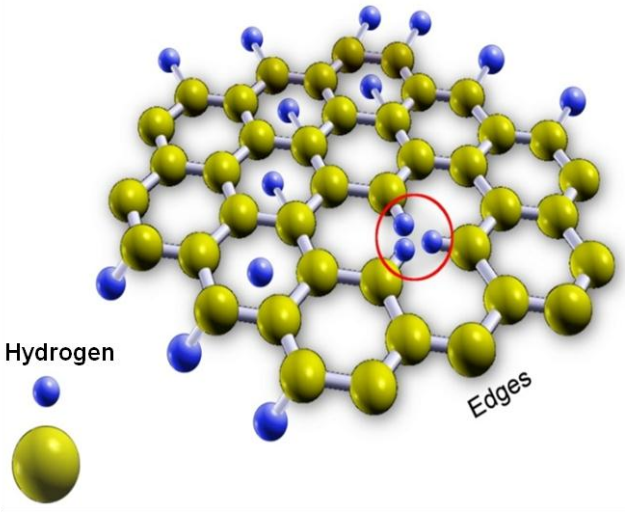

Fig. S5. Schematic of possible structural states in vertical graphenes.

Section 7. References

1. D. H. Seo, Z. J. Han, S. Kumar and K. Ostrikov, *Advanced Energy Materials*, 2013, 10.1002/aenm.201300431.
2. D. H. Seo, A. E. Rider, S. Kumar, L. K. Randeniya and K. Ostrikov, *Carbon*, 2013, **60**, 221-228.
3. D. H. Seo, A. E. Rider, Z. J. Han, S. Kumar and K. Ostrikov, *Advanced Materials*, 2013, 10.1002/adma.201301510.