Electronic Supplementary Material (ESI) for Materials Horizons.
This journal is © The Royal Society of Chemistry 2019

Supporting Information for

Structure Directing Effect of Single Crystal Graphene Film on Polymer Carbonization and Graphitization

*Benjamin V. Cunning, Bin Wang, Tae Joo Shin, Rodney S. Ruoff**

Dr. B. Wang, Dr. B. V. Cunning, Prof. R. S. Ruoff
Center for Multidimensional Carbon Materials
Institute for Basic Science (IBS)
Ulsan 44919, Republic of Korea

Prof. Tae Joo Shin
UNIST Central Research Facilities & School of Natural Science
Ulsan National Institute of Science and Technology (UNIST)
Ulsan 44919, Republic of Korea

Prof. R. S. Ruoff
Department of Chemistry
Ulsan National Institute of Science and Technology (UNIST)
Ulsan 44919, Republic of Korea

Prof. R. S. Ruoff
School of Materials Science and Engineering
Ulsan National Institute of Science and Technology (UNIST)
Ulsan 44919, Republic of Korea
E-mail: rsruoff@ibs.re.kr; ruofflab@gmail.com

Dr. B. Wang and Dr. B. V. Cunning contributed equally to this work.

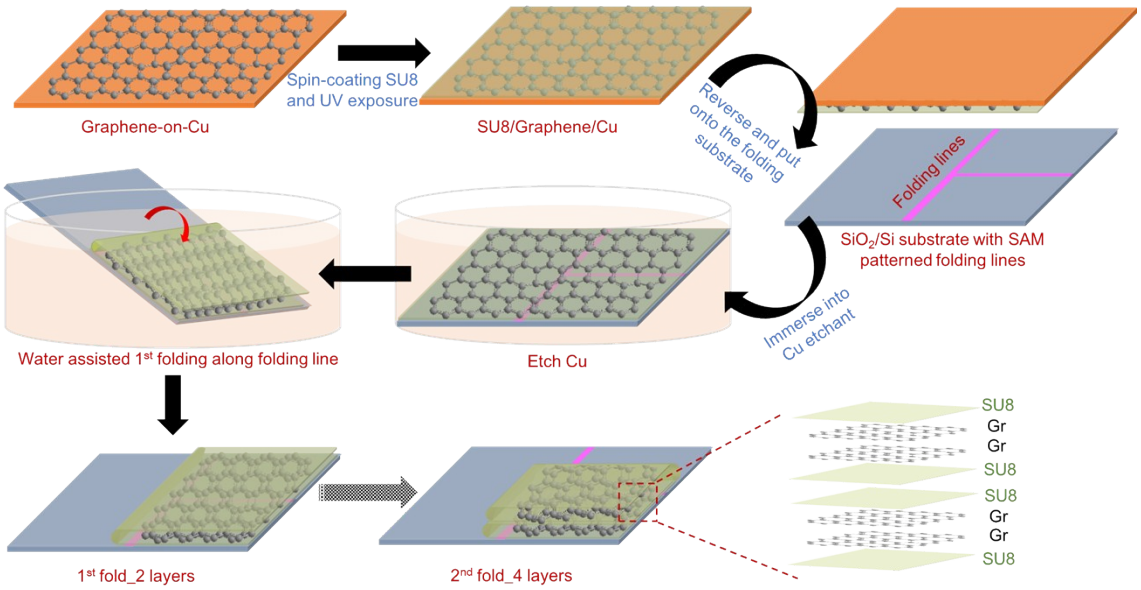

Figure S1. Schematic of the preparation of the thin film.

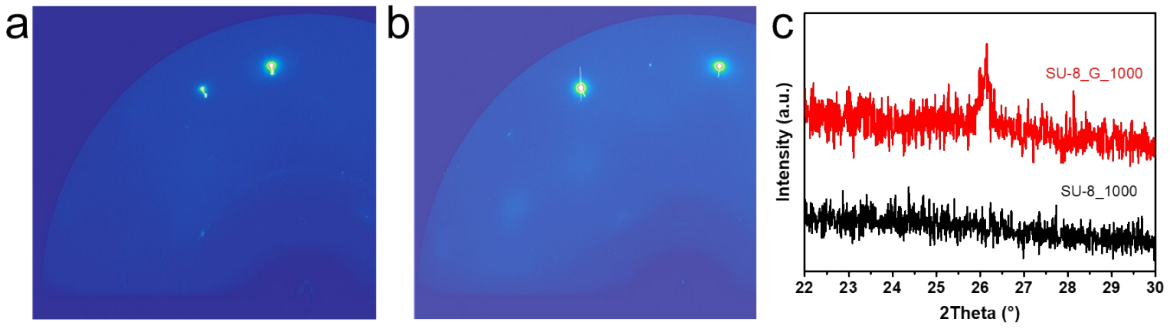

Figure S2. GIWAXS patterns for **SU-8_1000** (a) and **SU-8_G_1000** (b) samples on sapphire substrates. The bright spots in the images correspond to reflections from the sapphire substrate. XRD patterns (c) for **SU-8_1000** and **SU-8_G_1000** samples.

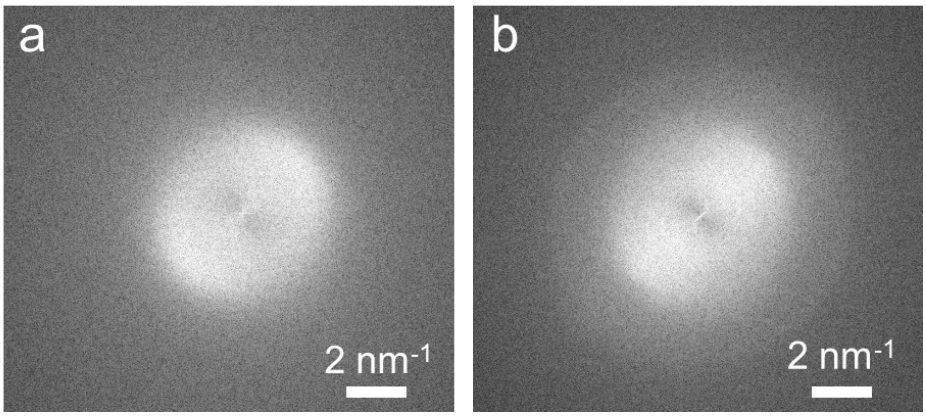

Figure S3. FFT images obtained from the high resolution TEM images in Figure 1 for **SU-8_1000** (a) and **SU-8_G_1000** (b) samples.

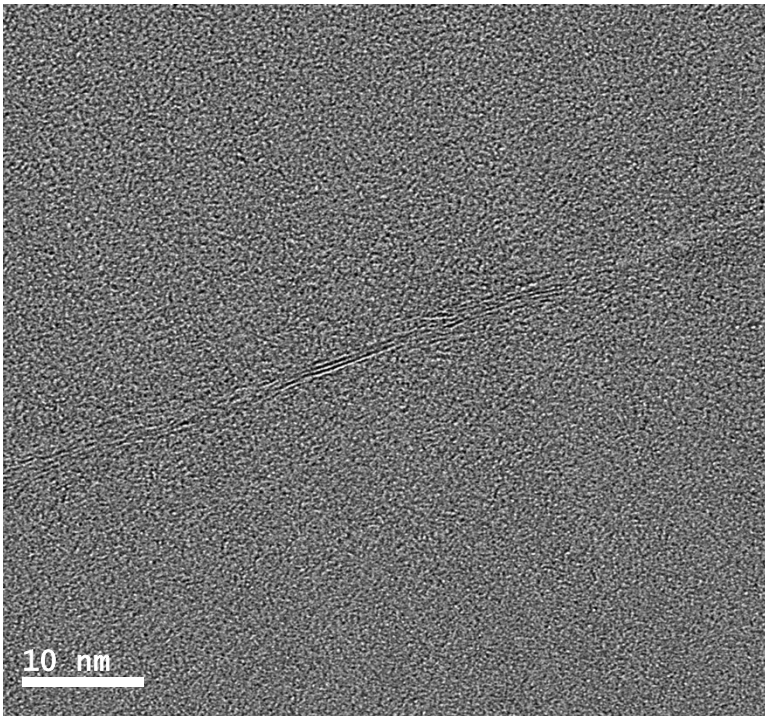

Figure S4. High resolution TEM cross section image of the folded SU8-graphene composite prior to heat treatment.

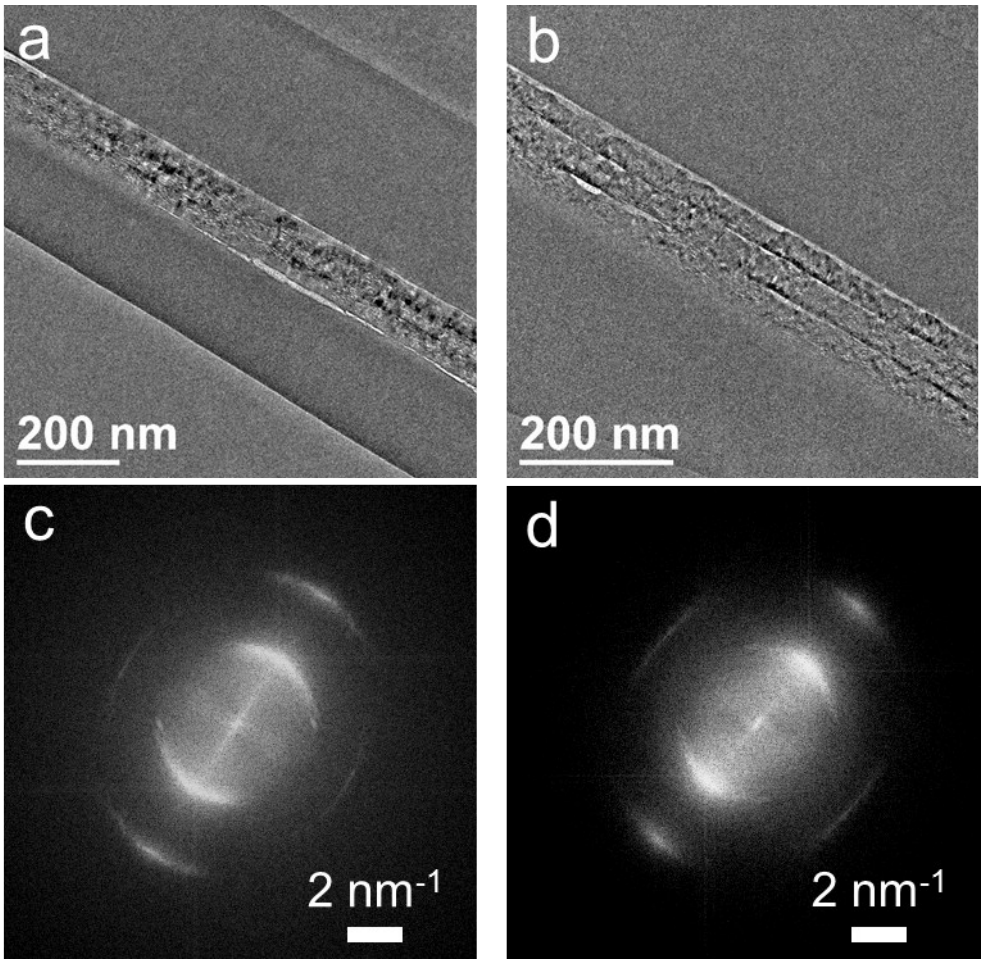

Figure S5. Low magnification TEM images show the cross-section of **SU-8_2000** (a) and **SU-8_G_2000** (b), and the corresponding FFT images (c-d) from the high resolution TEM images shown in Figure 2. The angular broadening and the thickness of the (002) plane in the FFT images match the observation from GIWAXS and powder XRD.

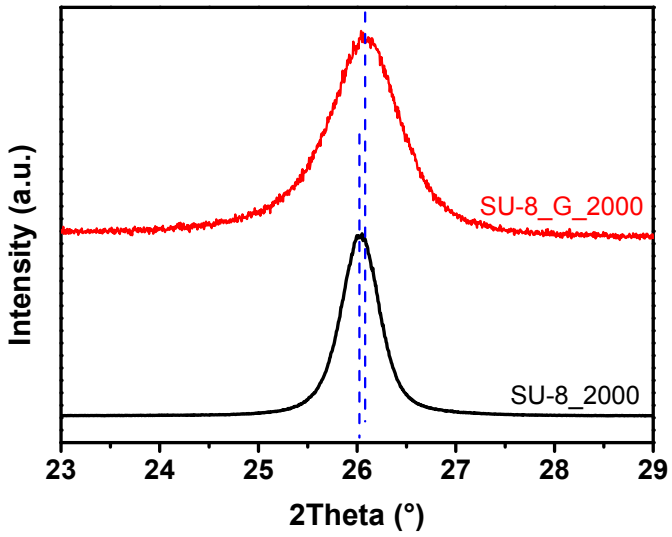

Figure S6. XRD patterns for **SU-8_2000** (a) and **SU-8_G_2000** (b) samples.

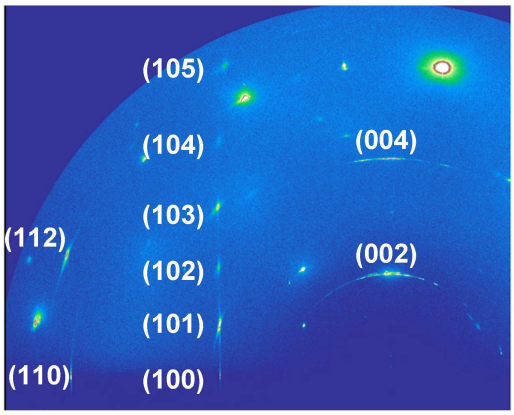

Figure S7. GIWAXS pattern for a HOPG thin film sample on a sapphire substrate.

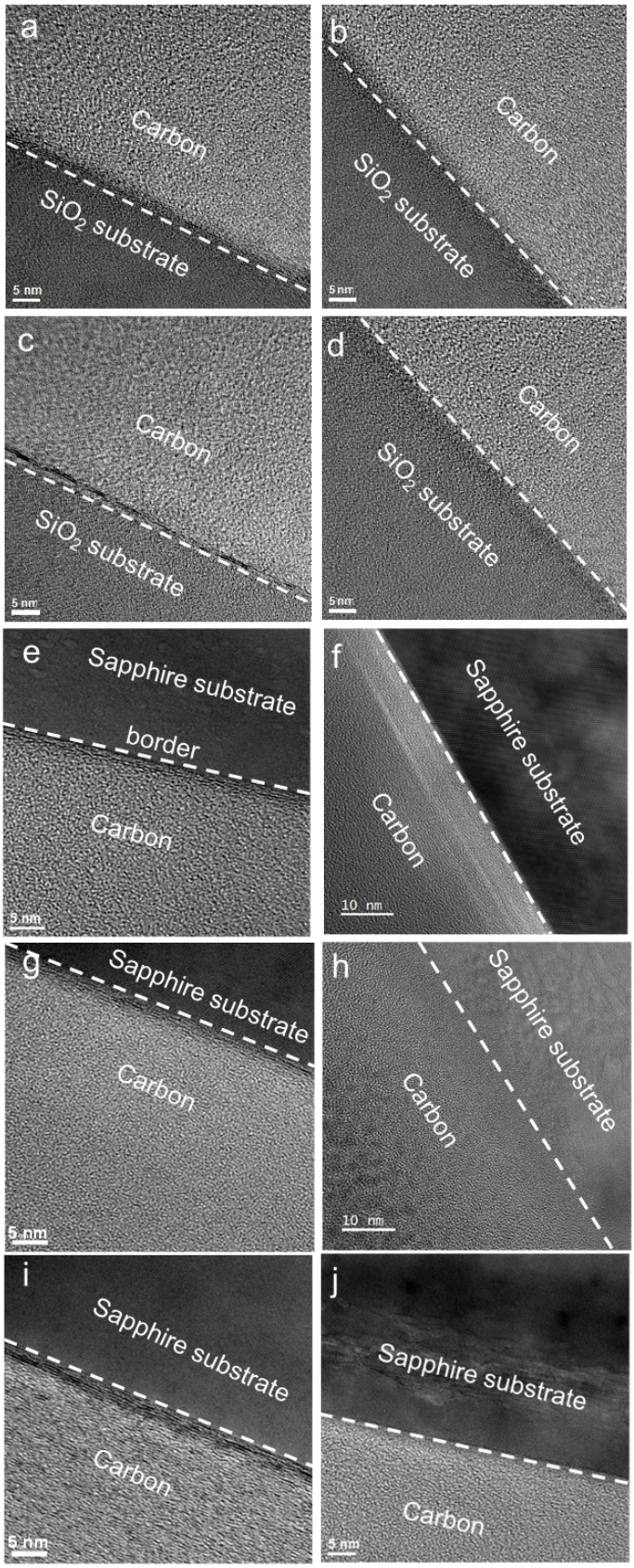
a
Carbon
SiO_2 substrate
5 nm
b
Carbon
SiO_2 substrate
5 nm
c
Carbon
SiO_2 substrate
5 nm
d
Carbon
SiO_2 substrate
5 nm
e
Sapphire substrate
border
Carbon
5 nm
f
Sapphire substrate
Carbon
10 nm
g
Sapphire substrate
Carbon
5 nm
h
Sapphire substrate
Carbon
10 nm
i
Sapphire substrate
Carbon
5 nm
j
Sapphire substrate
Carbon
5 nm

Figure S8. Cross-sectional TEM images of thin film SU-8 on SiO_2 or sapphire substrates with graphene (left column) and without graphene (right column) heated to 400 °C (a, b), 500 °C (c, d), 600 °C (e, f), 800 °C (g, h), and 1000 °C (i, j). All samples had a 2h ramp rate and 2h hold time under Ar flow. Samples containing graphene at the substrate/SU-8 interface show additional (002) lattice planes which are absent in the samples without graphene.

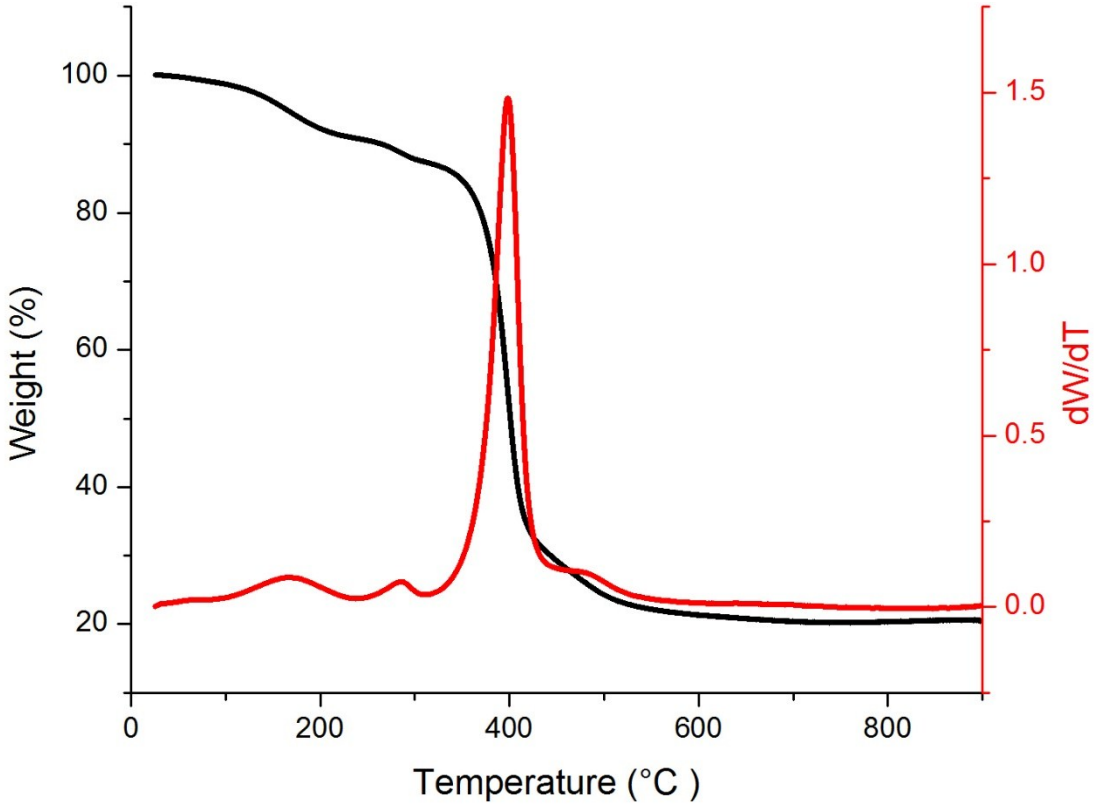

Figure S9. Thermogravimetric analysis of SU-8 as performed on a TA instruments Q500 under N_2 flow at a ramp rate of 4 °C/min.

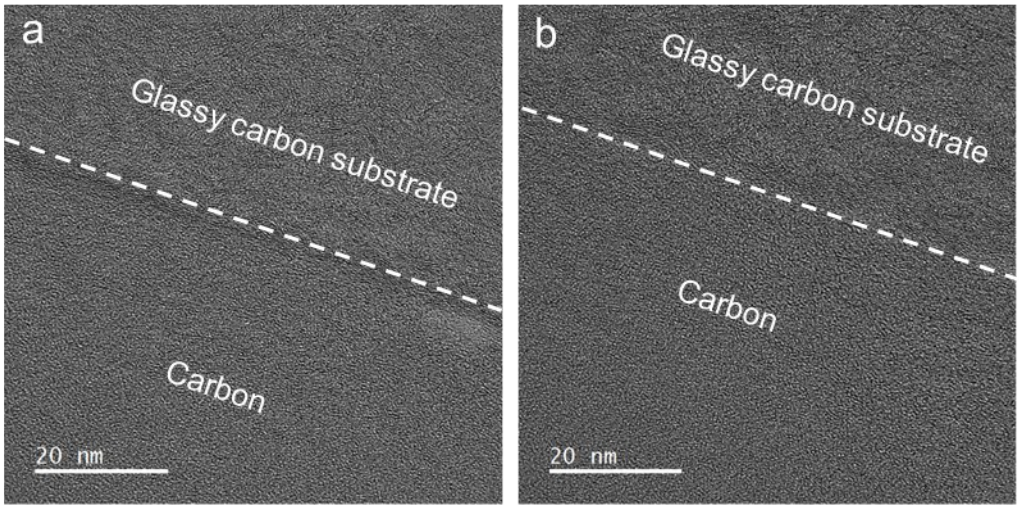

Figure S10. Cross-sectional TEM images of thin film SU-8 on glassy carbon substrate with graphene (a) and without graphene (b) at 1600 °C under Ar flow with a 2h ramp and 2 h hold time. A glassy carbon substrate was used due to the carbothermal reaction with sapphire. At this temperature no additional (002) planes (compared to the sample heat treated to 1000 °C) or a preferred orientation of the carbon away from these (002) planes were evident.

Table S1. FWHM of the pseudo-Voigt profile used to fit the circular cuts of the selected planes in Figure 3.

(002) Circular Cut	With Graphene	9.07
	Without Graphene	14.07
(101) Circular Cut	With Graphene	6.32
	Without Graphene	9.85
(102) Circular Cut	With Graphene	7.01
	Without Graphene	11.49
(103) Circular Cut	With Graphene	11.90
	Without Graphene	14.57

Table S2. Powder XRD parameters, d-spacing and estimated crystal size based on the Scherrer equation for samples heated to 2000 °C and above on a sapphire substrate. The peak position of the sapphire substrate (006) reflection was used as an internal standard to correct the (002) graphite reflection.

Sample	Sapphire (006)	Graphite (002)	Corrected (002)	d-Spacing	FWHM (002)	Crystal size
SU8 2000	41.733°	26.023°	25.972°	3.429 Å	0.45157°	18.89 nm
SU8G 2000	41.693°	26.060°	26.048°	3.419 Å	0.86510°	9.86 nm
SU8 3000	41.719°	26.545°	26.509°	3.361 Å	0.21672°	39.39 nm
SU8G 3000	41.739°	26.566°	26.510°	3.360 Å	0.21084°	40.49 nm