Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C

Supporting information

Synthesis and morphology transformation of single-crystal graphene domains based on activated carbon dioxide by chemical vapor deposition

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1 Main physical and chemical properties of catalyst for CO_2:

Table S1.The main physical and chemical properties of the Ni/Al_2O_3 catalyst for CO_2.

item	content
Chemical component	NiO: 18±1.0%; TiO_2: 6-8%; Al_2O_3:75±2%
Specification	Φ4.5～5.5 mm
Bulk density	0.9-1.0 g/cm^3
Chemical property	$CO_2+H_2 \xrightarrow{catalyst} CH_4+H_2O$

2 Experiment parameters of graphene synthesis:

Table S2. The experiment parameters of the graphene growth based on activated CO_2 at ambient pressure.

Carbon source	Experiment number (＃)	The flow rate ratio of CO_2 to H_2 (sccm)	Growth temperature (^oC)	Growth time (min)
CO_2	1	1:200	1000	30
	2	3:200		
	3	5:200		
	4	10:200		
	5	15:200		
	6	20:200		
	7	30:200		

Table S3. The experiment parameters of the graphene growth based on a mixture of CH_4 and H_2 diluted by CO_2 at ambient pressure.

Carbon source	Experiment number (#)	The flow rate ratio of CH_4 to H_2 to CO_2 (sccm)	Growth temperature (^oC)	Growth time (min)
CH_4	1	5:200:0	1000	30
	2	5:200:2		
	3	5:200:4		
	4	5:200:6		
	5	5:200:8		
	6	5:200:10		
	7	5:200:15		
	8	5:200:20		

3 Supplementary SEM characterizations

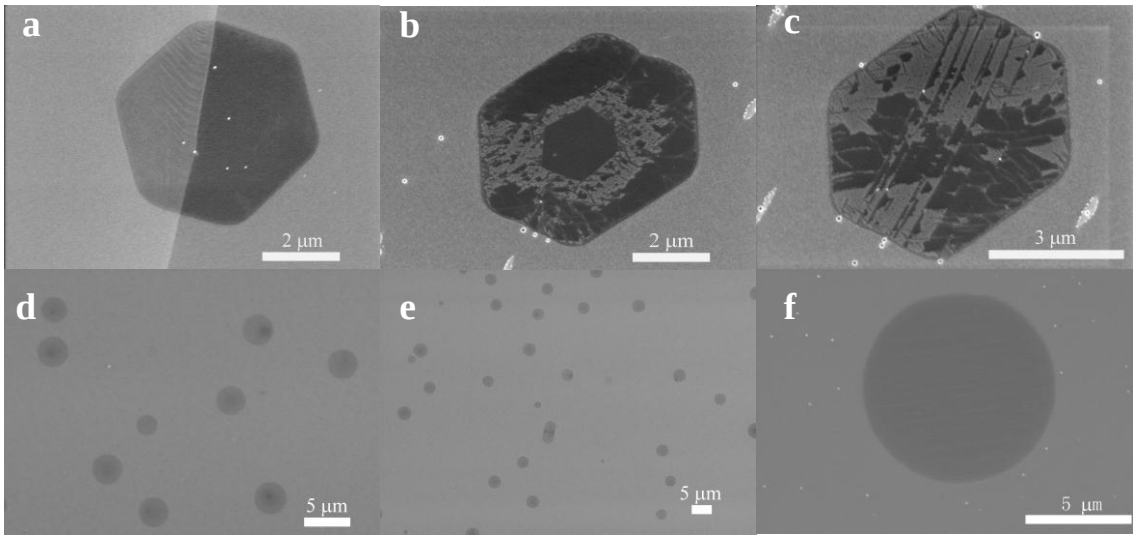

Figure S1. (a-c) High-magnified SEM images of graphene domains grown on Cu surfaces using a mixture of 5 sccm CO_2 and 200 sccm H_2. (d-f) Low and high-magnified SEM images of graphene domains grown on Cu surfaces using a mixture of 20 sccm CO_2 and 200 sccm H_2.

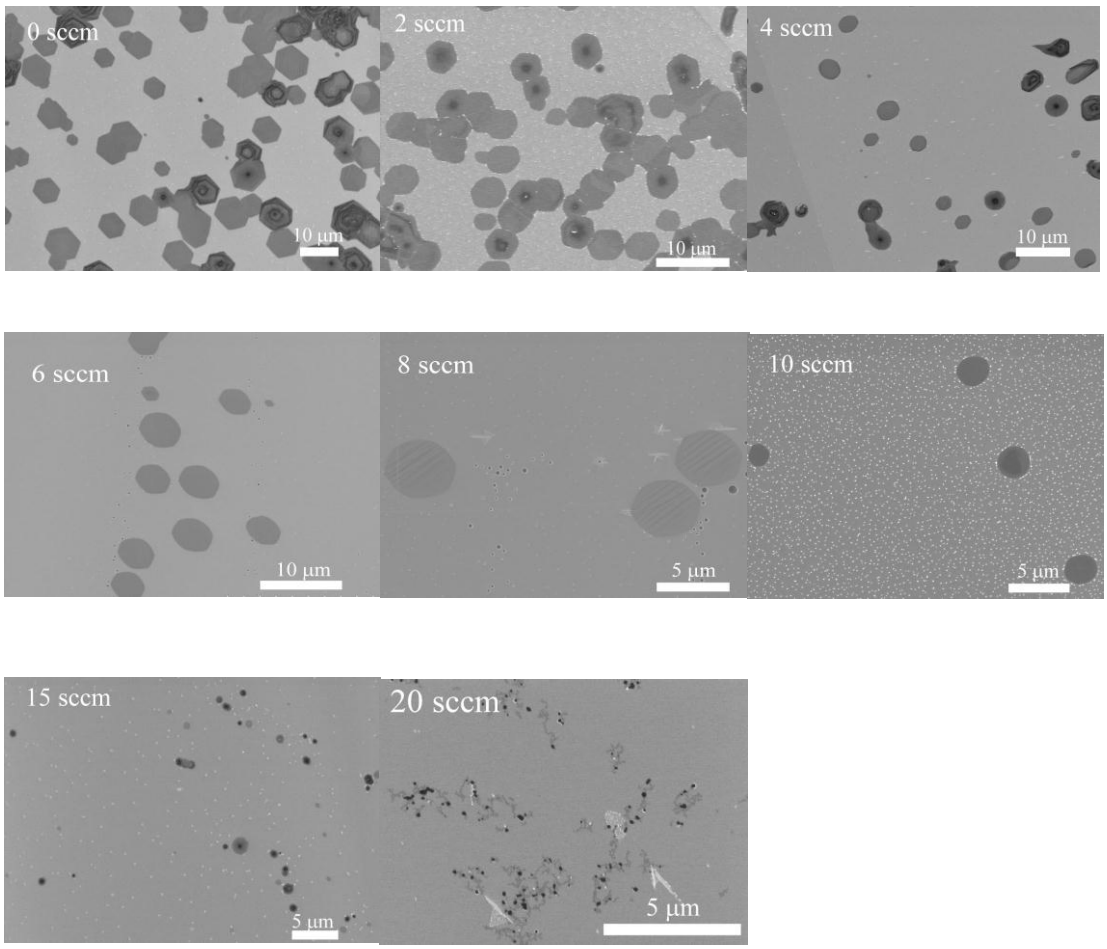

Figure S2. SEM images of graphene domains on copper foils using a mixture of 5 sccm CH_4 and 200 sccm H_2 diluted by different flow rates of CO_2 (also see Table S2). The growth time was 30 mins.

4 TEM characterizations of round graphene domain.

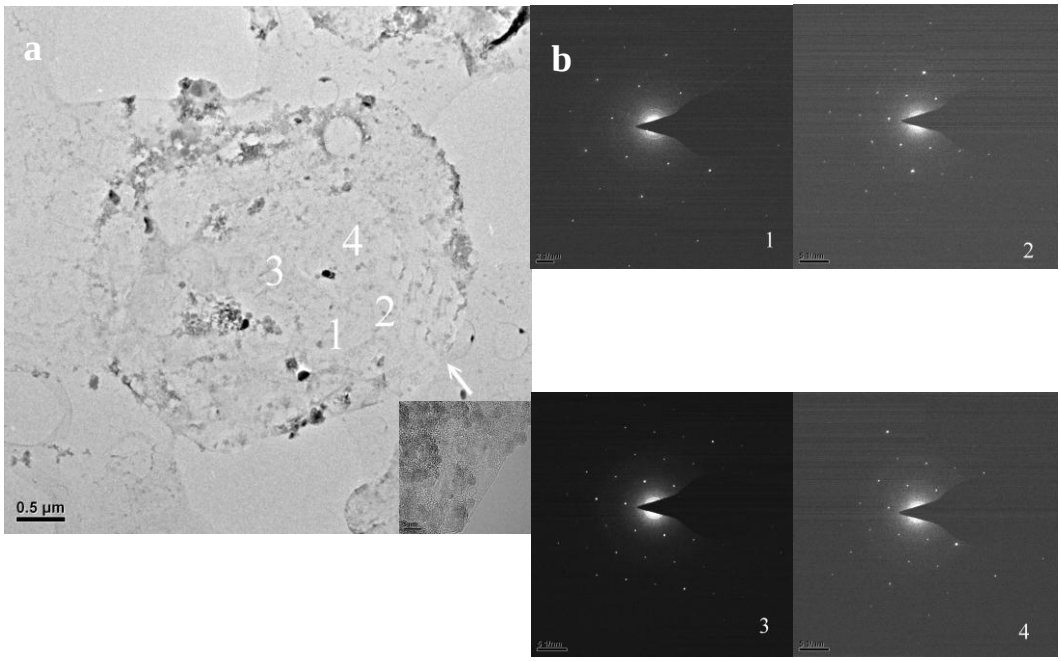

Figure S3. TEM characterization of round-shaped graphene. (a) Low-magnification TEM image showing an individual round graphene domain. The inset shows the high resolution TEM image corresponding to the region marked by white arrow in (a) showing single layer. (b) The corresponding SAED on the regions marked by numbers in (a) respectively.

5 Details of hexagon graphene devices performance

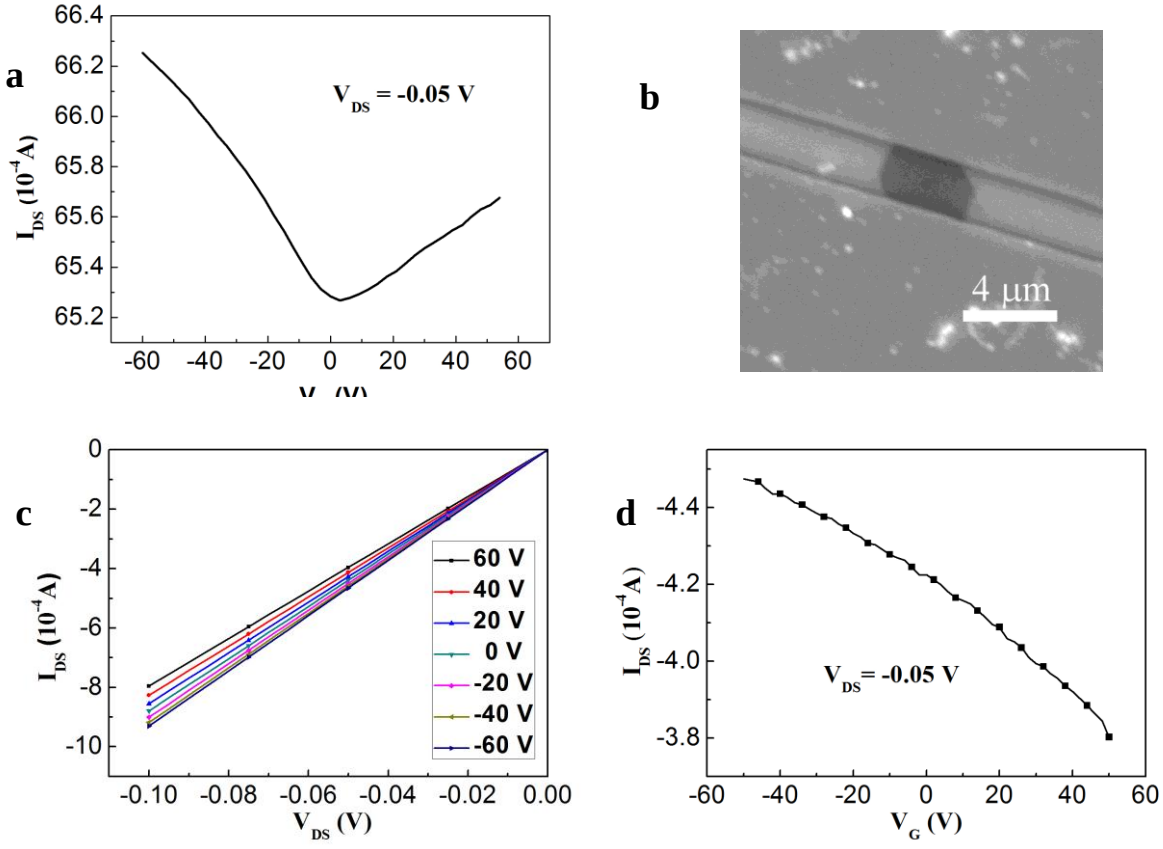

Figure S4. Electrical properties of hexagon graphene at room temperature. (a) Transfer characteristics of a device at V_{DS} = –0.05 V in N_2 and the neutral (Dirac) point is at ≈ 3 V. (b) A top view SEM image of the hexagon graphene device with a channel length of ~2.2 μm and channel width of ~4 μm. (c) I_{DS}–V_{DS} characteristics for the hexagon graphene device in air at varied V_G. (d) Transfer characteristics of the hexagon graphene device at V_{DS} = –0.05 V in air.

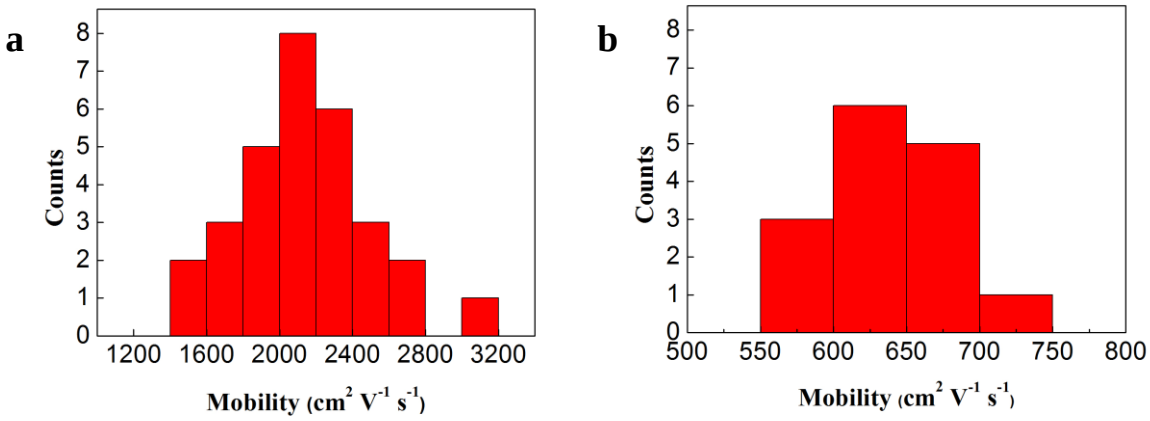

Figure S5. Histogram of mobility distribution from 15 CO_2-derived graphene devices (8 hexagon graphene devices and 7 round graphene devices). (a) Histogram of hole mobility distribution from 15 devices in air and N_2. (b) Histogram of electron mobility distribution from 15 devices in N_2.