The Pioneer of

CVD Graphene Commercialization

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GRAPHENE SQUARE

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Graphene Square, Inc. is a pioneer in the commercialization of graphene material and graphene films for use as a transparent conductor and in other electronics applications. Established in 2012 as a spin-off of the research of Prof. Byung Hee Hong at Seoul National University and with headquarters in Seoul, Korea.

Our mission is to be the world's first company commercializing CVD graphene technology and No.1 cost-competitive & best-quality graphene film supplier in both rigid and flexible electronic markets.

Business Areas

CVD Synthesis Systems

For researchers who want to synthesize their own graphene or 2D materials, Graphene Square markets a low-cost thermal CVD system that allows the users to easily begin synthesizing their own large-area, high-quality graphene and 2D materials samples in a lab environment. Graphene Square also provides training programs covering the current best practices for graphene growth, etching, patterning, and transfer. Other custom CVD systems are available for the synthesis of various 2D materials such as MoS2, WSe2, h-BN, etc.

Graphene Samples & Fab. Services

Using state-of-the-art chemical vapor deposition (CVD) methods developed in-house, Graphene Square offers the highest quality graphene samples currently on the market. In addition to the standard samples available online, Graphene Square can provide various fab. services including the sample transfer on the customers' own substrates as well as end-equipment prototype devices. Graphene Square also supplies graphene oxides (GOs) and graphene quantum dots (GQDs) for various biological, display, and energy researches.

IP Licensing & Consultant

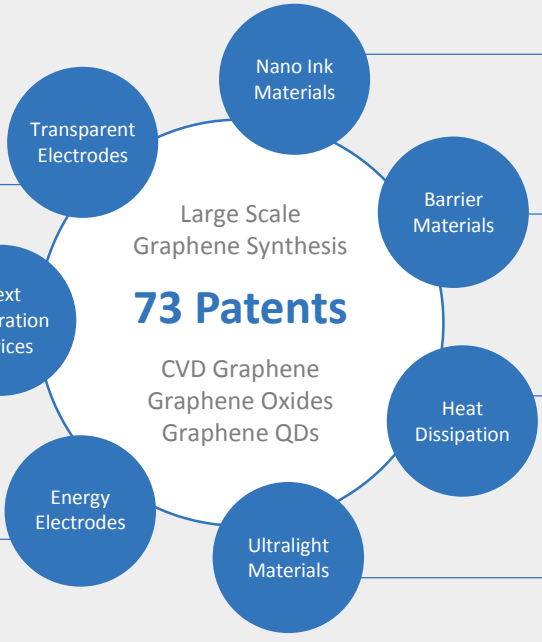
Graphene Square provides general consulting services and also licenses technology from its extensive patent portfolio, which has been recently highlighted by *Bloomberg* and *Businessweek*. Areas covered include: industrial graphene synthesis, transfer, and patterning using roll-to-roll techniques and their applications to current consumer electronic products as well as future applications including flexible and wearable electronics.

GSI's Patent Portfolio

15 Patent Flexible Displays
Touch Sensors

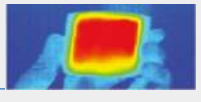
3 Patent Ultrahigh Speed
Transistors/
Photosensors RFID

13 Patent Solar Cells
Secondary Battery
Fuel Cells
Super Capacitors



3 Patent Flexible Displays
Touch Sensors

2 Patent Display Solar Cell
Anti-Oxidation
Heat Insulation



2 Patent LEDs, BLUs
ECUs &
PC Electronic

2 Patent Automobile &
Aerospace
Applications

CVD Systems for Graphene & 2D Materials

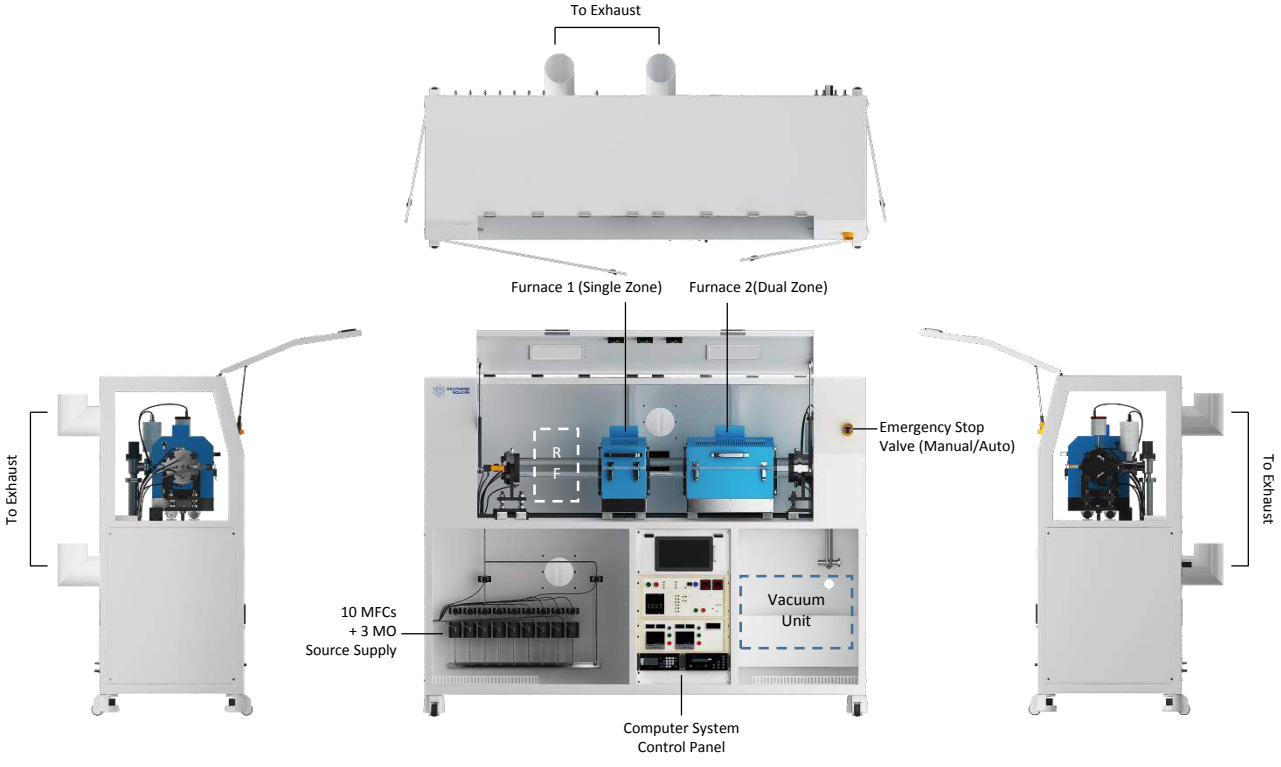
Sophisticated · Cost Effective · Reliable · Programmable Systems · for Highest Sample Quality
Fast Heating & Cooling · World's Best Training Service Available

The development of Graphene Square's CVD systems is based on the researches of Prof. Byung Hee Hong who reported the synthesis of large-area graphene by CVD for the first time in 2009. His continuous efforts toward the industrial synthesis of high-quality graphene enabled the development of most-reliable and cost-effective synthesis systems not only for graphene but also for h-BN and other 2D materials. The performance of our CVD systems for R&D have been proven by more than 100 systems installed across the world. Graphene Square also provides the world's best training service to researchers, including the latest synthesis, transfer, and patterning processes needed for the fabrication of the best-quality devices.

TCVD-RF100CA

Premium Custom-Designed System for TMDC & h-BN

Chemical vapor deposition (CVD) system for the syntheses of 2D materials at scales from a chip to a wafer, including the synthesis of **graphene, h-BN, TMDCs** on various substrates by use of gas-phase or solid precursors and metal-organic (MO) sources.



Features

- Size (mm): 2300(W) x 1770(H) x 750(D)
- Up to 10 gases and 3 MO sources for gas-phase synthesis.
- Motor-controlled movable heater for fast heating and cooling (patented).
- Fully computer-controlled programmable recipes.
- TCVD100 platform: Proven performance for ~100 systems for more than 5 years.
- Invited training for full sample preparation processes.

Customers / Demo Sites

Seoul National University
Graphene Research Center

ETH zürich IBM

IBM Zürich Nanotech Center

Technical Specification

CVD Reactor	• Tube type 4 inch diameter quartz
Substrate Size	• Lateral insertion of 10 mm to < 4 inch wafers possible. (Loading frames for small samples) • Rolled metallic foils can be loaded to synthesize A4 sized or larger 2D materials.
Heating	• Dual-zone heater and controller for graphene/h-BN synthesis. Single-zone precursor heater and Dual-zone deposition heater for TMDC synthesis. • The heaters are movable along two rails and the distance can be motor-controlled, enabling 10ºC/sec or faster temperature change rate.
Base Pressure	• 10^{-5} mbar (depending on the dryness of source)
Operating Pressure	• 10^{-3} mbar – 1 bar
Precursor	• Max 10 gas lines (ex. CH_4, C_2H_4, NH_3, B_2H_6, Ar, H_2, H_2S, H_2Se, N_2, O_2) + 2 extra ports. • Metal oxide sources of various transition metals placed in Heat Zone 1 for solid source growth.
Other metal organic (MO) sources	• Extra 3 Metal-Organic Source Injection Ports are included. (ex Mo(CO)6, Fe(CO)5) • Low-T cold trap for residual sources.
Flow control	• Precursor gases: 0.1 – 10 sccm • Other gases: 10 – 1000 sccm • Automatic flow control.
Vacuum	• Turbo pump 450 l/s (ISO160) < 10^{-6} mbar. • Dry scroll pump < 10^{-1} mbar. • Main Gate Valve Pneumatic type / Fore-line / roughing Angle Valve / Foamed bellows • By-pass pumping adaptor, clamp & centering.
T-measurement	• Standard Thermocouple (NIR calibrated)
Sample switching	• Position switching by sample loading stage.
System Control	• Control PC system (12" touch, dual core) • Serial Network module (4-ch) • Remote IO module (RS485) • System base programming / System recipe control module / System date file save module • Software upgrade support. • Gas valve, angle valve Open/Close / Rotary pump On/Off switch / Main power On/Off switch • Cooling water & air pressure switch.

TCVD-DC100CA

Premium Custom Design Dual CVD System with a Glove Box

Chemical vapor deposition (CVD) system for the syntheses of 2D materials at scales from a chip to a wafer, including the synthesis of **graphene, h-BN, TMDCs** on various substrates by use of gas-phase or solid precursors and metal-organic (MO) sources. The synthesized samples can be transferred to a glove box filled with inert gases for further processes without exposure to air environment.

Features

- Size(mm): 3000(W) x 1800(H) x 750(D)
- Up to 10 gases and 3 MO sources for gas-phase synthesis.
- Motor-controlled movable heater for fast heating and cooling (patented).
- Fully computer-controlled programmable recipes.
- TCVD100 platform: Proven performance for ~100 systems for more than 5 years.
- Invited training for full sample preparation processes from synthesis, etching, and transfer.
- Supply of high-quality source materials.
- 1 year warranty included (2 year extended warranty available)
- CVD chambers connected to a Glove Box. Free from air exposure.

Customers / Demo Sites

Seoul National University
Graphene Research Center

University of North Texas

Technical Specification

CVD Reactor	• Dual Tube type 4 inch diameter quartz. • Remote Microwave Plasma Module. • Connected to a Glove Box.
Substrate Size	• Lateral insertion of 10 mm to <4 inch wafers possible. (Loading frames for small samples) • Rolled metallic foils can be loaded to synthesize A4 sized or larger 2D materials.
Heating	• Dual-zone heater and controller for graphene/h-BN synthesis. Single-zone precursor heater and Dual-zone deposition heater for TMDC synthesis. • The heaters are movable along two rails and the distance can be motor-controlled, enabling 10ºC/sec or faster temperature change rate.
Base Pressure	• 10^{-5} mbar (depending on the dryness of source)
Operating Pressure	• 10^{-3} mbar – 1 bar
Precursor	• Max 10 gas lines (ex. CH_4, C_2H_4, NH_3, B_2H_6, Ar, H_2, H_2S, H_2Se, N_2, O_2) + 2 extra ports. • Metal oxide sources of various transition metals placed in Heat Zone 1 for solid source growth.
Other metal organic (MO) sources	• Extra 3 Metal-Organic Source Injection Ports are included. (ex Mo(CO)6, Fe(CO)5) • Low-T cold trap for residual sources.
Flow control	• Precursor gases: 0.1 – 10 sccm • Other gases: 10 – 1000 sccm • Automatic flow control.
Vacuum	• Turbo pump 450l/s (ISO160) < 10^{-6} mbar. • Dry scroll pump < 10^{-1} mbar. • Main Gate Valve Pneumatic type / Fore-line / roughing Angle Valve / Foamed bellows • By-pass pumping adaptor, clamp & centering.
T-measurement	• Standard Thermocouple (NIR calibrated)
Sample switching	• Position switching by sample loading stage.
System Control	• Control PC system (12" touch, dual core) • Serial Network module (4-ch) • Remote IO module (RS485) • System base programming / System recipe control module / System date file save module • Software upgrade support. • Gas valve, angle valve Open/Close / Rotary pump On/Off switch / Main power On/Off switch • Cooling water & air pressure switch.

TCVD-50B

2-Inch Table-Top Manual Type Thermal CVD

This small-size equipment has been developed on customers' demand for the lower cost but higher quality synthesis of graphene and 2D materials. TCVD-50B is the most ideal system for researchers who are limited in budget. The versatile specifications from fully manual to semi-automatic systems can be adjusted to fit the customers' budget. We recommend this system for training or laboratory classes, and the detailed instructing program and materials will be provided upon purchase.

Features

- Size(mm): 1500(W) x 893(H) x 590(D)
- Economic & space-saving model.
- Optimized for graphene, CNT, h-BN and TMDC growth.
- Water-cooled end chambers and doors.
- Process Temperature: ~1,100℃
- Protective design from heat
- Uniformity of Film Thickness: ≤+-3%
- Testing Uniformity: ≤+-3%
- Movable furnace method is our unique knowhow for fast heating and fast cooling of the sample

Customization

Furnace

- Single – 2 Heating Zones (Standard)
- Dual – 3 Heating Zones
- Single + RF M/W Module

Chamber Size

- 2 inch (Standard)
- 4 inch

Pumping Unit

- Oil Type Rotary Pump (Standard)
- Dry Scroll Pump
- Additional: Mechanical Turbo Pump

Gas Control Unit

- 3 MFCs +1 Spare (Standard)
- Up to 5 MFCs

Warranty

- 1 year – Included (Standard)
- 2 years – Optional

TCVD-100A

Standard 4-Inch Thermal CVD System with a Safety Cabinet

TCVD-100A is a very sophisticated and cost effective CVD system that can be equipped with semi-automatic or fully programmable gas-flow and temperature control modules. It is the most ideal equipment for the synthesis of high quality graphene and h-BNs, which can be easily extended to various 2D materials synthesis. The safety cabinet that covers the whole system protects users from any hazardous event, and the emergency stop button will ensure the safety even further.

Features

- Size(mm): 1750(W) x 1585(H) x 750(D)
- Advanced Semi-Auto System
- Optimized for graphene, CNT, h-BN and TMDC growth
- Water-cooled end chambers and doors
- Process Temperature: ~1,100℃
- Uniformity of Film Thickness: ≤+-3%
- Testing Uniformity: ≤+-3%
- Movable furnace method is our unique knowhow for fast heating and fast cooling of the sample
- Standard safety box

Customization

Furnace

- Single – 2 Heating Zones (Standard)
- Dual – 3 Heating Zones
- Single + RF M/W Module

Chamber Size

- 2 inch
- 4 inch (Standard)
- 6 inch
- 8 inch

Pumping Unit

- Oil Type Rotary Pump (Standard)
- Dry Scroll Pump
- Additional: Mechanical Turbo Pump

Gas Control Unit

- 3 MFCs +1 Spare (Standard)
- Up to 8 MFCs

Warranty

- 1 year – Included (Standard)
- 2 years – Optional

Customers

World-wide customers in US, EU, Middle East, and Asia countries.

	Graphene	h-BN	TMDC
# sales	~100 systems	8 systems	10 systems
Clients			

Proven performance in more than 100 systems installed in Korea.

TCVD-D100CA

4-Inch Automatic Dual-Furnace CVD System for TMDC Synthesis

TCVD-D100CA is an advanced equipment dedicated to the growth of TMDC materials such as MoS_2, WSe_2, etc. The computer-aided controlling module promises the reliable growth condition for multiple users. The movable dual furnace system enables the fast heating and fast cooling of source materials and substrates, which is important for the synthesis of higher quality TMDCs. The safety housing with emergency alarm/stop functions will ensure the safe operation by users.

Features

- Size(mm): 2300(W) x 1770(H) x 750(D)
- Advanced Computer Controlled Automatic System
- Optimized for graphene, CNT, h-BN and TMDC growth
- Water-cooled end chambers and doors
- Process Temperature: ~1,100℃
- Uniformity of Film Thickness: ≤+-3%
- Testing Uniformity: ≤+-3%
- Movable furnace method is our unique knowhow for fast heating and fast cooling of the sample.
- Standard safety box

* Price will be determined after consultation. (Different customization from the standard parts will affect the overall price.)

Customization

Furnace

- Single – 2 Heating Zones
- Dual – 3 Heating Zones (Standard)
- Triple – 4 Heating Zones
- Single or Dual + RF M/W Module

Chamber Size

- 2 inch
- 4 inch (Standard)
- 6 inch
- 8 inch

Pumping Unit

- Oil Type Rotary Pump (Standard)
- Dry Scroll Pump
- Additional: Mechanical Turbo Pump

Gas Control Unit

- 3 MFCs +1 Spare (Standard)
- Up to 10 MFCs

Warranty

- 1 year – Included (Standard)
- 2 years – Optional

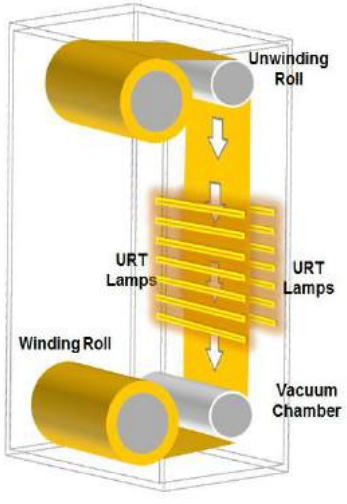
Customers

Institute for Basic Science

TCVD-V200A

8-Inch Rapid Thermal Vertical Roll-to-Roll System

Graphene Square was the first group to publish paper on Roll-to-Roll(R2R) method for mass production of graphene. TCVD-V200A is a vertical tube type equipment that enables the large scale deposition of graphene film.



In-Chamber Roll-to-Roll

Features

- Size(mm): 1500(W) x 2500(H) x 1000(D)
- Advanced Semi-Auto Vertical Tube Roll-to-Roll System
- Optimized for large graphene synthesis
- Rapid heating furnace reaches 1,000℃ in 5 min.
- Water-cooled end chambers and doors
- Process Temperature: ~1,100℃
- Uniformity of Film Thickness: ≤+-3%
- Testing Uniformity: ≤+-3%
- Rapid heating and automatic rolling system is the ideal the first stage of graphene mass production.
- Standard safety box

* Price will be determined after consultation. (Different customization from the standard parts will affect the overall price.)

Customization

Furnace

- Single – 8 Heating Zones (Only Option)

Chamber Size

- 8 inch (Only Option)

Pumping Unit

- Oil Type Rotary Pump (Standard)
- Dry Scroll Pump
- Additional: Mechanical Turbo Pump

Gas Control Unit

- 3 MFCs +1 Spare (Standard)
- Up to 5 MFCs

Warranty

- 1 year – Included (Standard)
- 2 years – Optional

Customers

LG

MELFAS
making electronics friendly and smart

Graphene Samples

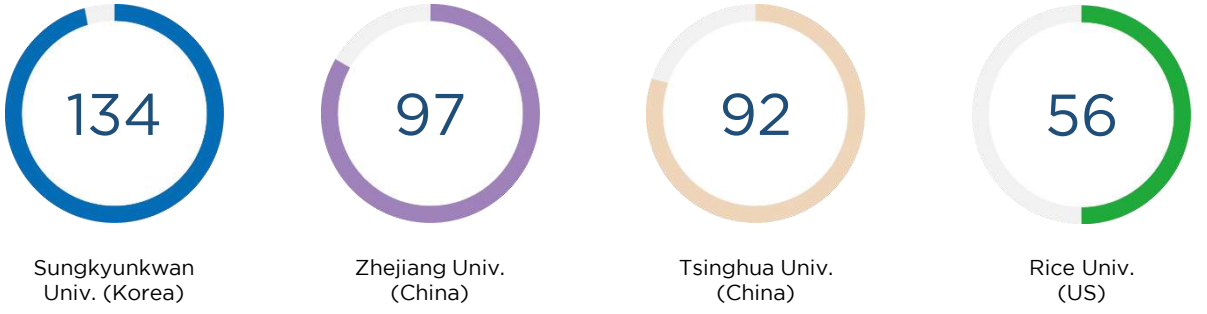
The Highest Quality CVD Graphene Films on Custom Substrates · Graphene Oxides (GOs)
Graphene Quantum Dots (GQDs) · Consumables for Graphene Researches

Using state-of-the-art chemical vapor deposition (CVD) methods developed in-house, Graphene Square offers the highest quality graphene samples currently on the market. In addition to the standard samples available online, Graphene Square can provide various fab. services including the sample transfer on the customers' own substrates as well as end-equipment prototype devices. Graphene Square also supplies graphene oxides (GOs) and graphene quantum dots (GQDs) applicable to various biological, display, and energy researches.

IP Development & Licensing

Sungkyunkwan Univ. (SKKU) famous for the world's most graphene patent applications has transferred the most important graphene-related 42 patents to Graphene Square Inc. in 2012.

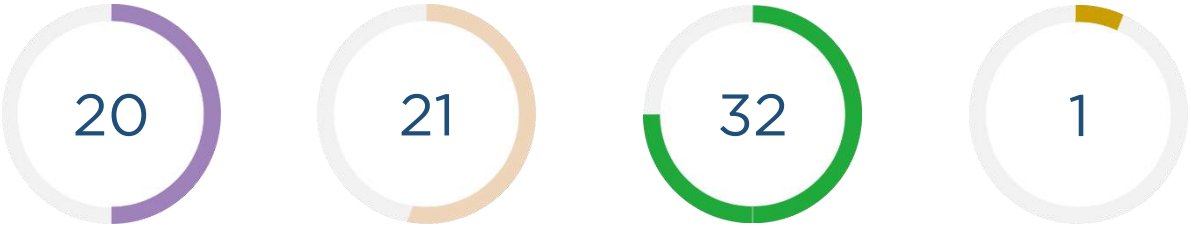
BBC News "Graphene : patent surge reveals global race



Sungkyunkwan Univ. (Korea) | Zhejiang Univ. (China) | Tsinghua Univ. (China) | Rice Univ. (US)

MIT (US) | Manchester Univ.

Graphene Square's IPs (June 20, 2014)



Registered Patents | Applied Patents (Domestic) | Applied Patents (International) | Registered Design (GSI Logo)

GSI's Key Patents Highlighted by Bloomberg & Businessweek

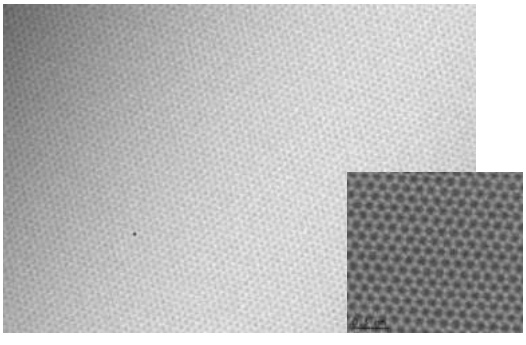
"Hong's patents are key in making cost-efficient, large-scale graphene for touchscreen panels in mass volume."

(Samsung-Apple Smartphone Battleground Is Single Atom Thick May 15, 2014, Bloomberg.com)

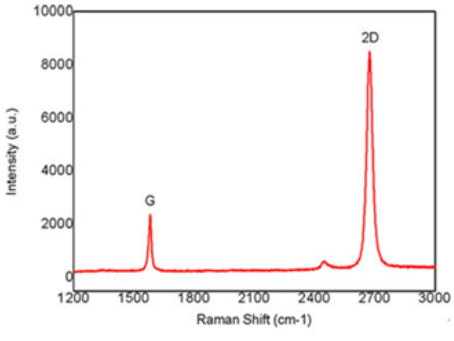
CVD Graphene on Cu foils

Product Size	Up to 500x600㎟
Film Morphology	Continuous Monolayer (>95%)
Sheet Resistance	-
Mobility	>3500cm²/Vs
Transmittance	>97%
Substrate	Cu foil (35㎛ thick)
Domain Size	10-20 ㎛

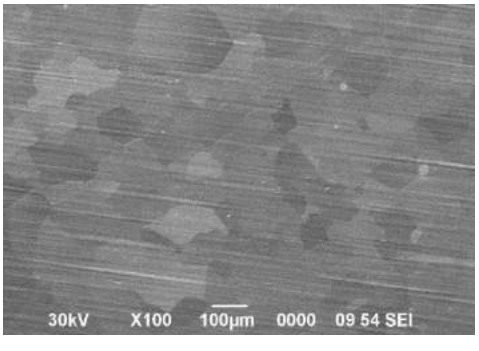
High-Resolution TEM Images



Raman Spectrum (after transfer)



SEM Image of Graphene on Cu



Reference

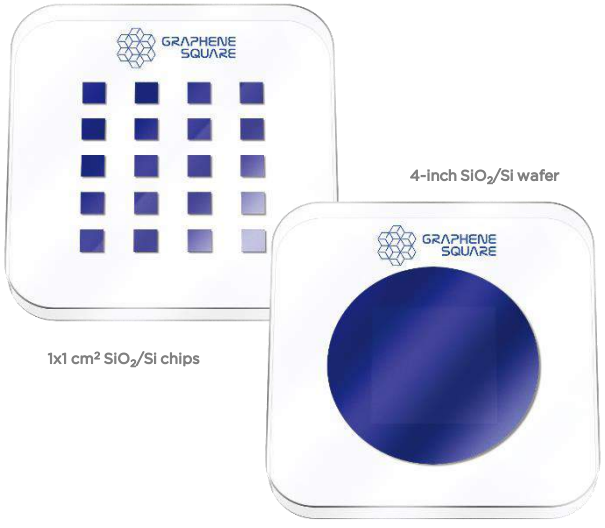
(1) S. Bae*, H. Kim* *et al.* **Roll-to-roll production of 30 inch graphene films for transparent electrodes** *Nature Nanotech*. **5**, 574 (2010).

(2) Y. Lee *et al.* **Wafer-Scale Synthesis and Transfer of Graphene Films**.*Nano Lett.* **10**, 490-493 (2010).

(3) H.-A-S. Shin *et al.* **Graphene-induced Unusual Microstructural Evolution in Ag Plated Cu Foils.** *Nanoscale* **6**, 7209-7214 (2014).

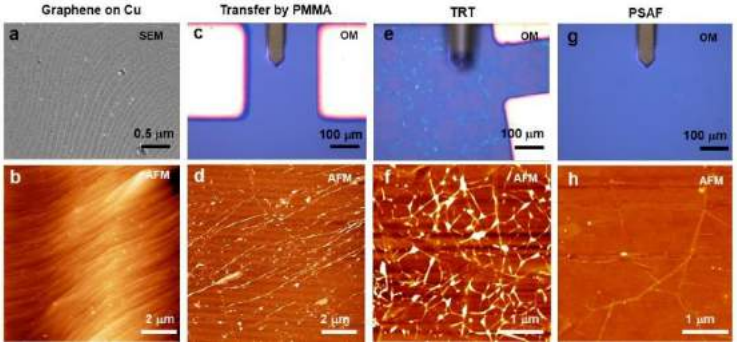
(4) Hae-A-Seul Shin*, Jaychul Ryu* *et al.* **Highly Uniform Growth of Monolayer Graphene by Chemical Vapor Deposition on Cu-Ag Alloy Catalysts.** *Phys. Chem. Chem. Phys.* **16**, 3087-3094 (2014).

Ultra-Clean Graphene on SiO_2/Si Wafers

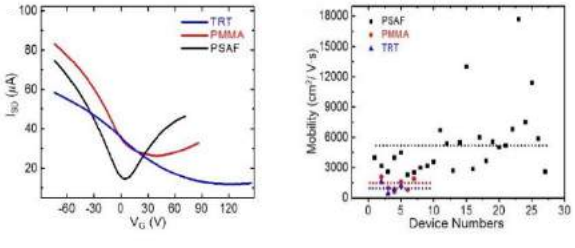


Product Size	Up to 90 x 90 ㎟ (Max)
Film Morphology	Continuous Monolayer (>95%)
Sheet Resistance	Av. < 250~400 Ω/sq
Mobility	>3500 cm^2/Vs (Max. 17,000 cm^2/Vs)
Transmittance	>97%
Substrate	SiO_2(300nm)/Si wafer (Standard)
Domain Size	10-20 ㎛

Ultra-Clean Transfer by Pressure Sensitive Adhesive Films



Electrical Properties



Reference

(1) S. Kim *et. al*. **Ultra-Clean Patterned Transfer of Single-Layer Graphene by Recyclable Pressure Sensitive Adhesive Films.** *Nano Lett.* (accepted).

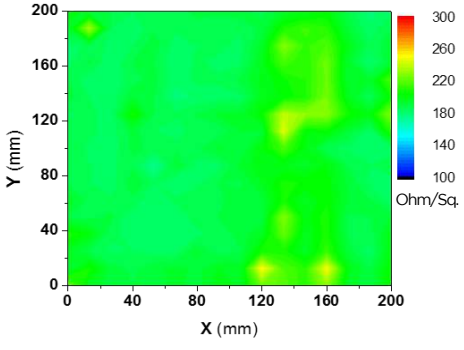
(2) S. Bae*, H. Kim* *et al*. **Roll-to-roll production of 30 inch graphene films for transparent electrodes** *Nature Nanotech*. **5**, 574 (2010).

Graphene on PET

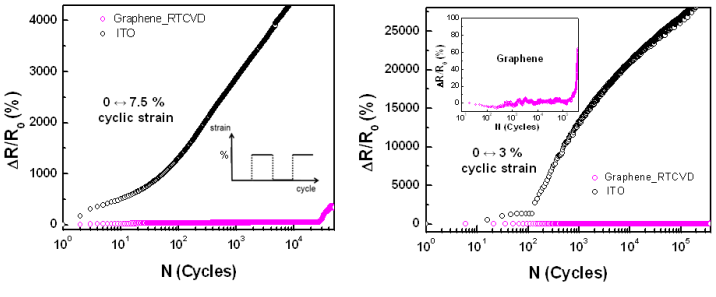
Product Size	Up to 500 x 600 ㎟
Film Morphology	Continuous Monolayer (>95%)
Sheet Resistance	Av. < 250~400 Ω/sq
Mobility	>3500 cm^2/Vs
Transmittance	>97%
Substrate	PET (188㎛) (Standard)
Domain Size	10-20 ㎛

Application of Graphene on PET for Flexible Touch Screen

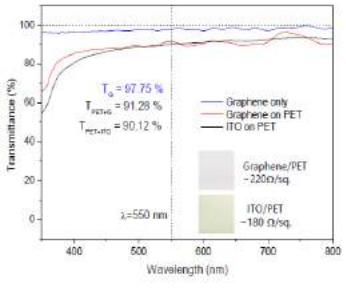
Sheet Resistance Uniformity



Mechanical Properties of Graphene on PET



Optical Transmittance



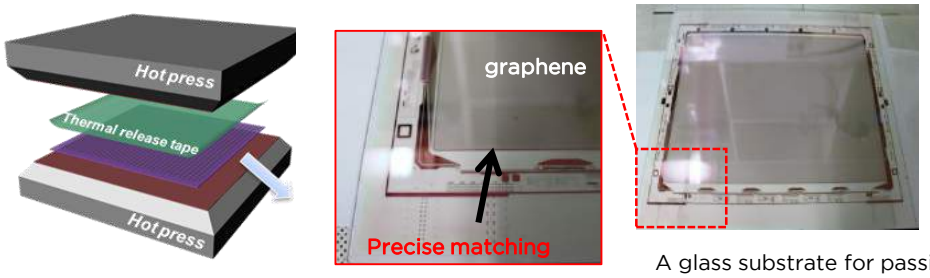
Reference

J.-H. Ahn & B. H. Hong **Graphene for displays that bend.** *Nature Nanotech*. **9**, 737-738 (2014).

Graphene on Glass

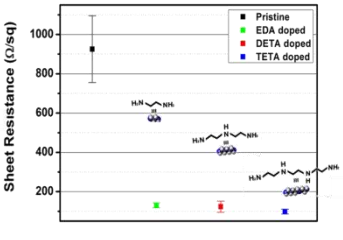
Product Size	Up to 80 x 150 ㎟
Film Morphology	Continuous Monolayer (>95%)
Sheet Resistance	Av. < 250~400 Ω/sq
Mobility	>3500 cm^2/Vs
Transmittance	>97%
Substrate	Glass (variable thickness)
Domain Size	10-30 ㎛

Transfer of Graphene onto Rigid Substrates by Hot Pressing



A glass substrate for passive matrix LCDs

N-doped Graphene for Low Sheet Resistance Applications



	Pristine	EDA doped	DETA doped	TETA doped
Dirac Voltage (Vg)	1.37 ± 2.27	-126.64 ± 6.06	-166.37 ± 1.78	-192.27 ± 6.49
Carrier concentration(10^{13})	0.01 ± 0.016	-0.912 ± 0.043	-1.198 ± 0.013	-1.384 ± 0.047
Mobility(h) [cm^2/Vs]	6219 ± 1288			
Mobility(e) [cm^2/Vs]	3809 ± 876	3711 ± 913	3388 ± 531	2817 ± 475
Sheet resistance (Ohm/sq)	925 ± 170	130 ± 12	124 ± 28	98 ± 12

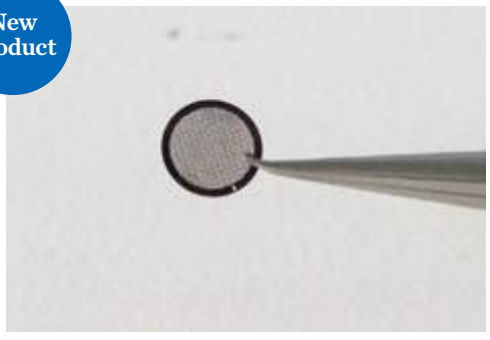
Reference

(1) J. Kang *et al.* **Efficient Transfer of Large-Area Graphene Films onto Rigid Substrates by Hot Pressing**. *ACS Nano* **6,** 53060-5365 (2012)

(2) Y. Kim *et al.* **Vapor-Phase Molecular Doping of Graphene for High-Performance Transparent Electrodes**. *ACS Nano*, **8** , 868–874 (2014).

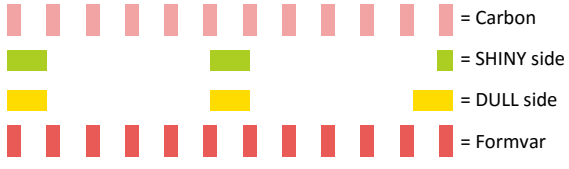
CVD-Graphene on TEM Grid

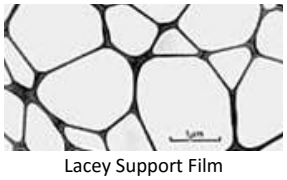
New Product



TEM Grid	Graphene
Grid Hole Size : 63µm	Sheet Resistance : Av. < 250~400 Ω/sq
Lacey Carbon Type-A	Mobility : >3500cm2/Vs (Max. 17,000 cm2/Vs)
300 mesh	Transmittance : >97%
Copper frame	Coverage : <30% (PMMA-free), <60% (2-layers)

Grid Cross Section

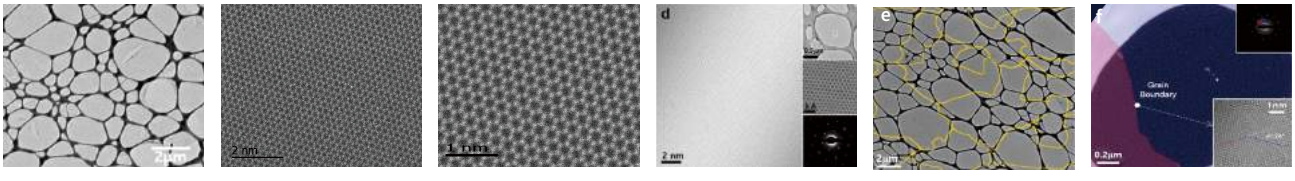



Lacey Support Film


Bare TEM Grid

Lacey carbon Type A : The Lacey formvar film is applied to the dull side of the grid and carbon deposited onto the shiny side. When the formvar is removed in solvent the carbon film is left on the shiny side.

Measurement data



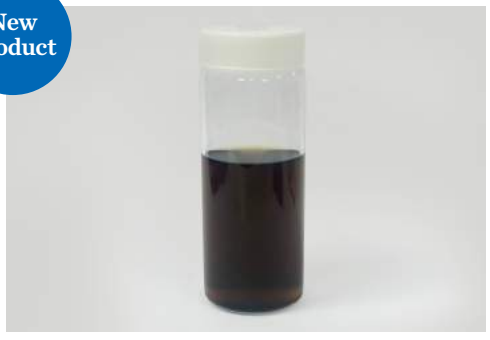
(d) HR-TEM results showing the atomic lattice structures of RT-CVD graphene. The graphene samples were prepared with holey carbon grid (upper inset). The aberration-corrected scanning TEM image provides an atom-by-atom analysis of graphene (mid inset). The diffraction pattern indicates the corresponding graphene is a highly crystalline monolayer (lower inset). (e) Graphene domain distribution investigated by selected area diffraction patterns (SADP) and TEM imaging. (f) Graphene boundaries of RT-CVD graphene characterized by dark-field TEM and aberration-corrected HR-TEM images . The left and right parts of the grain boundary are imaged with an aperture at the red and blue circled spots of the diffraction pattern (upper inset). The atomic image shows that two graphene domains are smoothly connected with an angle of 36° (lower inset). See also Supporting Figure S2 for more dark-field TEM analyses.

Reference

(1)Kim, Sang Jin, et al. "**Simultaneous etching and doping by Cu-stabilizing agent for high-performance graphene-based transparent electrodes.**" *Chemistry of Materials* 26.**7** (2014): 2332-2336.
(2)Ryu, Jaechul, et al. "**Fast synthesis of high-performance graphene films by hydrogen-free rapid thermal chemical vapor deposition.**" *ACS nano* **8**.1 (2014): 950-956.

Graphene Quantum Dot

New Product



Properties

- Solvent : DIW
- Concentration : 0.5g/L
- Flake size : <10nm
- Thickness : 1 atomic layer - at least 60%
- Color : Brown

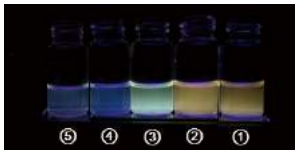
Production Method

Top-down method (by Carbon fiber)

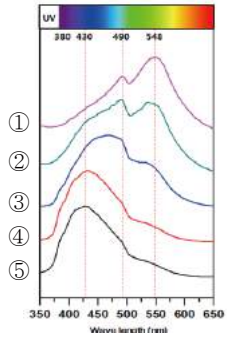
Applications

- Nanocomposite materials
- Graphene based field effect transistor (GFET)
- Energy conversion & storage
- Chemical reaction catalyst
- Drug delivery carrier
- Tissue engineering

Measurement data



Photograph under UV light



Photoluminescence (PL) spectra

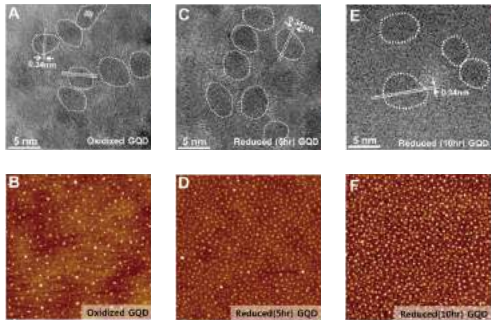
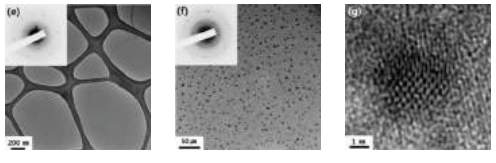


Figure 3. TEM and AFM images of GOQDs (A, B), 5 h reduced GQDs (C, D), and 10 h reduced GQDs (E, F), respectively. The AFM scan ranges are 3 ㎛ X 3㎛.



(e) TEM image of monolayer graphene supported by holely carbon grids. (f, g) Low and high-resolution TEM images of N-GQSs on a graphene-supported grid.

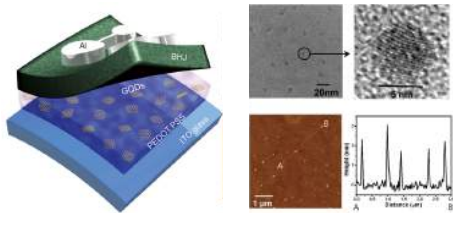


Figure 1. Schematic of device, and TEM and AFM images of GQDs. Schematic of OPV device with a GQD-incorporated PEDOT:PSS layer, and TEM images of the GQDs. The scale bar is 20nm on the TEM image, and 5nm on the inset image. AFM image of GQDs (5㎛ by 5㎛) and height distribution from A to B.

Reference

(1) J. Moon et al. **One-Step Synthesis of N-Doped Graphene Quantum Sheets from Monolayer Graphene by Nitrogen Plasma.** *Adv. Mater*. **26**, 3501–3505 (2014).
(2) Jung Kyu Kim*, Sangjin Kim* et al. **Graphene Quantum Dots Incorporated Hole Extraction Layer for Efficient Organic Photovoltaics.** *Sci. Rep*. **5**, 14276

Graphene Square in Global Market, As the Leader of Graphene Commercialization

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All about Graphene

Graphene Square, Inc. is a pioneer in the commercialization of graphene material and graphene films for use as a transparent conductor and in other electronics applications. Established as a spin-off of the research of Prof. Byung Hee Hong at Seoul National University and with headquarters in Seoul, Korea. Graphene Square will continue to stay as the world leader of the graphene commercialization research, also will continue to provide the best quality graphene and equipment to all over the world for the continuous development of carbon and 2D materials for the bright future of the science & technology for mankind.

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