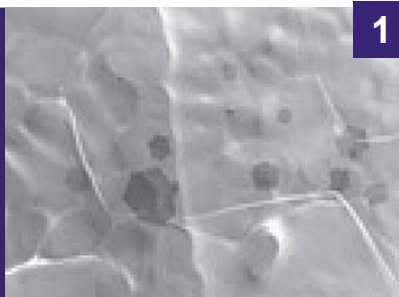


HSMG® is sold under license for research purposes only. U.S. Patent no. 9,284,640 B2.

Monolayer High Strength Metallurgical Graphene, HSMG®

| | | |
|----------------|--|------|
| 06-0345 | Monolayer High Strength Metallurgical Graphene, HSMG®, on PMMA (10x10 mm) | 1 pc |
| 06-0355 | Monolayer High Strength Metallurgical Graphene, HSMG®, on PMMA (25x25 mm) | 1 pc |
| 06-0360 | Monolayer High Strength Metallurgical Graphene, HSMG®, on PMMA (50x50 mm) | 1 pc |
| 06-0365 | Monolayer High Strength Metallurgical Graphene, HSMG®, on GLASS (10x10 mm) | 1 pc |

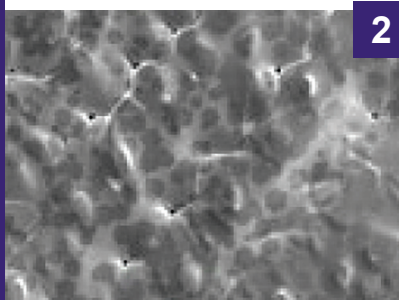
HSMG® GROWTH PROCESS



1

Absorption and incorporation of carbon atoms into the crystal structure of the copper matrix occurs during the carburization process. Maximum carbon content is significantly lower for liquid copper matrix than for solid state matrix, therefore, after heating above the melting point, the metal matrix becomes supersaturated with carbon atoms. **HSMG® growth is based on the controlled carbon precipitation from the liquid metal matrix.**

The growth process originates with nucleation of single hexagonal flakes on the metallic substrate. Liquid matrix enables grain rotation and rearrangement during nucleation process which results in larger grain sizes and improved graphene properties. This process is fully controlled and enables the production of graphene sheets with specified number of layers.

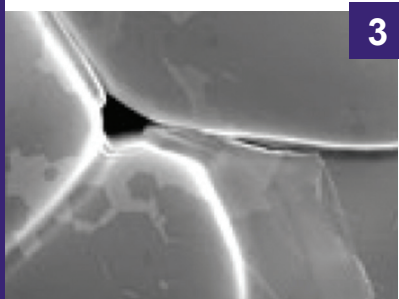


2

STABLE NEGATIVE THERMAL COEFFICIENT

The HSMG® samples show anti-phase temperature resistance relationships during cyclic tests.

HSMG® Temperature coefficient of resistance
 $-1.7 \cdot 10^{-3} \div -4 \cdot 10^{-4} [1/K]$



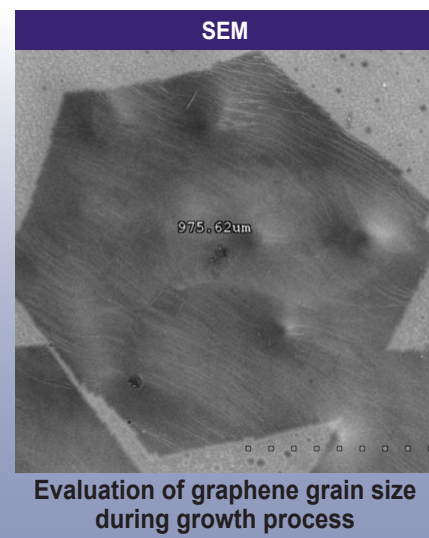
3

EFFICIENT GAS ABSORPTION

HSMG® shows susceptibility to reversible gas sorption (including selective hydrogen sorption from gas mixture) which enables application of HSMG® as the functional material for future gas sensors.



4



Visit www.strem.com for new product information and a searchable catalog.

Strem Chemicals, Inc.
 7 Mulliken Way
 Newburyport, MA 01950
 U.S.A
 Tel: 978.499.1600
 Fax: 978.465.3104
 Email: info@strem.com

Strem Chemicals, Inc.
 15, rue de l'Atome
 Zone Industrielle
 67800 BISCHEIM France
 Tel: (33) 03 88 62 52 60
 Fax: (33) 03 88 62 26 81
 Email: info.europe@strem.com

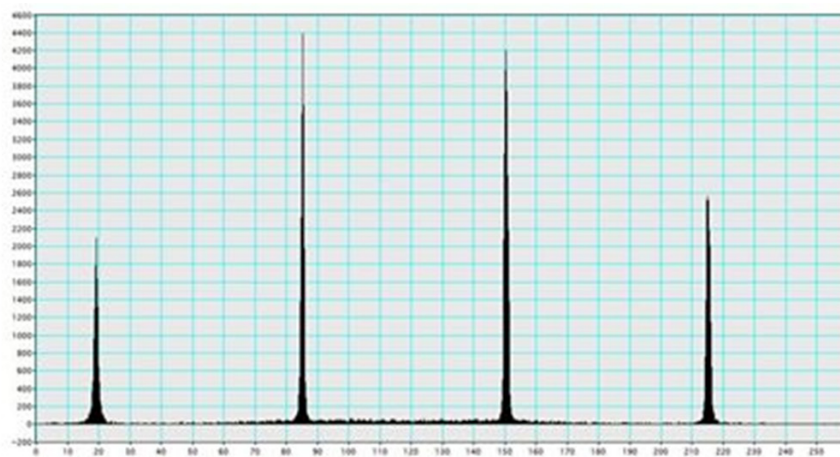
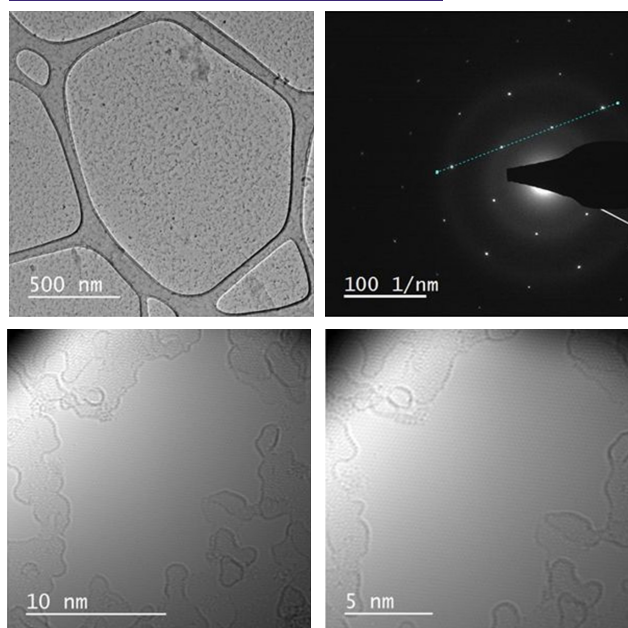
Strem Chemicals, Inc.
 Postfach 1215
 77672 KEHL
 Germany
 Tel: 0 78 51/ 7 58 79
 Email: info.europe@strem.com

Strem Chemicals UK Ltd.
 An Independent Distributor of Strem Chemicals Products
 Newton Hall, Town Street
 Newton, Cambridge
 England CB22 7ZE
 Tel: +44 (0)1223 873 028
 Fax: +44 (0)1223 870207
 Email: enquiries@strem.co.uk

PRODUCT DATA

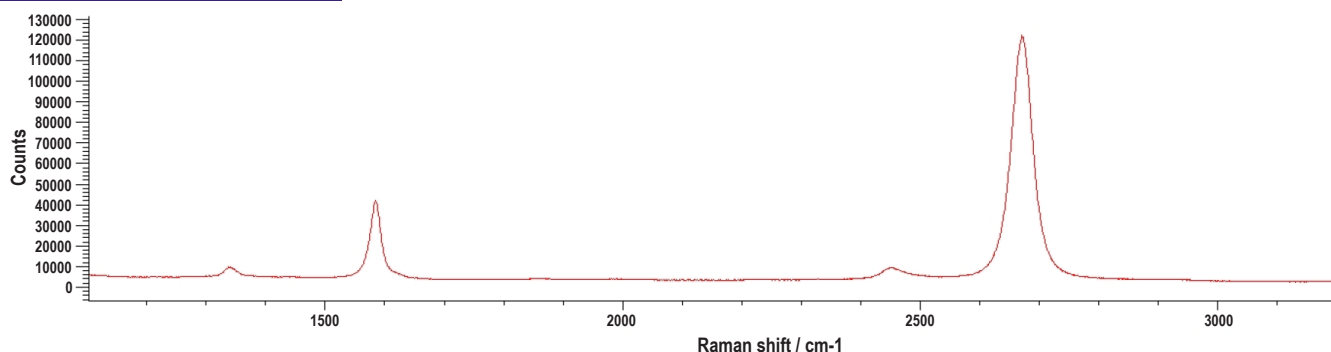
| | |
|--|---|
| GROWTH METHOD | Metallurgical graphene growth on liquid metal |
| STANDARD SUBSTRATES | PMMA, Si/SiO ₂ , quartz |
| TRANSFER AVAILABILITY | Transfer on custom substrates available upon request |
| QUALITY CONTROL | Raman spectroscopy Optical microscopy SEM microscopy |
| FORM | Graphene film |
| GRAIN SIZE | Up to 1mm |
| COVERAGE* | >95% |
| OPTICAL TRANSMITTANCE* | >97% (measured on quartz with UV-Vis method) |
| THICKNESS (THEORETICAL) | 0.345 nm |
| AVERAGE SHEET RESISTANCE* | <250 Ω/cm ² (measured on Si/SiO ₂ with van der Pauw method) |
| *values confirmed by EIT+ Wroclaw Research Centre independent product evaluation study | |

TEM*



HSMG® suspended on TEM grids

Raman spectroscopy



Visit www.strem.com for new product information and a searchable catalog.

Strem Chemicals, Inc.
7 Mulliken Way
Newburyport, MA 01950
U.S.A
Tel: 978.499.1600
Fax: 978.465.3104
Email: info@strem.com

Strem Chemicals, Inc.
15, rue de l'Atome
Zone Industrielle
67800 BISCHEIM France
Tel: (33) 03 88 62 52 60
Fax: (33) 03 88 62 26 81
Email: info.europe@strem.com

Strem Chemicals, Inc.
Postfach 1215
77672 KEHL
Germany
Tel: 0 78 51/ 7 58 79
Email: info.europe@strem.com

Strem Chemicals UK Ltd.
An Independent Distributor of Strem Chemicals Products
Newton Hall, Town Street
Newton, Cambridge
England CB22 7ZE
Tel: +44 (0)1223 873 028
Fax: +44 (0)1223 870207
Email: enquiries@strem.co.uk