SETTING THE STANDARD FOR THE GRAPHENE REVOLUTION

STANDARD GRAPHENE
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   ① Water treatment
   ② Textile coating
   ③ Heat dissipation coating

3. Others
Company overview
Company overview

Name
STANDARD GRAPHENE

Web
http://standardgraphene.com/

CEO
Lee, JoungHoon

Established
Feb 9th, 2012

Address
413 Fine Chemical & Material Technical Institute, Techno Park Jongga-ro 15, Jung-gu, Ulsan, Korea

Main Product
GO, rGO

Capacity
2.5 ton/year
Characteristics of GO/rGO

Graphite

GO

rGO

Oxygen content: ~10%

Oxygen content: ~50%

Thickness: 1~1.7 nm (typically monolayer)

Thickness: 1~2 nm (3-6 layers)
Potential application of Graphene is limitless across many sectors such as...

- **Energy**: Secondary Battery, Super-Capacitor, Thermal energy management, Dye-Sensitized Solar Cell
- **Composite & Coating**: Airplane Parts, Aerospace Coating, Lightweight/Sound-absorption Material
- **Electronic Devices**: Bistable Memory Semi Conductor Resonator, Veselago Lens
- **Display**: Flexible Transparent Electrode
- **Biotech**: ECG Electrode
- **Water Filtration**: Drinking Water Purification, Wastewater Treatment

Potential application of Graphene is limitless across many sectors such as...
Applications

1. Water treatment
2. Textile coatings
3. Heat dissipation coating
**Super Graphite**

What is **Super Graphite**?

Super Graphite is a micro-sized carbon material, developed by STANDARD GRAPHENE’s core technology for Water Treatments.

- **Features**
  - No turbidity build-up material
  - Excellent color, COD, and turbidity removal
  - Ammonia Nitrogen, T-P removable

- **Applications**
  - Industrial Wastewater Treatment (Color Wastewater, etc.)
  - Water Treatment Plant
  - Pre-/Post-processing of pre-installed processes
Water treatment facility installation (2019.06, Nepal)

In preparations:

- Additional water purification facilities in Nepal (delayed by COVID19)
- Village water purification facility in old towns with aging facilities (Korea)
Super Graphite composite filters

Filter module, systems

Super Graphite Carbon Block

- Various types of block filters under development
Water treatment test results

**Color (Pt-Co) Removal Rate Result**

- SG: 100% Removed
- Sample A: 95%
- Sample B: 80%
- Sample C: 75%

**Turbidity (NTU) Measurement Result**

- SG: 100% Removed
- Sample A: 95%
- Sample B: 80%
- Sample C: 75%

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Dye Waste Water</th>
<th>Purified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity (NTU)</td>
<td>6.37</td>
<td>0</td>
</tr>
<tr>
<td>COD</td>
<td>235</td>
<td>20</td>
</tr>
<tr>
<td>Hardness</td>
<td>294</td>
<td>128</td>
</tr>
<tr>
<td>Ammonia</td>
<td>3.1</td>
<td>1.9</td>
</tr>
<tr>
<td>TDS</td>
<td>5,600</td>
<td>3,990</td>
</tr>
<tr>
<td>Electric Conductivity (mS/cm²)</td>
<td>12.9</td>
<td>10.2</td>
</tr>
</tbody>
</table>

**COD Removal**

- COD Removal Rate [%] vs. Accumulated Treated Flow [L]

**Color Removal**

- Color Removal Rate [%] vs. Accumulated Treated Flow [L]

**Escherichia Coli Counts Result**

- Before Treatment: 800,000
- SG Product: 300
  - 99.97% Removed

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Applications

1. Water treatment
2. Textile coatings
3. Heat dissipation coating
Test Report

7. Test Results

<table>
<thead>
<tr>
<th>Test Items</th>
<th>Test Method</th>
<th>Test Results</th>
<th>Testing Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Early Conc. (CPU/mL)</td>
<td>After 24h Conc. (CPU/mL)</td>
</tr>
<tr>
<td>Antibacterial</td>
<td>BLANK</td>
<td>1.2 x 10^8</td>
<td>9.2 x 10^7</td>
</tr>
<tr>
<td>test: Staphylococcus aureus</td>
<td>KCL-FIR-1003</td>
<td>1.2 x 10^8</td>
<td>&lt; 10</td>
</tr>
<tr>
<td></td>
<td>BLANK</td>
<td>1.0 x 10^8</td>
<td>5.6 x 10^7</td>
</tr>
<tr>
<td>Antibacterial</td>
<td>BLANK</td>
<td>1.0 x 10^8</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>test: Klebsiella pneumoniae</td>
<td>Graphene Film (50g SB)</td>
<td>1.0 x 10^8</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>

* CFU: Colony Forming Unit
* Incubum concentration (CPU/mL): Staphylococcus aureus: 1.2 x 10^8
  Klebsiella pneumoniae: 1.0 x 10^8
* Test strain: Staphylococcus aureus ATCC 6538P
  Klebsiella pneumoniae ATCC 4932
* Sample: 5 cm x 5 cm. Blank: Sterilizer film: 5 cm x 5 cm
* Location: unit106, Industry-Academic Cooperation Foundation, Hankyong National University,
  327, Jungang-ro, Ansaeong-si, Gyunggi-do, 17576, Korea

Institute: KCL
Test standard: KCL-FIR-1003:2018
Specimen fabrication: GO spray coating to filter sheet
Product: GO-V50, Standardgraphene, Inc.
Amount: 0.334 mg/200 cm²
<table>
<thead>
<tr>
<th></th>
<th>After graphene coating</th>
<th>Cotton</th>
<th>Wool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before laundry</td>
<td></td>
<td>890 V</td>
<td>620 V</td>
</tr>
<tr>
<td>After laundry</td>
<td></td>
<td>120 V</td>
<td>58 V</td>
</tr>
</tbody>
</table>
Applications

1. Water treatment
2. Textile coatings
3. Heat dissipation coating
Heat sink coatings

- The malfunction of electric device is mainly due to heat (55%) and humidity (19%).

- Graphene coating can enhance the thermal performance of heat sinks with higher thermal conductivity than conventional paints.

5°C of Reduction on average

For LED chip with the power consumption of 21 W, LED
Heat Sink with SG product can reduce 5°C (of LED heat) on average compared to reference coating module.
TIM (Thermal Interface Material)

Various types of TIMs; images extracted from google

Laser-flash method is used to measure the thermal conductivity $k$ value of typical commercially-available TIMs: 3-4 W/m-K

RoHS, CE underway
**Possible mechanism**

- **Heat**
- **Medium**

**Radiation**

**Convection**

**Conduction**

\[ q = \varepsilon \sigma T^4 \]  
(Stephan-Boltzmann's equation)

Emittance

(Matullii et al, 2020)

- **GO 0.005%**

(Nika et al., 2016)
Others
KRISS (Korean NIST) CRM approval

BET measurement

1 - Degas
2 - Evacuate
3 - Volume
4 - Evacuate
5 - Adsorption
6 - Desorption

- Heat and evacuate (or add N2)
- Evacuate to tubes
- Measure dead volume with He
- Add N2 to tubes
- Evacuate N2 for adsorption isotherm
- Evacuate N2 for desorption isotherm

CRM (Certification of Reference Material) approval for BET measurement

First ‘made in Korea’ nanomaterial approved by KRISS
WHO officially designated as an experimental institution for drinking water and water purifiers

NSF International's most prestigious certification mark for water

NSF/ANSI/CAN 61 Drinking Water System Components - Health Effects

- Standards for evaluating material safety for water products and materials
- Confirm that human harmful substances exposed through contact with drinking water were detected below the allowable standards
- Passed 104 review items

NSF/ANSI 42 Drinking Water Treatment Units - Aesthetic Effects

- Evaluation of water purifier finished products and related parts according to water purifier standards
- Meets the criteria by evaluating the safety of materials through the chemical dissolution test
- Passed 141 review items

First in graphene industry NSF/ANSI401 testing underway
Thank you