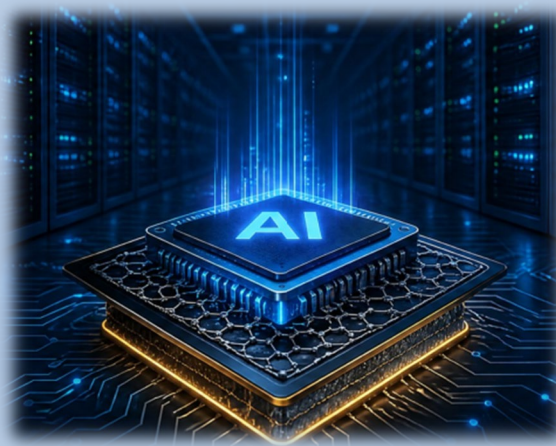




GLOBAL GRAPHENE GROUP (G3)

Powering the AI Revolution

Graphene-Enabled Thermal Management Solutions for AI Data Centers

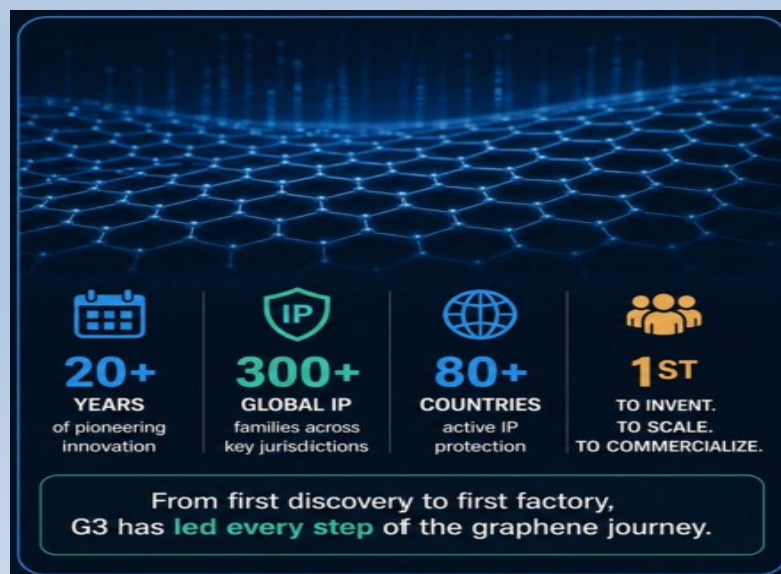


Patent-Protected

The Ultimate Material Meets Urgent Needs of AI Data Centers

Key Advances in Graphene Thermal Management

- G3 filed the world's first patents on pristine single-layer graphene in 2002, two years before Nobel Prize winners published in Science, marking a foundational innovation in the field.
- North American investment in AI hardware is rapidly increasing, but physical heat dissipation limits pose severe challenges to scaling AI compute power.
- G3's patented graphene technology offers a unique solution to the growing thermal-management challenge in AI data centers, enabling more efficient cooling at unprecedented scales.
- The company holds the largest global patent portfolio on graphene-based thermal management, underscoring its leadership and innovation in this critical technology.
- Next-generation AI chips are encountering a critical 'thermal wall' where conventional cooling methods no longer suffice, making G3's technology essential for continued AI advancement.



The AI Bottleneck: Overheating

Key Thermal Challenges in AI Scaling

The rapid growth of AI model complexity is driving unprecedented heat generation in data centers, making cooling a critical bottleneck.

Current thermal management technologies are insufficient, leading to high energy costs and reduced hardware lifespan, underscoring the urgent need for innovative cooling solutions.

Cooling systems now consume up to 40% of total data center energy, significantly raising operating expenses.

Current heat sinks and standard thermal interface materials have reached physical limits, unable to cope with escalating thermal loads.



The Solution: G3's Advanced Graphene Materials

4-10x

Heat Conduction Speed

Graphene conducts heat 4-10 times faster than copper and aluminum, enabling rapid dissipation of thermal energy from AI chips.

**4x
lighter**

Weight Advantage

Graphene is 4 times lighter than copper, reducing overall weight in thermal management systems without sacrificing performance.

**1,700 —
5,300
W/m·K**

Thermal Conductivity

Suspended single-layer graphene possesses the highest thermal conductivity (5,300 W/m·K) of any known material and thick thermal films exhibit thermal conductivity up to 1,700 W/m·K, providing unmatched heat transfer efficiency.

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Core Product Matrix: Four Pillars of Thermal Innovation

Graphene In-plane Film

- Ideal for foldable devices and electric vehicle (EV) batteries due to unmatched flexibility.
- Features a flawless sp^2 -conjugated carbon network enabling superior thermal conduction.
- Delivers exceptional heat dissipation with high in-plane thermal conductivity.
- Supports lightweight, flexible thermal management solutions in emerging tech markets.

Graphene Through-plane Film

- Known as the Crown Jewel product breaking the thermal conductivity barrier along the Z-axis.
- Replaces liquid metals traditionally used in liquid-cooled AI servers for enhanced reliability.
- Offers proprietary pricing power due to patented technology.
- Enables vertical heat transfer critical for high-density AI and data center cooling.

Artificial Graphite Film

- Targets defense and telecommunications sectors requiring rigid thermal management solutions.
- Provides high in-plane thermal conductivity up to 1800 W/m·K for demanding applications.
- Manufactured from premium precursors ensuring material rigidity and durability.
- Ideal for environments with stringent mechanical and thermal stability requirements.

Graphene-Silicone Soft Pads & Thermal Grease

- Effective heat sink solutions for laptops, CPUs, RAM modules, and graphics cards.
- Highly resistant to chemicals, oils, and water, ensuring long-term performance.
- Exhibits excellent high-temperature stability for intensive computing environments.
- Flexible and conformal materials allowing optimal microscopic contact and heat transfer.



Patented

(1) Graphene In-plane Film: The AT1100 Series



The AT1100 Series by G3 offers a major advancement in thermal management, featuring high thermal conductivity, EMI shielding, and flexible, lightweight materials. Its superior heat spreading capabilities significantly reduce operating temperatures in electronics, enhancing performance and reliability across industries such as AI chips, communications devices, large-screen displays, and LED lighting.



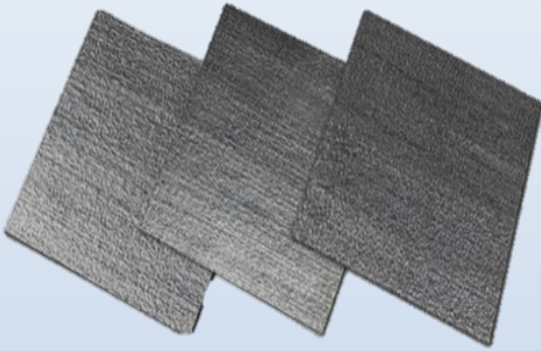
Patented

(1) Graphene In-plane Film: The AT1100 Series

Property	Specification	Notes / Applications
Thermal Conductivity (in-plane)	1100 - 1300+ W/m·K	Enables efficient heat dissipation in high-performance electronics
Film Thickness	25 - 150 μm	Flexible for integration in various device architectures
Operating Temperature Range	-20°C to +120°C	Suitable for demanding thermal environments
Electrical Conductivity	High	Supports applications where electrical conduction is needed
Mechanical Flexibility	High	Ideal for foldable devices and wearable tech
Typical Applications	AI servers, GPUs, Foldable Smartphones, EV batteries, Wearables	Wide industry applicability
Moisture Resistance	Good	Enhances durability in humid environments
Chemical Stability	Excellent	Ensures longevity under industrial conditions

Patented

(2) Graphene Through-plane Film The AT500-T Series



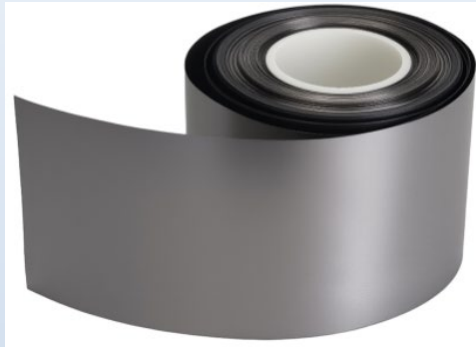
G3's graphene thermal film with exceptional through-plane thermal conductivity breaks the Z-axis barrier, offering superior cooling solutions that replace liquid metals in AI servers while maintaining broad applicability.

Key Properties of Graphene Through-Plane Film

Property	Specification	Notes
Thermal Conductivity (Through-Plane)	≥ 70 to ≥ 130 W/m·K	Enables efficient heat transfer along Z-axis for cooling
Thickness	20 to 2000 μm	Customizable for various cooling system designs
Operating Temperature Range	-40°C to 150°C	Suitable for demanding electronics environments
Density	< 0.95 g/cm ³	Lightweight for easy integration
Typical Applications	AI servers, electronics cooling, thermal interface materials	Replaces liquid metals with broad applicability

(3) Artificial Graphite Film The AT1500, AT500 Series

Patented



Artificial Graphite Sheet AT1500

- Thermal conductivity: High in-plane (XY-axis) thermal conductivity ranging from ≥ 1350 to ≥ 1500 W/m·K for superior heat dissipation.
- Thickness: Thin profile between 17 to 70 micrometers, enabling lightweight yet effective thermal management.
- Operating temperature range: Wide span from -55°C to $+400^{\circ}\text{C}$, suitable for extreme environments.
- Density: Approximately 2.0 to 2.1 g/cm³, providing a rigid and durable structure.
- Target applications: Primarily designed for defense and telecom sectors, leveraging high rigidity derived from premium graphite precursors.

Flexible Graphite Sheet AT500

- Thermal conductivity: Effective XY-plane heat dissipation with conductivity ≥ 350 W/m·K.
- Thickness: Ranges from 137 to 280 micrometers, balancing flexibility and performance.
- Operating temperature range: Also supports -55°C to $+400^{\circ}\text{C}$, adaptable for diverse industrial uses.
- Density: At least 1.5 g/cm³, offering a flexible yet robust material option.
- Applications: Widely used across smartphones, vehicles, foldable devices, electric vehicle batteries, and robotics where flexibility and reliable thermal management are critical.

(4) Thermal Pad & Phase Change Material

Thermal Pad Features and Properties

- Thickness range: 0.5 to 12.0 mm, providing versatile options for various device gaps and applications.
- Thermal conductivity spans from 1.2 to 15.0 W/m·K, enabling efficient heat transfer in electronic assemblies.
- Thermal impedance can be as low as $\leq 0.065 \text{ }^{\circ}\text{C}\cdot\text{cm}^2/\text{W}$, minimizing thermal resistance between components.
- Density varies between approximately 2.0 and 3.3 g/cm³, balancing weight and performance.
- Hardness ranges from 10 to 65 Shore, offering flexibility and durability for conformal contact.
- High dielectric breakdown voltage up to $\geq 7.5 \text{ kV/mm}$, ensuring electrical insulation and safety.

Phase Change Material (PCM) Characteristics

- Thickness range: 0.20 to 1.0 mm, suitable for thin and space-constrained thermal interface solutions.
- Thermal conductivity between 4.0 and 8.5 W/m·K, providing superior heat conduction relative to standard pads.
- Phase transition temperature from 50 to 60°C; material softens upon reaching this range for enhanced surface conformity.
- Softening effect fills microscopic gaps between heat source and heat sink, effectively reducing thermal resistance.
- Ideal for dynamic thermal management where component temperatures fluctuate during operation.
- Improves long-term reliability by maintaining consistent thermal contact despite mechanical stresses.



(5) Graphene Thermal Grease The AT006 Series

Patented



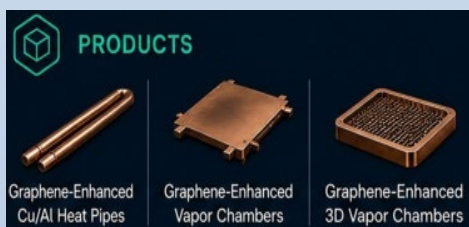
G3's graphene-enhanced thermal grease and paste provide superior heat conduction with a non-metallic, silicon-free formula, optimizing micro-device cooling with exceptional thermal performance and application ease.

Thermal Grease & Paste Properties

Property	Value	Benefit
Thermal Conductivity	Up to 6 W/m·K	Significantly improves heat transfer efficiency
Thermal Impedance	≤ 0.017 °C·cm ² /W	Reduces temperature buildup in devices
Composition	Non-metallic, silicon-free	Ensures chemical stability and electrical insulation
Graphene Nanostructure Effect	Enhanced penetration of micro-pores	Improves contact and coating quality, optimizing cooling



(6) Next-Gen Graphene-Metal Cooling Technologies



- Graphene-enhanced copper and aluminum nano-intermediates form the basis of advanced thermal management components for AI servers.
- Product lineup includes high-performance Cu/Al heat pipes, vapor chambers, 3D vapor chambers, and thermally conductive foils.
- Thermal transfer rates are boosted by 2-4 times compared to standard metal heat sinks, reducing hotspot temperatures and improving reliability.
- Vapor chambers cover copper units rated from 150 W to 750 W recommended power, with precise surface flatness: 0.1 mm on heat side and 0.3 mm on cool side.
- Custom vapor chamber designs are available to meet specific power densities and form factor requirements in AI server cooling applications.

Integrating graphene with copper and aluminum creates cutting-edge cooling technologies that significantly enhance heat transfer efficiency for AI servers. Graphene-enhanced metal heat pipes and vapor chambers deliver 2 to 4 times faster heat dissipation than traditional metals, enabling greater performance and reliability in high-power AI hardware.

The Partner of Choice for AI Data Centers

CONCLUSION

Why G3: Patent Protection, Scale, and the AI Thermal Future

Global Graphene Group (G3) leads with patented graphene innovation, scalable production, and Tier 1 validation. Its portfolio solves AI thermal challenges, making G3 the partner of choice for AI hardware performance and reliability.

Unmatched Patent Portfolio

- Holds the world's first and largest series of patents (>300 patents and applications related to graphene), with more than 50 patents on graphene thermal management alone.
- Patents authored by co-founders Dr. Bor Z. Jang and Dr. Aruna Zhamu, pioneering graphene innovation since 2002.
- Ensures strong intellectual property protection and market exclusivity in advanced thermal solutions.

Leading Graphene Producer

- World's first commercial-scale producer of graphene, providing critical cost and scale advantages.
- Enables consistent availability and rapid fulfillment for global AI data center needs.
- Proprietary production methods deliver high-quality graphene materials competitively.

Proven Tier 1 Validation & Comprehensive Portfolio

- Validated by Tier 1 global corporations.
- Comprehensive portfolio includes films, sheets, pastes, pads, PCM, heat spreaders, and vapor chambers.
- Purpose-built solutions address the AI data center thermal crisis with next-gen cooling.





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