VHD Graphite Proven Superior in Thermal Expansion Testing & Furthers Data Centre Collaboration

- Recent developments with potential customers include requests for confirmation of the thermal expansion performance of VHD graphite and for the provision of sample material to support next-stage computer modelling.
- GCM continued to progress its collaboration with GreenSquareDC (GSDC). GCM will provide samples for GSDC to conduct material testing and develop a computational fluid dynamics model.
- GCM further validated its next-generation VHD Graphite as an advanced thermal management solution, designed to address the critical challenges of heat dissipation in high-performance computing systems and data centres.
- UNSW has performed testing to allow the evaluation of the thermal expansion of VHD graphite heat sinks, measuring how they expand or contract with temperature changes.
- VHD graphite has been found to be ~8 – 12 times superior to conventional metals used in heat spreaders, heat sinks and cold plates.
- VHD graphite's coefficient of thermal expansion has been found to closely match silicon, making it highly compatible with silicon wafer chips.
- By closely matching silicon's coefficient of thermal expansion, VHD graphite minimises stresses and strains, which normally occurs when joined materials expand or contract at different rates under temperature changes.
- These results prove VHD graphite heat sinks offer an equal to or better outcome for next-generation high-performance computers and servers running compute-intensive workloads, reducing thermal load risks while maintaining exceptional thermal performance.

Green Critical Minerals Ltd ('GCM' or 'the Company') (ASX:GCM) is pleased to provide an update on recent customer engagement interactions. The commercialisation process involves numerous steps, including the provision of technical information, technical due diligence, and prototyping. GCM has been engaging with potential customers globally, across Asia, Australia, Europe, and North America, covering sectors such as data centre providers, semiconductor manufacturers, machine shops and thermal engineering solution providers.

Recent developments with potential customers include requests for confirmation of the thermal expansion performance of VHD graphite and for the provision of sample material to support next stage computer modelling.

Green Critical Minerals' Managing Director, Clinton Booth, commented: *"We are very pleased to share our positive coefficient of thermal expansion (CTE) test results, which confirm that VHD graphite delivers clear advantages over conventional heat sink materials.*

"Our CTE results demonstrate the potential to reduce strain at the chip-to-sink interface, ensuring stronger, more reliable contact through repeated temperature cycles. This translates into greater mechanical reliability and stability, without compromising thermal performance, ultimately with the potential to deliver higher performance and reduce costly hardware failures. We look forward to continued engagement with our customers to validate these potential benefits in real world situations.

"Our recent results have continued to enhance our customer engagement program by showcasing real-world value to potential partners who prioritise reliability and efficiency. These results highlight VHD graphite as a superior solution for addressing thermal management challenges in high-performance computers, data centres, AI computing, and high-performance electronics.

"We are also pleased to see our collaboration with leading Australian data centre, GreenSquareDC, progressing. In a tangible step forward, we will provide GSDC with samples of our VHD product for them to use as they develop a CFD model to demonstrate VHD's efficiency in their operations."

THERMAL EXPANSION PROPERTIES OF VHD

Background

High-performance computing (HPC), data centres and AI computing generate significant heat loads which move from their source, the central processing units (CPUs) and graphics processing units (GPUs) to the external environment. The process of removing the heat involves the interaction of different materials, from the silicon CPU and GPU dies through to the metal (or other material) heat spreaders, heat sinks or cold plates.

The application and removal of heat (thermal load) to a material causes the material to expand or contract, known as thermal expansion. Thermal expansion is measured by how much a material expands per degree of temperature increase, relative to the materials dimension, and is presented as its coefficient of thermal expansion (CTE).

Different materials behave differently under thermal loads, so this variation in their behaviour must be managed to ensure efficient and reliable heat transfer. When a heat sink material expands at a different rate to the chip package, this results in the materials pushing and pulling against each other, resulting in stresses and strains. Over time these stresses and strains may lead to issues such as component distortion, premature expiry of the thermal interface material, solder fatigue, or even die cracking over time. These failure mechanisms can degrade device reliability and shorten their lifespan.

Superior expansion performance

Testing performed by the University of New South Wales (UNSW) and analysed by Professor Andrew Ruys determined the superior thermal expansion performance of VHD graphite. **Table 1** reports the CTE results for VHD graphite and the typically reported values for conventional heat sink materials, aluminium and copper. The CTE of silicon is also provided, which is the typical base semiconductor material used in the manufacture of CPUs and GPUs. In-plane and out-of-plane CTE results are presented for VHD graphite, given its anisotropic nature.

These results demonstrate that VHD significantly outperforms conventional heat sink metals of copper and aluminium in-plane and is also superior out of plane, further validation of the advanced material status of VHD graphite for use in thermal applications.

Material	CTE value	Efficiency compared to VHD (in-plane)
VHD graphite	~2.0 $\times 10^6$/K in plane ~15.2 $\times 10^6$/K out of plane	N/A
Silicon (die)	~2.6 $\times 10^6$/K	Comparable
Copper	~16.6 $\times 10^6$/K	Expands ~8 times more than VHD graphite per °C
Aluminium	~21–24 $\times 10^6$/K	Expands ~10-12 times more than VHD graphite per °C

Table 1 CTE Results

SAMPLE MATERIAL REQUEST AND NEXT STAGE COMPUTER MODELLING

GCM and GreenSquareDC (GSDC) continue to progress their previously announced collaboration[1]. Since announcing the collaboration, GCM and GSDC have had numerous engagements, including the sharing of VHD technical data by GCM to support GSDC's technical due diligence.

Given the results of its due diligence to date, GSDC has advised GCM that it will progress to the development of a VHD-specific computational fluid dynamics (CFD) model. As part of this CFD model development process, GSDC has requested samples of the VHD material, which it can test and use to support the model's development.

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[1] ASX announcement dated 23 April 2025.

Authorisation

The provision of this announcement to the ASX has been authorised by the Board of Directors of Green Critical Minerals Limited.

Forward Looking Statements

This announcement contains general information about GCM's activities current as at the date of the announcement. The information is provided in summary form and does not purport to be complete.

This release contains estimates and information concerning our industry and our business, including estimated market size and projected growth rates of the markets for our products. Unless otherwise expressly stated, we obtained this industry, business, market, and other information from reports, research surveys, studies and similar data prepared by third parties, industry, and general publications, government data and similar sources. This announcement also includes certain information and data that is derived from internal research. While we believe that our internal research is reliable, such research has not been verified by any third party. Estimates and information concerning our industry and our business involve a number of assumptions and limitations. Although we are responsible for all of the disclosure contained in this announcement and we believe the third-party market position, market opportunity and market size data included in this announcement are reliable, we have not independently verified the accuracy or completeness of this third-party data. Information that is based on projections, assumptions and estimates of our future performance and the future performance of the industry in which we operate is necessarily subject to a high degree of uncertainty and risk due to a variety of factors, which could cause results to differ materially from those expressed in these publications and reports.