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Low-cost laser-induced graphene heaters for polymerase chain reaction

A graphene heater for portable devices with low power consumption and cost of manufacturing

IP Status: PCT Pending; Application No. WO 2024/173793

Applications

- Portable PCR
- Portable Loop-Mediated Isothermal Amplification (LAMP)
- Alternative heating source for on-chip applications
- Wearable medical devices
- Micro gas chromatography
- Flow meters

Key Benefits & Differentiators

- **Ultra-low cost (<$0.1/each):** Laser-induced graphene (LIG) is manufactured with a commercial system found in most machine shops
- **Faster heating and cooling, excellent temperature accuracy and uniformity:** Highly porous 3D structure promotes thermal conductivity
- **Low power consumption:** Graphene sheets exhibit high conductivity

Technology Overview

Polymerase Chain Reaction (PCR) is widely considered a gold standard for disease detection due to its ability to sensitively and specifically detect target DNA and RNA in samples. Traditional PCR is limited to centralized facilities due to the need for specialized equipment and personnel. Miniature PCR kits have been developed for portable use, but are hampered by commercial metal heaters and the need for complex flow control to overcome these limitations. Due to these constraints, portable PCR kits have been limited due to the high cost of manufacturing. Therefore, new heating approaches are required to decrease the cost of manufacturing and in turn increase the widespread availability of PCR diagnostics.

Researchers at the University of Minnesota have developed a rapid, low-cost heater from laser-induced graphene (LIG). To manufacture the heater, a carbon dioxide laser is used to irradiate a polyimide tape and induce carbonization, forming graphene-like structures. This approach results in a complex structure at multiple scale levels. The combination of filamentous structures composed of graphene sheets promotes high thermal and electrical conductivity, making LIG an excellent material for a portable heater. These advantageous thermal and electrical properties result in comparable performance to commercial PCR heaters. Combined with the low fabrication cost, these high-quality properties position LIG to enable portable molecular diagnostics.

Phase of Development

TRL: 3-4

Technology ID
2023-021

Category
All Technologies
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Engineering & Physical Sciences/Materials
Engineering & Physical Sciences/Nanotechnology
Engineering & Physical Sciences/Processes

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Proof of concept heater for DNA amplification and CRISPR-Cas9 biosensing demonstrated

Desired Partnerships

This technology is now available for:

- License
- Sponsored research
- Co-development

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Researchers

- **Tianhong Cui, PhD** Professor, Mechanical Engineering
- **Terrence Simon, PhD** Professor, Mechanical Engineering
- **Peng Zhou, PhD** Postdoc, Mechanical Engineering
- **Yingming Xu** Graduate Student, Mechanical Engineering
- **Yang Wang, PhD** Visiting Scholar, Mechanical Engineering
- **Khoi Nguyen** Graduate Student, Mechanical Engineering

References

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