Ultralight Carbon Coldplate (UCP)

Lightweight Cooling Solutions for Superior Thermal Management

Highlights

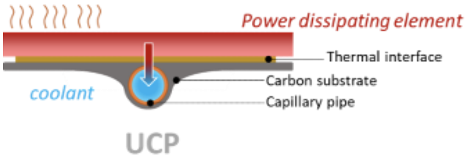
Exceptional Cooling Performance
Utilizes high thermal conductive carbon substrates with micro-macro vascular pipes to efficiently cool power-dissipating elements.

Lightweight and Durable
Optimized layout of carbon plies and non-metallic tubes, providing minimal material thickness while maintaining structural integrity.

Versatile Coolant Compatibility
Compatible with various coolants, including single-phase liquids like water and two-phase evaporative coolants like C4F10.

Radiation Hardness
Incorporates materials like polyimide pipes known for their high radiation resistance, ideal for high-radiation environments.

Keywords
Carbon Composite Materials, Advanced Thermal Management, High Thermal Conductivity



Description

The Ultralight Carbon Cold Plate (UCP) was developed at CERN for use in the ALICE experiment's Inner Tracking System (ITS). This innovative cooling technology helps manage the heat generated by electronic components and sensors in high-energy physics experiments, which is crucial for maintaining the accuracy and longevity of scientific instruments.

The UCP combines intricate piping systems embedded within carbon-based materials that have a high capacity for conducting heat. This design not only pulls heat away from sensitive components swiftly but does so with minimal impact on the overall system's weight—a key factor in many technological applications where bulk can hinder performance and efficiency. This technology's successful implementation in the ALICE ITS and other high-energy physics experiments underscores its reliability and effectiveness in extreme conditions.

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Advantages

Unmatched Cooling Efficiency

High thermal conductivity materials and ultralight polyimide cooling pipes maintain optimal temperatures for power-dissipating components. Validated for operation across a temperature range from ambient conditions down to −25 °C, with the potential for further extension depending on system requirements.

Robust Construction

The UCP combines HTC carbon prepreg, pyrolytic graphite foil, and quasi-isotropic carbon lamina for a lightweight yet durable structure. Cyanate ester resin enhances stability and reduces humidity absorption.

Adaptability and Scalability

Customizable to accommodate various cooling pipe sizes and configurations, suitable for applications ranging from small-scale devices to large-scale industrial equipment exceeding 1.5 meters. The heat-sink structure is not limited to a flat-plate but can be engineered in cylindrical or other application-specific geometries, ensuring optimal integration across diverse use cases.

Applications

Cooling capabilities for:

- High energy physics
- Medical & BioTech
- Data centers
- Automotive & Aerospace
- Telecommunications & renewable energy

The versatility of the technology encourages further exploration and development.

Publications

GARGIULO, C. (2019). TRACKING DETECTORS - LIGHT MECHANICAL SUPPORT STRUCTURE. [POWERPOINT SLIDES]. EP DEPARTMENT, CERN. Link

GÓMEZ MARZOA, M. (2016). Innovative low-mass cooling systems for the ALICE ITS Upgrade detector at CERN [Doctoral dissertation] EPFL. Link

"No cold plate as lightweight as the one we propose currently exists."

– Corrado Gargiulo

only 1g
to cool a surface of 5x5 cm^2

Unique cooling performance and minimum material thickness and weight

For further information and licensing requests, please reach out to the CERN Venture Connect Program Manager.

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