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Market for thermal management technologies

The global market for thermal management technologies was valued at $16.1 billion in 2022 and is expected to grow at a compound annual growth rate (CAGR) of 8.5% to reach $26.1 billion by 2028.

Thermal management technologies are used to maintain the temperature of a system. With the development of smaller and smaller electronics, thermal management technologies have become more necessary to safeguard product performance and reliability by reducing the heat generated by the devices. Most systems employ various thermal management strategies. These strategies can involve convection cooling (transfer of heat through air or liquid) or conduction cooling (transfer of heat through solids) and use both passive and active thermal management technologies.

Passive thermal management technologies

- **Heat sinks:** A piece of thermally conductive metal attached to the heat-generating component. Thermal energy is transferred from the heat source to the metal via conduction. The energy is then dispersed into the surrounding atmosphere via natural convection from the heat sink's surface area.
- **Heat spreaders:** Thermally conductive foils or metal plates that aid in the spread of focused heat over a larger area. Heat spreaders are typically used as an intermediary material between the heat source and secondary heat exchangers.

Active thermal management technologies

- **Forced convection:** A blower or fan improves airflow near the heat-generating component. This approach improves heat dissipation by increasing convection and allowing high-temperature air to move away faster.
- **Thermoelectric coolers:** Thin, small devices that are typically placed between a heat source and a heat sink. When voltage is applied to the unit, a temperature difference is created between the heat sink and source. This greater temperature delta accelerates conduction.

Across all thermal management solutions, the thermal interface material is an essential component. This material facilitates heat transfer and reduces air gaps, improving cooling and enhancing the system's reliability. Table 1 overviews different types of thermal interface materials on the market.

The COVID-19 pandemic had mixed effects on the thermal management technologies market. It posed challenges in terms of disruptions and reduced demand, but it also highlighted opportunities in sectors such as remote work, healthcare, and digital transformation. As the world transitioned into the post-pandemic era, the market has experienced a shift in priorities toward digitalization, healthcare, sustainability, and supply chain resilience, driving both challenges and opportunities for the thermal management industry.

About the author

BCC Publishing Staff provides comprehensive analyses of global market sizing, forecasting, and industry intelligence, covering markets where advances in science and technology are improving the quality, standard, and sustainability of businesses, economies, and lives. Contact the staff at Helia.Jalili@bccresearch.com.

Resource

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Table 1. Characteristics of the most common thermal interface materials in the market

Type	Characteristics	Advantages	Disadvantages
Greases	Typically, silicone-based matrix loaded with particles to enhance thermal conductivity.	– High bulk thermal conductivity. – Thin bond line thickness with minimal attach pressure. – Low viscosity enables matrix material to easily fill surface crevices. – No curing required.	– Susceptible to grease pump-out and phase separation. – Considered messy in a manufacturing environment due to a tendency to migrate.
Phase change materials	Polyolefin, epoxy, low molecular weight polyesters, acrylics typically with boron nitride or aluminum oxide fillers.	– Higher viscosity leads to increased stability and thus less susceptibility to pump-out. – Easier application and handling than greases.	– Lower thermal conductivity than greases. – Surface resistance can be greater than greases (but can be reduced by thermal pre-treatment). – Requires attach pressure to increase thermal effectiveness and thus could lead to increased mechanical stresses.
Gels	Aluminum, aluminum oxide, or silver particles in silicone, olefin matrices that require curing.	– Conforms to surface irregularity before cure. – No pump-out or migration concerns.	– Cure process needed. – Lower thermal conductivity than grease. – Lower adhesion than adhesives; delamination can be a concern.
Adhesives	Typically, silver particles in a cured epoxy matrix.	– Conforms to surface irregularity before cure. – No pump-out or migration concerns.	– Cure process needed. – Delamination post-reliability testing is a concern. – Cured epoxies have a modulus, so coefficient of thermal expansion mismatch-induced stress is a concern.