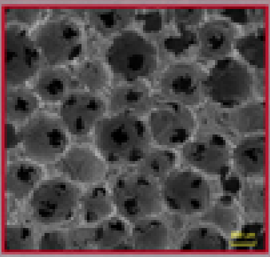
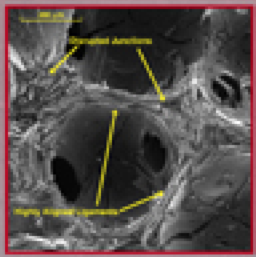
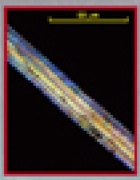
High-Thermal-Conductivity Graphite Foam

Unique, high-conductivity, high-surface-area graphite foam is ideal for heat transfer

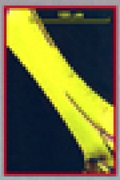




Superior alignment along carbon foam ligaments results in higher thermal conductivity



High-Conductivity Carbon Fiber

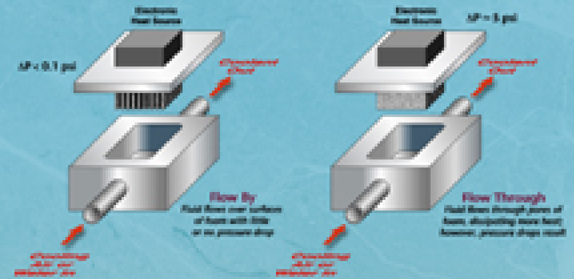


Carbon Foam Ligament

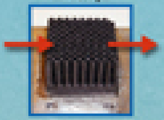
Material	Density (g/cm^3)	Thermal conductivity (W/m·K)
Aluminum 6061	2.7	180
Copper	8.9	400
Carbon fiber	2.2	1000
Synthetic diamond	3.5	1000
Graphite foam ligament	2.23	1700
Perfect diamond	3.5	2000

Power Electronics

Miniaturization of power electronics often results in overheating and failure of these circuits. A simple test system was developed to evaluate various heat sink designs. Finned aluminum and Al foam heat sinks were compared with various graphite foam designs

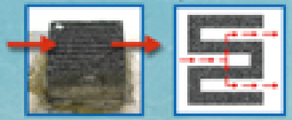


ΔP < 0.1 psi



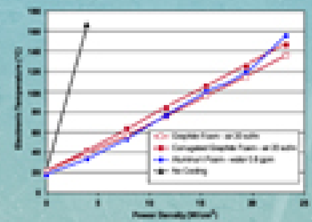
Pin Fins

ΔP < 0.34 psi



Corrugated Foam

Air-cooled graphite foam removed as much heat as water-cooled aluminum foam



Efficient Graphite Foam Heat Sinks Are Being Developed for Microturbines

Adequately cooling the electronics of microturbines that operate in desert climates or enclosed spaces (high ambient temperatures) can be problematic. Inadequate cooling causes a reduction in power output or shutdown to protect the electronics from overheating. Very efficient graphite foam heat sinks are being developed and tested on microturbine generators

Capstone microturbine generators use air-cooled aluminum-finned heat sinks to cool the power electronics

Developmental graphite foam heat sink

- Graphite foam heat sinks will be 2 to 5 times lighter than conventional heat sinks
- Ultraefficient graphite foam heat exchangers can be 3 to 4 times smaller than conventional heat exchangers

Heat transfer coefficients of foam-based heat exchangers can be orders of magnitude greater than those of conventional heat exchangers

	Heat transfer coefficient h-(W/m²·K)		ΔP/L @6 m/s (psi/in.)
	Air	Water	
Finned aluminum	70–350		<0.1
Pin-finned aluminum	550		<0.1
Aluminum foam	250		0.12
Finned graphite foam	1000	2100	<0.1
Pin-finned graphite foam	1500	2500	<0.1
Solid graphite foam	3100	9000	4.8
Corrugated graphite foam	3100		0.34
Graphite foam with blind holes (pin fin negative)	2000	4600	~2
Graphite foam with blind holes (parallel to air flow)	3100	4500	~2

Conclusions

- High-conductivity, high-surface-area graphite foam is ideal for heat transfer
- The use of ultraefficient graphite foam reduces the size and weight or coolant flow requirements of conventional heat sinks
- Flow-through designs dissipate more heat than flow-by designs but create greater pressure drops

Office of Transportation Technologies

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http://www.eren.doe.gov/der/microturbines/microturbines.html