

Metal Matrix Composites

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Metal Matrix Composites

- What are metal-matrix composites?

Metal matrix composites have a metal matrix.

Examples include silicon carbide fibers in aluminum, graphite fibers in aluminum.

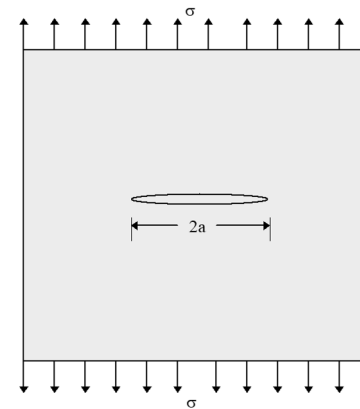
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Advantages of MMCs

- Higher specific strength and modulus over metals.
- Lower coefficients of thermal expansion than metals by reinforcing with graphite.
- Maintenance of high strength properties at high temperatures.

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Degrading properties in MMCs



- Are there any properties which degrade when metals are reinforced with fibers?

Yes, they may have reduced ductility and fracture toughness.

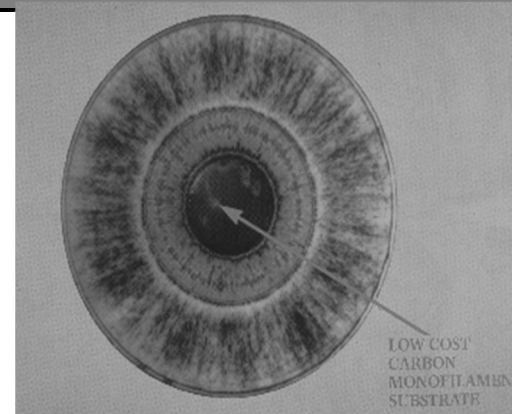
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Typical mechanical properties of metal matrix composites

Property	Units	SiC/ Aluminum	Graphite/ Aluminum	Steel	Aluminum
Specific Gravity		2.6	2.2	7.8	2.6
Young's modulus	Msi	17	18	30	10
Ultimate Tensile Strength	Ksi	175	65	94	34
Coefficient of Thermal Expansion	$\mu\text{in/in}/^\circ\text{F}$	6.9	10	6.5	12.8

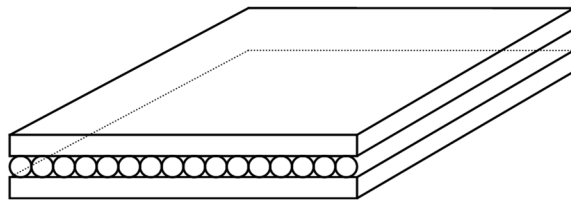
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Boron Fiber



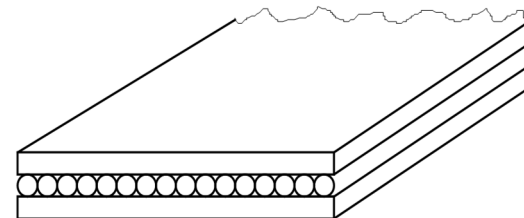
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Step 0: Cutting the shape



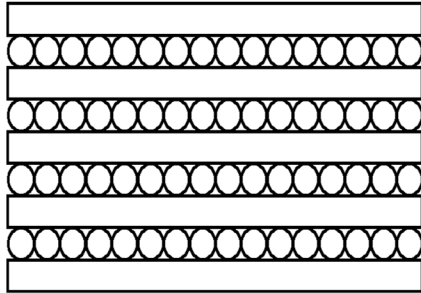
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Step 1: Apply Aluminum File



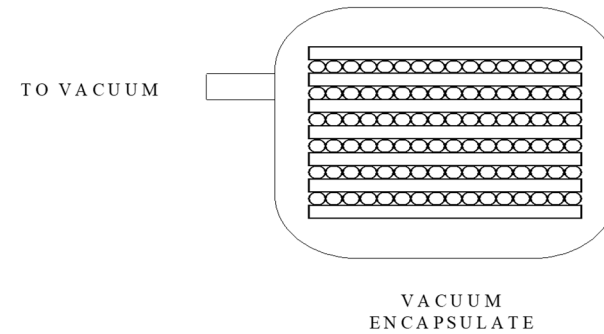
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Step 3: Lay Up Desired Plies



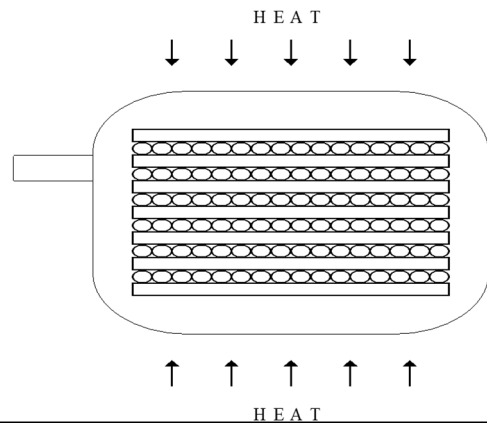
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Step 4: Vacuum the specimen



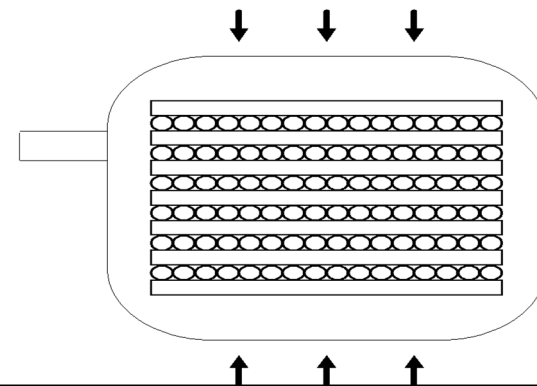
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Step 5: Heat to Fabrication Temperature



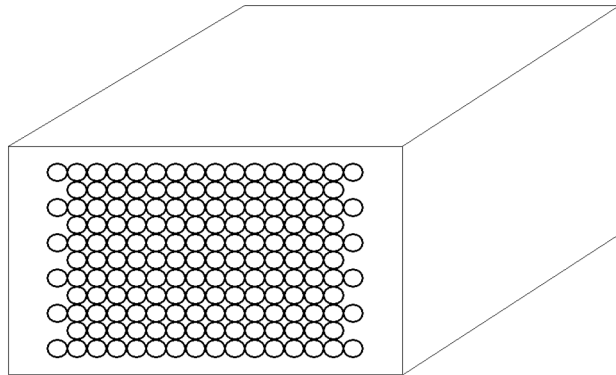
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Step 6: Apply Pressure and Hold for Consolidation Cycle



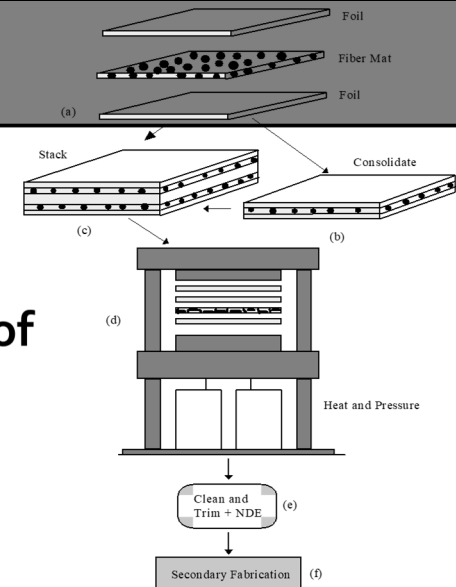
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Step 7: Cool, Remove and Clean Part



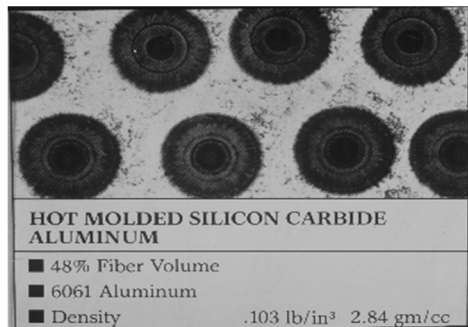
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Schematic of Diffusion Bonding



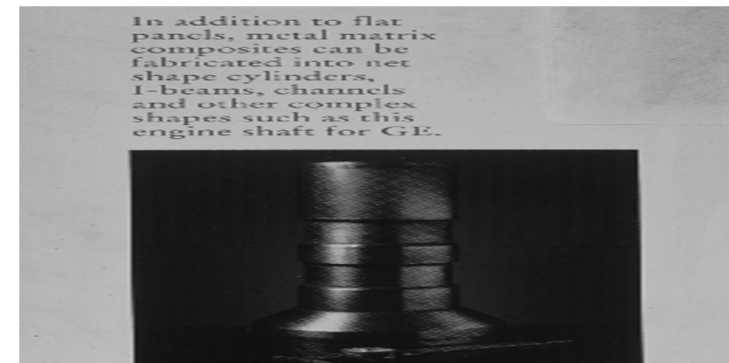
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Silicon Carbide/ Aluminum Composite



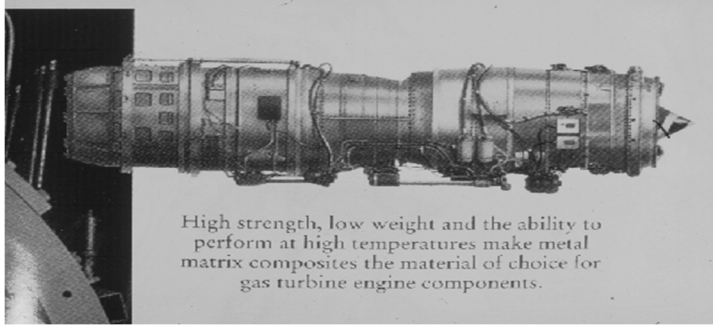
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Application of MMCs



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Application of MMCs



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Application of MMCs

POTENTIAL APPLICATIONS	MANUFACTURER	CANDIDATE COMPONENTS	BENEFITS
National Aerospace Plane (NASP) 	Rockwell McDonnell Douglas Rocketdyne General Dynamics Pratt & Whitney	Structural components	Weight savings, higher operating temperatures
Advanced Fighters 	Northrop McDonnell Douglas Lockheed	Aft fuselage structure, nose landing gear, arresting gear, drag braces, torque tubes	Life cycle, cost savings, weight savings
Gas Turbine Engines 	General Electric Pratt & Whitney Allison Garrett	Exhaust nozzle links, vanes, blades, cases, shafts, rings	Weight savings and higher operating temperatures

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