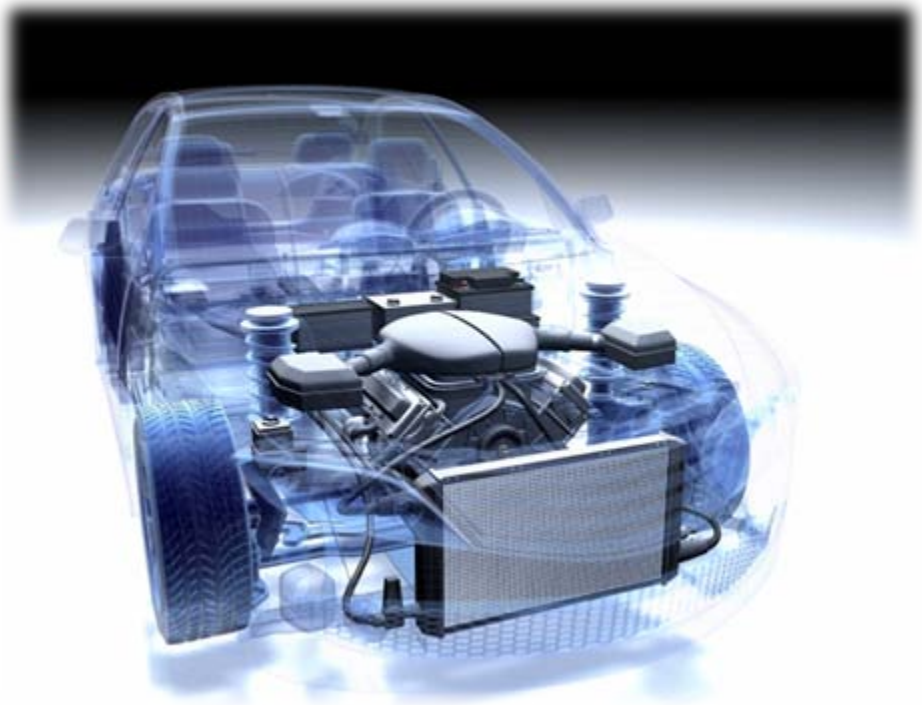


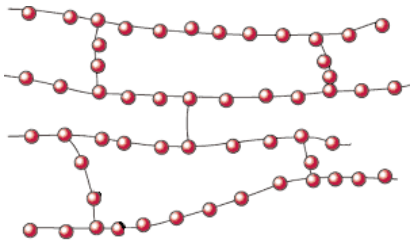
BULK MOLDING COMPOUNDS, INC

"Complete Composite Solutions"

- Citadel Portfolio Company
  - Bulk Molding Compounds, Inc *(Thermoset Composites)*
  - The Matrixx Group *(Thermoplastic Compounding)*
- 12 manufacturing operations, 6 countries on 4 continents
- TS-16949 Certified

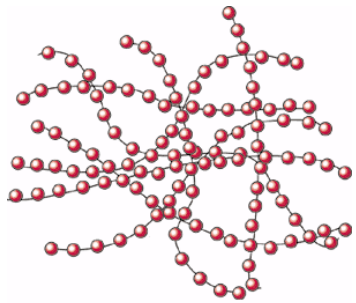
THERMOSETS

- BMC Polyester Composites
- BMC Vinyl Ester Composites



THERMOPLASTICS

- Polypropylene
- Polycarbonate
- Polyamide
- Acetal
- PET
- PBT
- Alloys



World's Largest Supplier of BMC Thermoset Composites

- Automotive
- Electrical
- Energy
- Appliance
- Consumer

BMCI Global Footprint

BMCI has 7 compounding facilities locating in North America, South America, Europe and Asia to serve the global automotive market. Each of these markets are supported by local BMC sales and technical service representatives.

- USA - Chicago, IL, Perrysburg OH
- Mexico – Juarez, Mexico City
- Brazil –Rio Claro
- Germany – Hamburg
- China- Dongguan



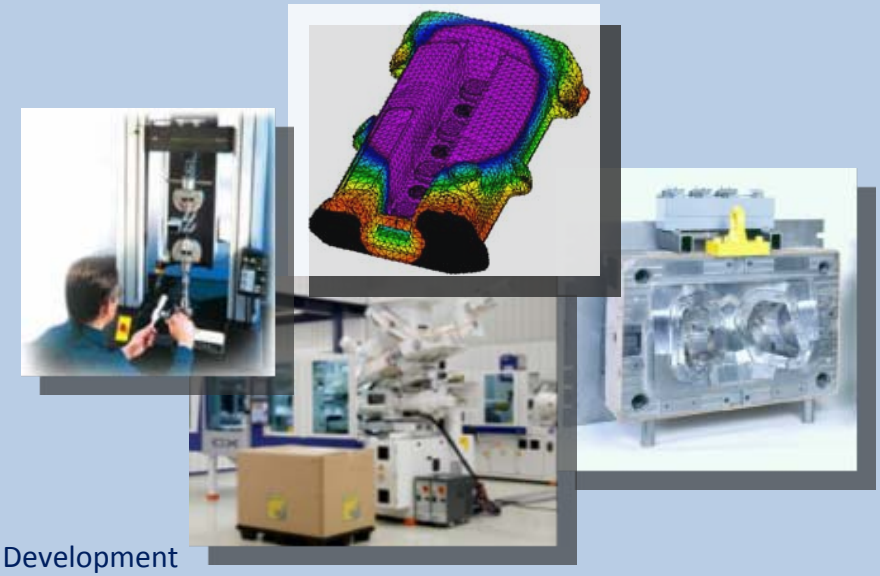



BMCI In-House Technical Support Capabilities

BMCI offers a range of application development support services to help select and/or develop materials with the right balance of properties and cost to meet requirements. Customization of formulations allows us to insure we are providing an optimized solution for each application with correct balance of properties vs. cost.

A breadth of in house material development, testing, design engineering and prototyping enables us to help customers deliver solutions to meet the most demanding deadlines and requirements.

- Material Selection
- Material Formulation/Sampling
- Full Service Materials Lab/Testing
  - Instron, Dynatup, Gas Chromatograph
  - FTIR, DSC, DMA, TGA
- Engineering/Design
- Materials/Product Training
- Prototyping
  - Injection molding
  - Compression Molding
  - Rapid Prototyping
- Full Service Tool Shop
  - Prototype and Production Tooling Fabrication
  - Conversion of Die Cast or Thermoplastic Molds for BMC Development

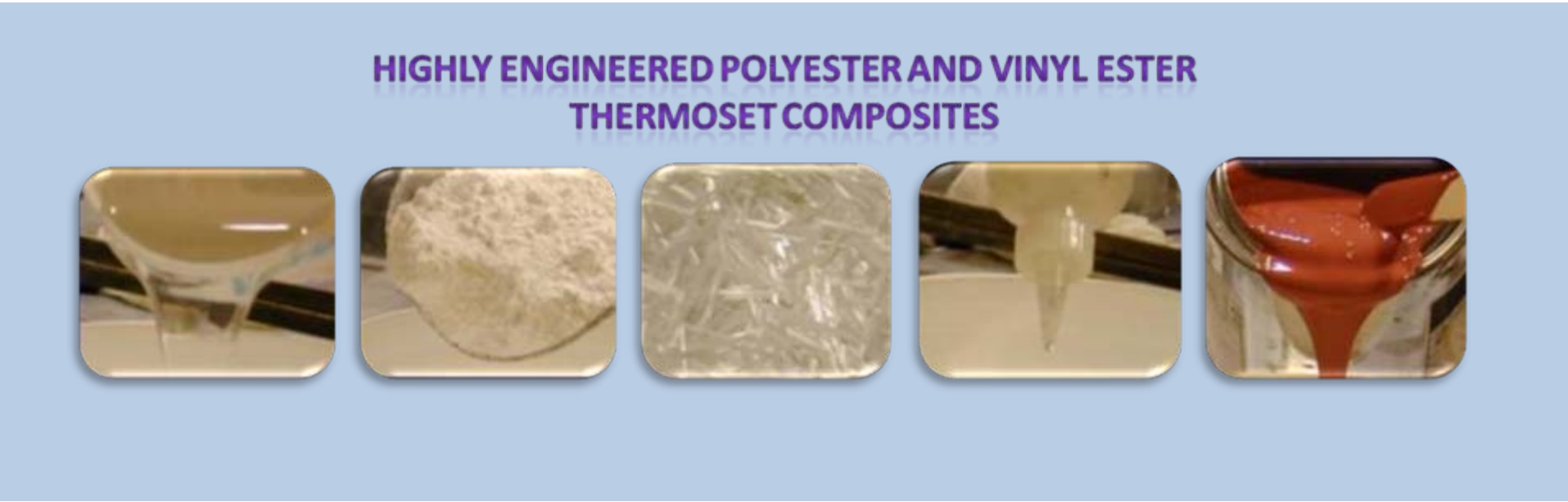


Wide Range of Materials/Properties

Bulk Molding Compounds Inc. is the worlds leading supplier of unsaturated polyester and vinyl ester based ***thermoset*** composite materials.

BMC composite compounds are composed of various raw materials including resins, low profile additives, catalysts, pigments, mould release agents, fillers and fiber reinforcements.

At BMCI we work closely with our customers to custom formulate our materials to deliver properties specific to each applications unique requirements to insure the correct balance of performance versus price.



BMC Range of Properties

BMC's unique blend of properties make them ideal for use in the extreme environments found in a wide variety of automotive applications.

- Automotive Electrical and Lighting Systems
- Under the Hood/Powertrain
- Body Structures
- Exterior Trim
- Alternative Fuel Vehicles (Hybrid Electric/Fuel Cell)

Property	Standard	Units	Value
Density	ISO 1183	g/cm3	1.5-2.5
Shrinkage	ISO 2577	%	0.3 - minus 0.1
Out of Mold Shrinkage	ISO 2577	%	< 0.05
Flexural Strength	ISO 178	MPa	75 - 150
Flexural Modulus	ISO 178	GPa	9.0 - 20.0
Impact Strength	ISO 1790	KJ/m^2	10 - 50
Compressive Strength	ISO 604	MPa	140 - 180
Tensile Strength	ISO 527	MPa	30 - 70
Tensile Modulus	ISO 527	GPa	10.0 - 15.0
Elongation at Break	ISO 527	%	0.2 - 0.5
Thermal Coefficient of Linear Expansion	VDE 0304/T.1	$10^{-6}/K^{-1}$	11 - 22
Heat Deflection Temp HDT-A	ISO 75	C	> 250
Heat Deflection Temp HDT-C	ISO 75	C	> 200
Max Service Temperature		C	190 - 200
Thermal Conductivity		W/mk	0.4 - 0.8
Flammability	UL 94	class	HB - V0/0.8mm
Water Absorption	ISO 62	mg (1d)	<30 (0.25%)
Surface Resistivity	IEC 60093	Ω	10^{12}
Volume Resistivity	IEC 60093	Ω cm	10^{14}

BMC materials are strong yet lightweight, versatile and flexible, allowing technological innovation and design freedom.

BMC can molded into components of complex geometries that often replace several parts made of other materials, thus simplifying assemblies and reducing costs.

BMCs' light weight characteristic also helps reduce the overall weight per vehicle, which reduces fuel consumption and allows for more sophisticated systems and components to be included in today's vehicles without adding to the overall weight.

BMC's Typically Replace:

- Die Cast Metals
- PhenolicThermosets
- Engineering Thermoplastics
  - PA6, PA6-6, PA4-6, PPA, PPS, PEI

✓ Weight Reduction
✓ Cost Reduction
✓ Performance Improvements

BMC vs. High Performance Materials

BMC thermosets offer the most cost-effective performance at elevated temperatures under load, pressure, and chemical exposure in automotive applications compared to metal and engineered thermoplastics.

Bulk molding compounds specifically offer *"the best balance of physical properties at the lowest possible cost when compared to engineering thermoplastics and die cast metals."*

(Average Material Attribute Comparison)

	Flexural Strength	Flexural modulus	Impact Resistance	Chemical Resistance	Hydrolytic Stability	High Tg	Tight Tolerances	Dimension Stability	Creep Resistance	Weldability	Total Part Cost	Tooling Cost	Energy Content	Part Weight	Recyclability	Awareness
Alum.	○	○	○	◑	○	○	○	○	○	○	●	●	●	●	○	○
BMC	○	○	◑	○	○	○	○	○	○	●	○	○	○	◑	●	●
Phenolic	○	○	●	○	○	○	●	○	○	●	◑	◑	○	◑	●	◑
PPS	○	○	◑	○	○	◑	◑	○	◑	●	●	○	◑	○	○	○
PPA	○	◑	◑	◑	◑	◑	●	◑	◑	○	◑	○	◑	○	○	○
PA 4,6	○	◑	◑	◑	◑	◑	●	◑	◑	○	◑	○	◑	○	○	○
PA 6,6	◑	◑	◑	◑	●	●	●	●	●	○	○	○	◑	○	○	○

PERFORMANCE ○ Good ◑ Moderate ● Weak

BMC Range of Molding Processes

BMC materials are produced in multiple forms, shapes, and sizes to meet each customers specific processing requirements.

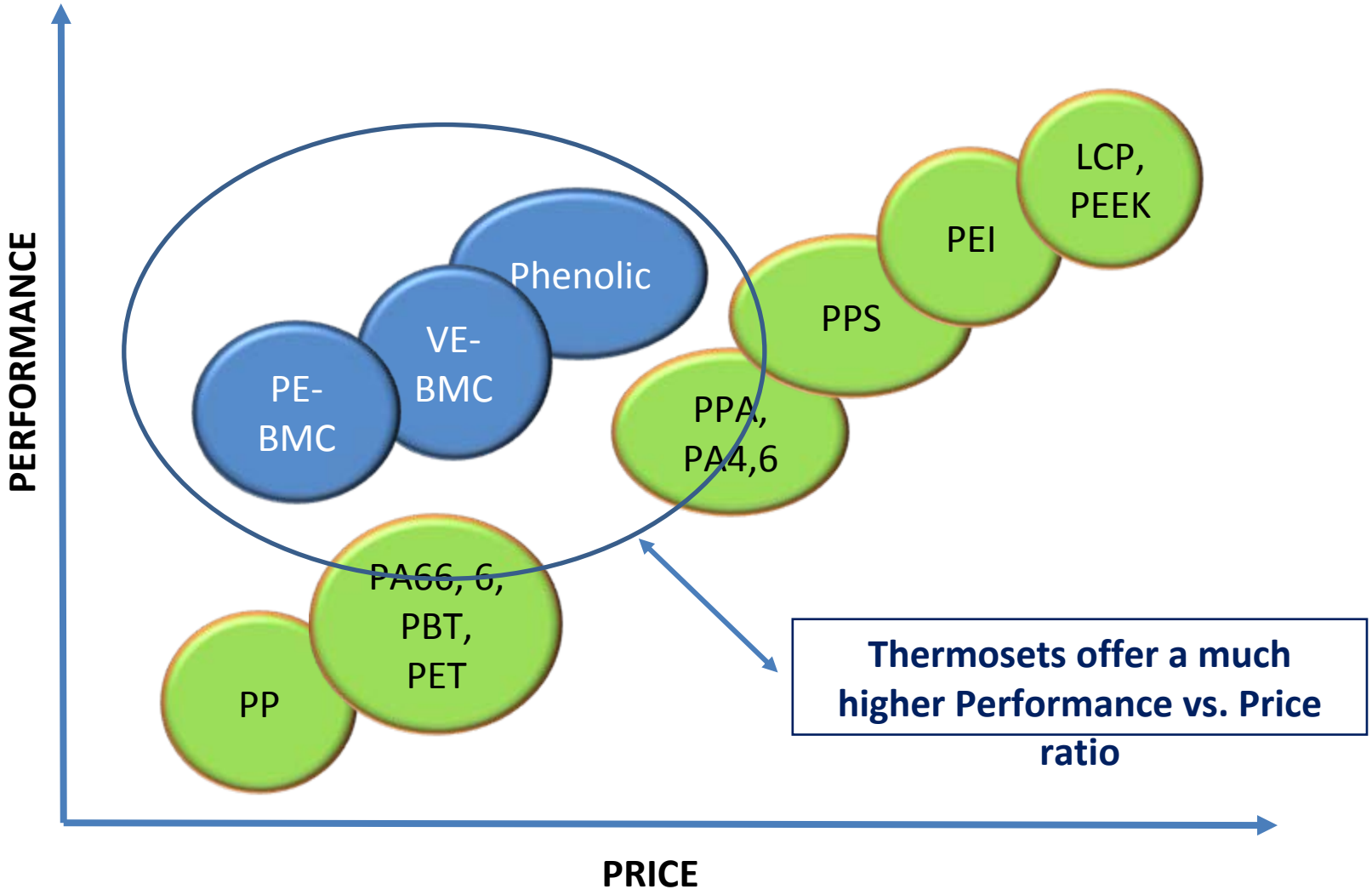
BMC materials can be processed by injection, compression, injection-compression, or resin transfer molding depending on the part size, shape, tolerancing, physical properties, and production volumes

Tool life in most cases exceeds more than one million shots making it a very economical process when compared to metal die casting processes.

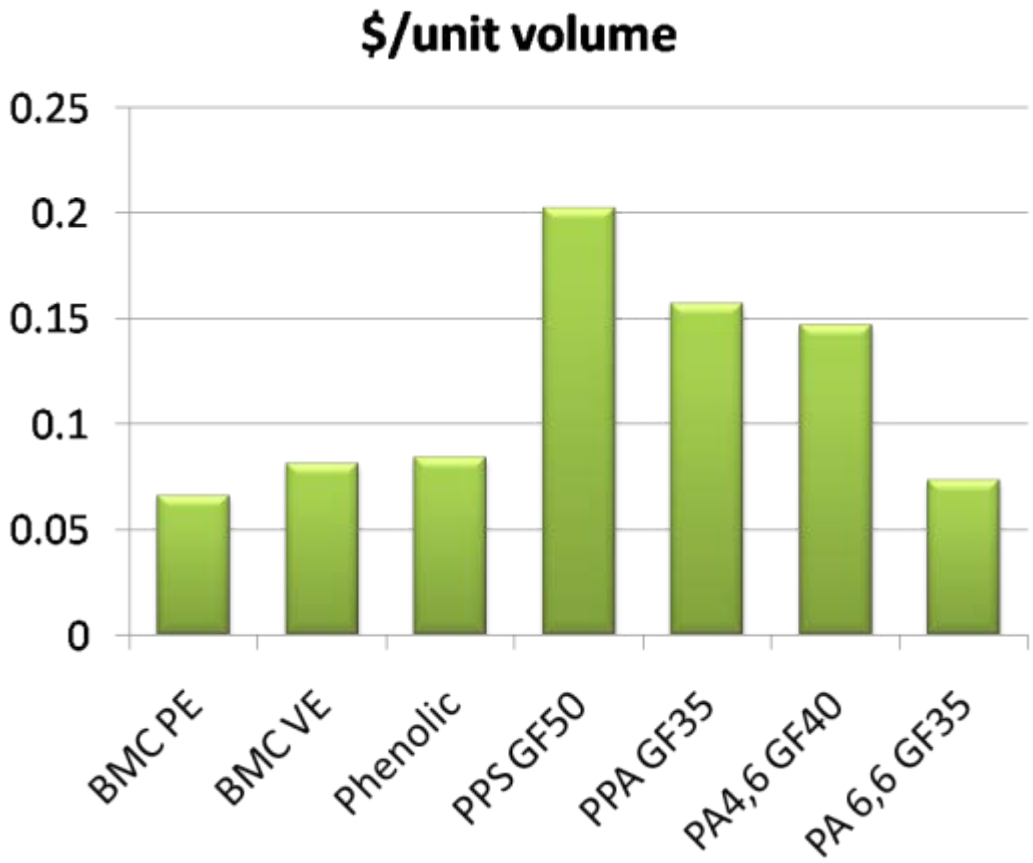
High Performance – Low Cost

- ✓ High temperature resistance – Tg> 200C
- ✓ Very high strength to weight ratio (Flexural modulus greater than 18 GPA)
- ✓ Chemically resistant to most automotive fluids
- ✓ Repeatable molded part dimensions (zero post mold shrink possible)
- ✓ Excellent dimensional stability/tight tolerances over wide range of temperatures (low CLTE)
- ✓ Low warpage/excellent part flatness
- ✓ Extremely high creep resistance
- ✓ Excellent flammability resistance (UL94V-0)
- ✓ Excellent electrical properties (insulating or conductive)
- ✓ Low relative cost to alternative high performance materials
- ✓ High temperature assembly possible (soldering, welding, etc.)

BMC vs. High Performance Thermoplastics

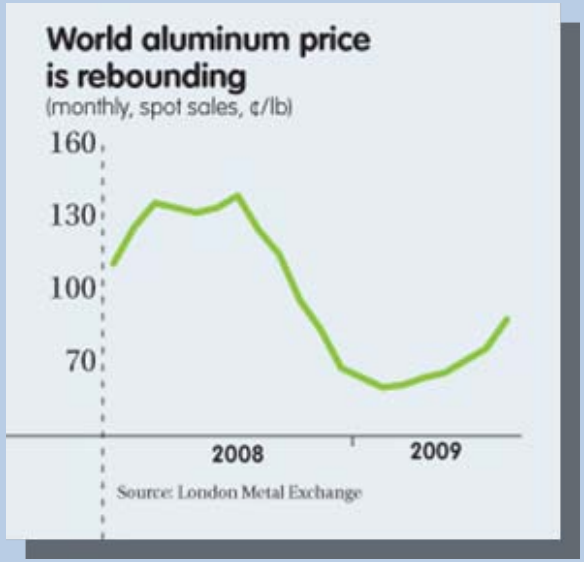


On a cost / unit volume basis thermosets offer significantly higher value compared to many High Performance Thermoplastics.



BMC Price Stability vs. Aluminum and ETP

High loading of functional mineral fillers and glass fiber reinforcements reduce formulation costs and maximize compound price stability

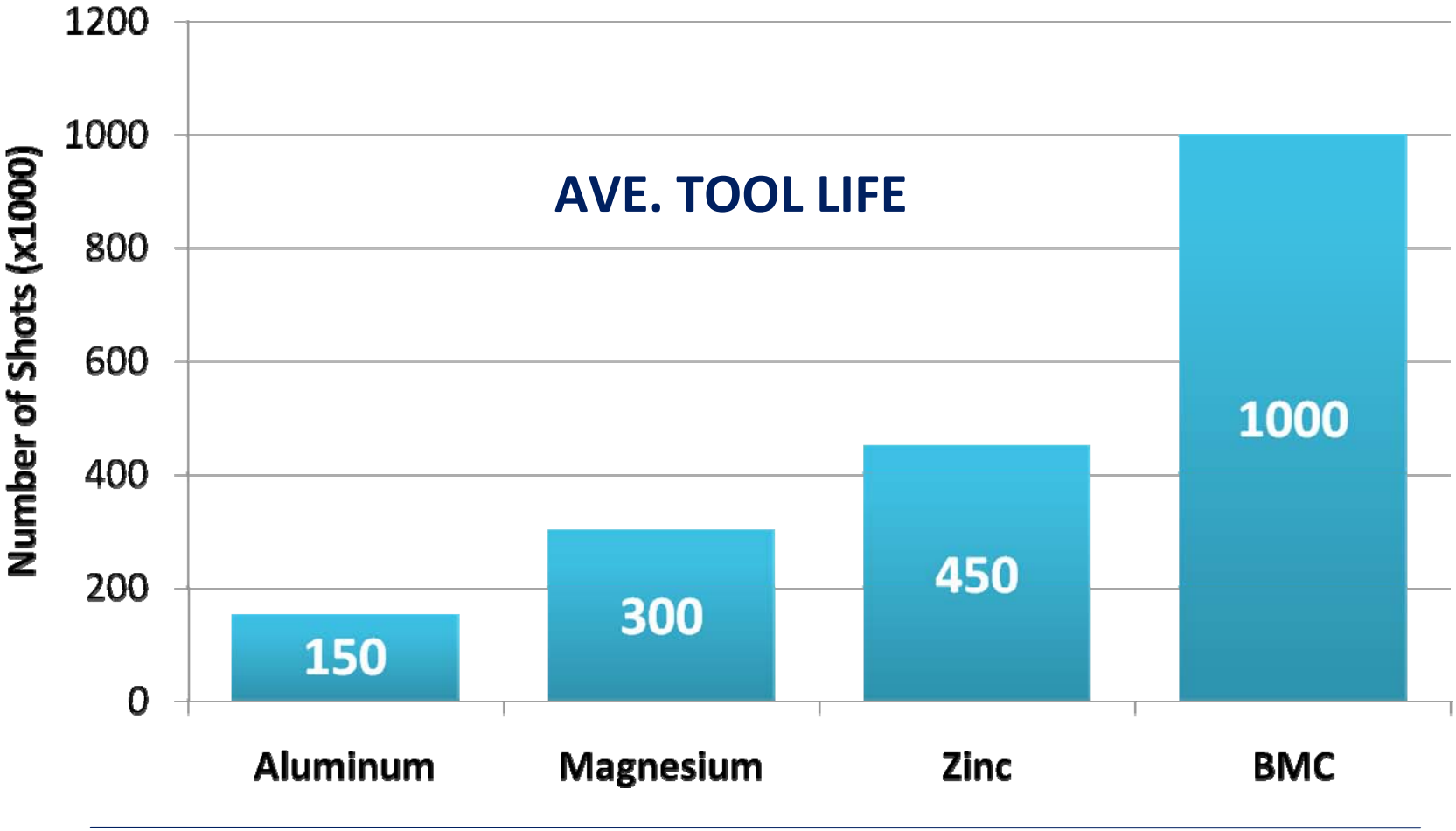


BMC vs. Aluminum Die Casting

Aluminum Housing	BMC Housing	Advantage BMC
Volume – 250,000 / yr	Volume – 250,000 / yr	
Program Life – 5 Years	Program Life – 5 years	
Tool – 4 Cavity	Tool – 4 cavity	
Weight – 250 g	Weight – 195 g	25% Reduction
Tool costs = $270,000	Tool Costs = $170,000	37% Reduction
Parts Price = $5.75	Part Price = $3.35	42% Reduction

Costing Savings Through Longer Average Tool Life

BMC composites provide for significant additional savings when it comes to tool life



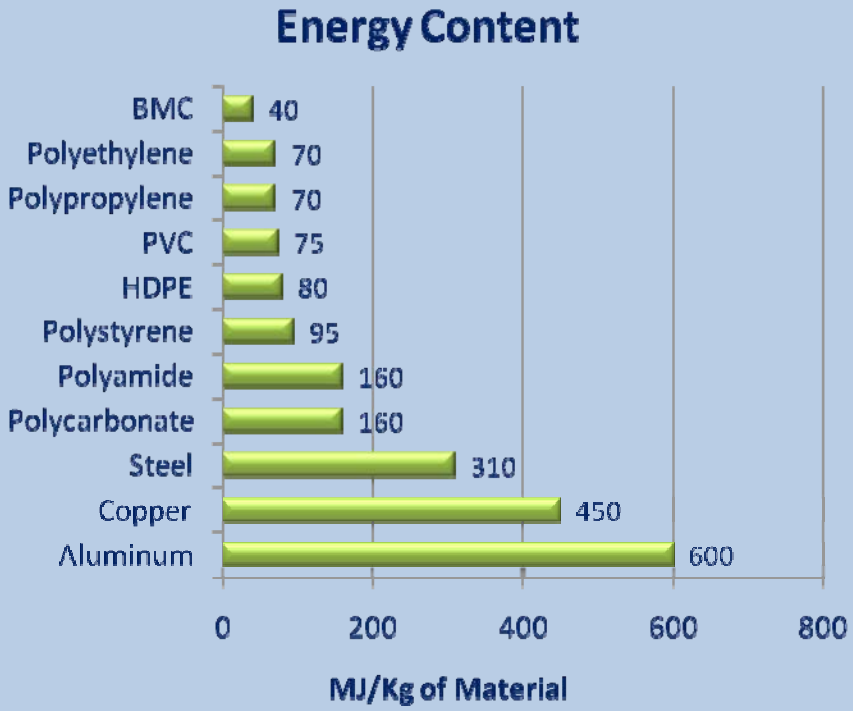
- BMC Dimension X
  - Zero Out of Mold Shrinkage
- Green BMC
  - Soy-based polyester resin with thermoset regrind and natural fibers
- BMC 945
  - Conductive BMC
- Super Tough BMC
  - High Impact, High Tensile Strength
- Low Abrasion BMC 584
  - Excellent dimensional precision combined with self lubricating properties

BMC Sustainable Material Solutions

The major environmental and social impacts of products throughout their life cycle along with the materials from which they are produced, is increasingly being recognized by customers across all market sectors. Many companies have embraced the importance of product sustainability, driven by environmental objectives and increased demand and prices of energy and resources.

BMC materials offer immediate solutions to this demand with core products that offer one of the lowest energy content and cost solutions in light weight/high performance materials.

BMCI has further responded to the demand for renewable materials by developing a line of bio-based BMC composites that employ the use of vegetable oils based resins, recycled fillers, and natural and organic fiber reinforcements.

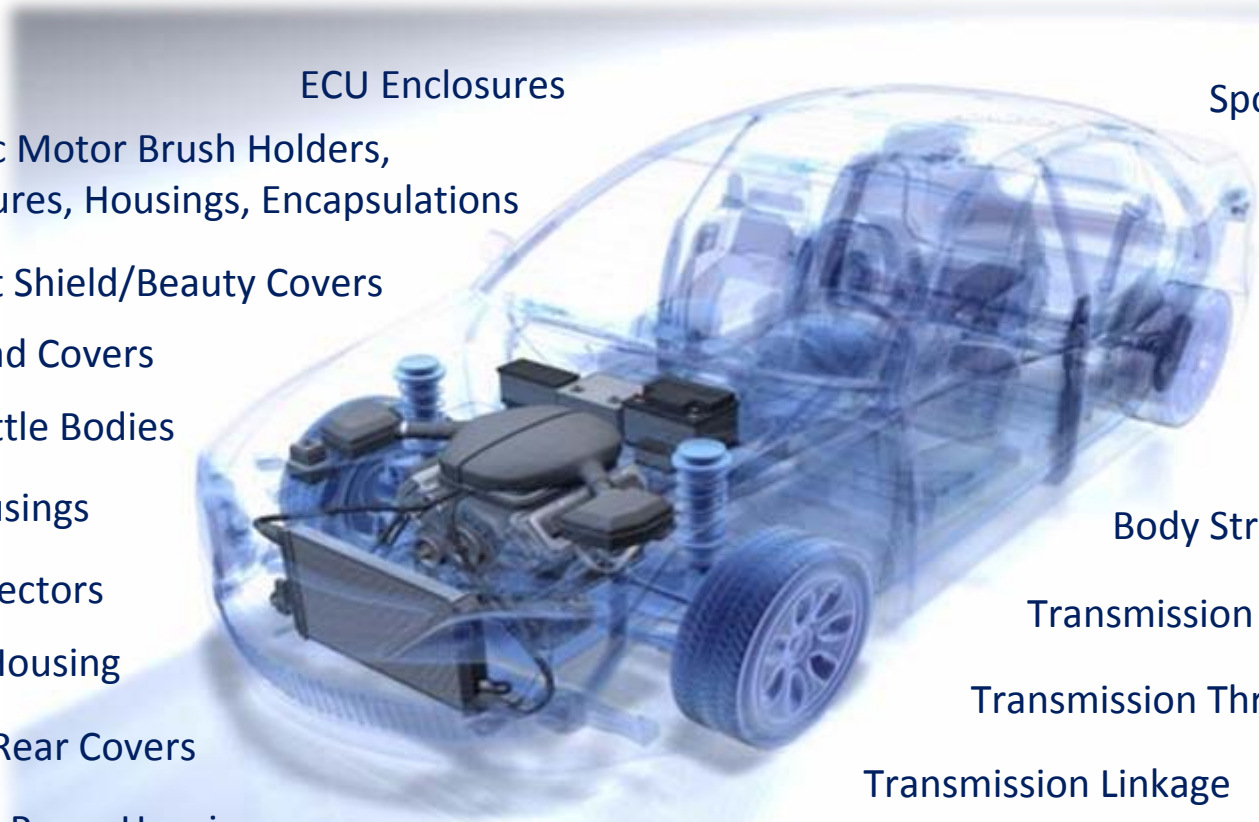


Green BMC

Green BMC is manufactured using 100% soy based resin an doffers properties comparable to standard to standard grades at competitive costs.

Green BMC also provides a solution to thermoset reprocessing but using pulverized molded BMC as 10% of its filler content.

BMC Range of Automotive Applications



ECU Enclosures

Electric Motor Brush Holders, Armatures, Housings, Encapsulations

Engine Heat Shield/Beauty Covers

Cylinder Head Covers

Electronic Throttle Bodies

Thermostat Housings

Head Lamp Reflectors

Vacuum Pump Housing

Engine Front/Rear Covers

Cooling Pump Housing

Oil Pump Housing

Oil Filter Housing

Turbo Systems

Oil Sump/Pan

Starter Solenoid End Cap

Transmission Linkage

Transmission Thrust Washers

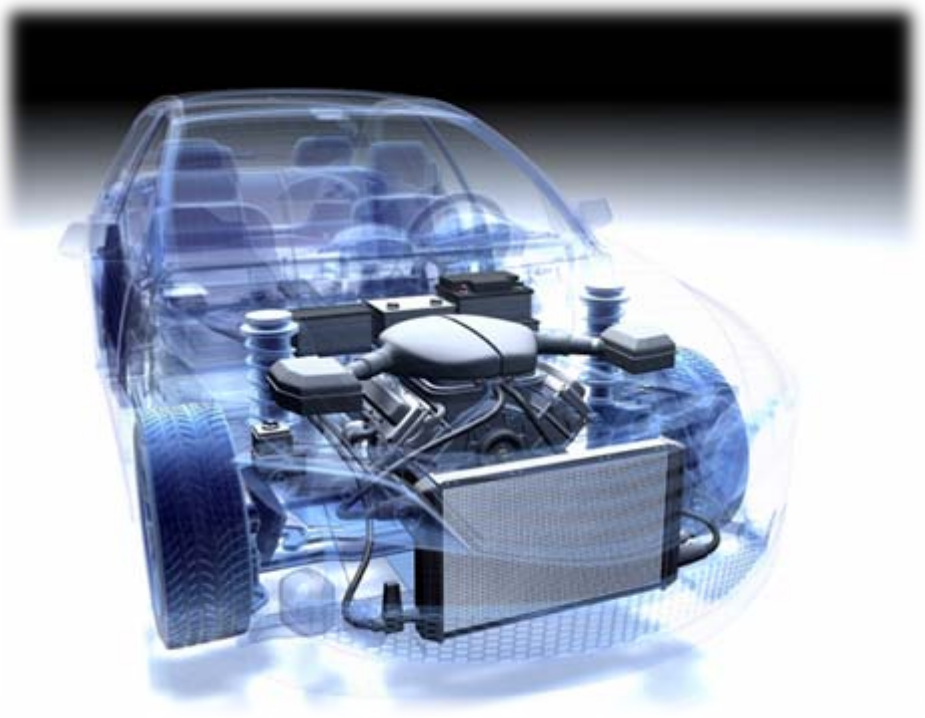
Transmission Sump Pan

Body Structural Inserts

Under Body Heat Shields

Fuel System Components

Spoilers, Air Vents



BMC AUTOMOTIVE APPLICATIONS OVERVIEW


TT RS
D
IN RS 2501
CarWalls.com

Cylinder Head Covers

Process: Injection or Compression Molding

Material: BMC 675, 685, 695, 695HT Polyester and Vinyl Ester Composites

Benefits of BMC over Al, Mg:

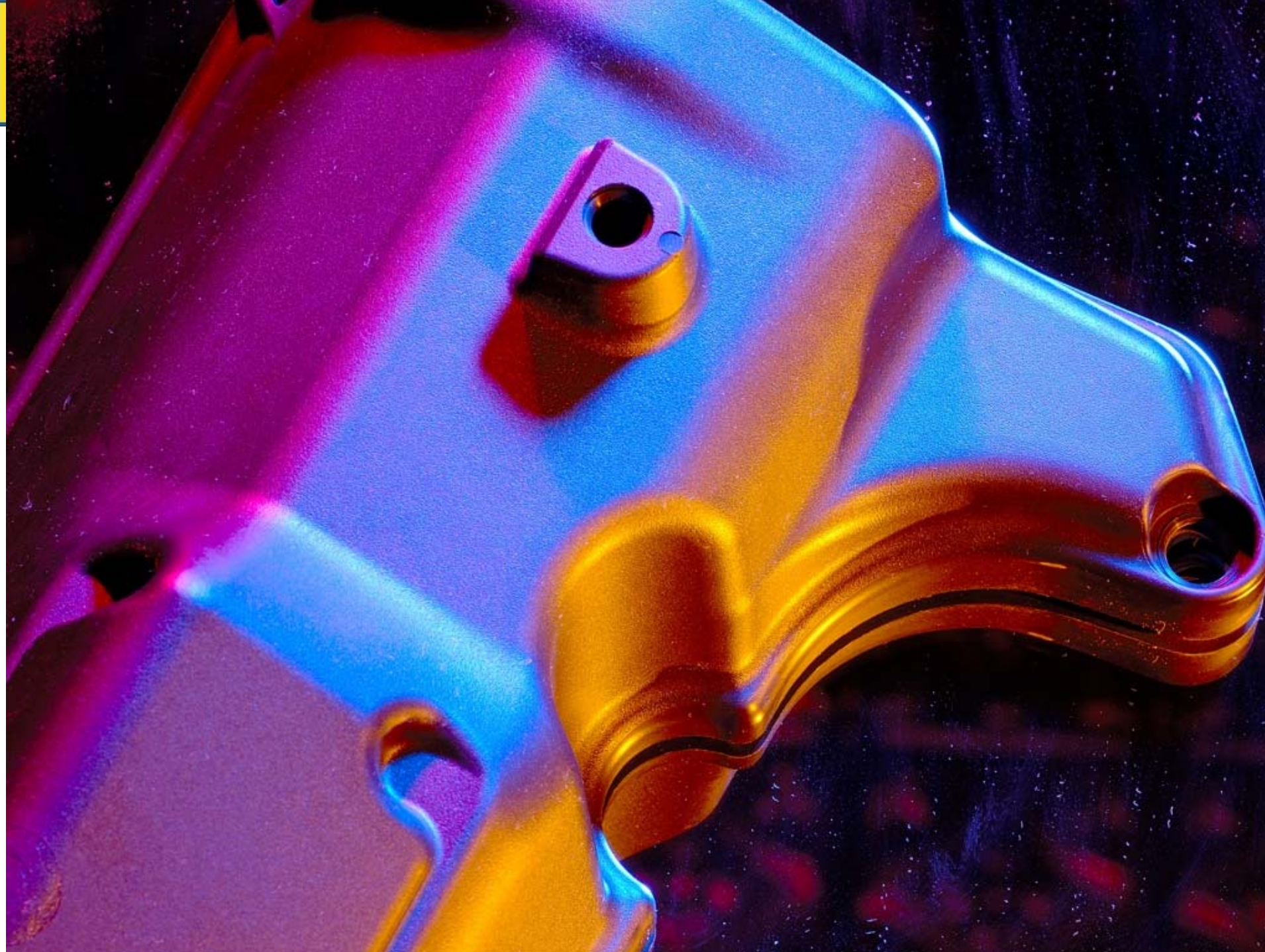
- ✓ Piece Price Savings: 30-40%
- ✓ Tooling Cost Reduction
- ✓ Weight Savings: 25-30%
- ✓ Improved NVH/Damping Properties

Benefits of BMC over PA66

- ✓ Higher temperature capabilities
- ✓ Improved flatness of sealing flange
- ✓ Dimensional stability and creep resistance
- ✓ Improved sealing for multi-planar head surface
- ✓ Ease of coloring/aesthetics
- ✓ Supports larger bolts spans
- ✓ Excellent Flame Resistance (UL94 V-0)

Typical application requirements

- Temp : -40C to 130C
- Tight tolerances and dimensional stability over operating range
- Flexural creep resistance to maintain seal
- Chemical resistance to under hood fluids
- Long term exposure to hot engine oil



Engine Front and Rear Covers

Process: Injection Molding or Compression Molding

Material: BMC 695 Vinyl Ester Composite

Benefits of BMC over Die Cast Aluminum:

- ✓ Piece Price Savings: 15-35%
- ✓ No Machining Operations
- ✓ Component/Feature Integration
- ✓ Tooling Cost Reduction
- ✓ Weight Savings: 20-35%

Typical application requirements

- Temp : -40C to 130C+
- Tight tolerances and dimensional stability over operating range (positioning, sealing)
- Creep resistance
- Impact Resistance
- Chemical resistance to under hood fluids
- Long term exposure to hot engine oil

Electronic Throttle Body/Diesel Air Control Valve

Process: Injection Molding

Material: BMC Dimension X, BMC L420 Polyester Composite

Benefits of BMC over Aluminum:

- ✓ Piece Price Savings: 30-40%
- ✓ Tooling Cost Reduction
- ✓ Weight Savings: 25-30%
- ✓ Improved icing / no heating
- ✓ Eliminates coking performance issues
- ✓ Equivalent or better dimensional tolerances
- ✓ Print Tolerance: +/- 0.05mm flatness/roundness
- ✓ Improved safety during crash
- ✓ Reduced manifold dynamic loading

Benefits of BMC over High Performance ETP

- ✓ Piece Price Savings: 30-75%
- ✓ Zero out of mold shrinkage
- ✓ Lower CLTE/better dimensional stability
- ✓ Larger bores possible

Typical application requirements

- Temp : -40C to 150C
- Very tight tolerances
- Dimensional stability for concentricity of bore diameter over operating range
- Creep resistance
- Chemical resistance to under hood fluids


SIEMENS VDO


VIPER
VIPER

Engine Covers/Heat Shields

Process: Injection Molding or Compression Molding

Material: BMC 304 Polyester, BMC 675, 695 Vinyl Ester Composite

Benefits of BMC:

- ✓ Low Cost
- ✓ High Temperature Resistance Tg.> 200C
- ✓ Very Low Warpage
- ✓ Low Thermal Conductivity
- ✓ Dimensional Stability
- ✓ Excellent Flame Resistance (UL94 V-0)
- ✓ Flexibility of processing (injection or compression)
- ✓ Design Flexibility/Functional Integration

Potential Applications:

- Underbody
  - Spare Tire, Fuel Tank
- Underhood
  - Fuel System, Turbo System, EGR System, Aesthetic Cover

Typical application requirements

- Temp : -40C to 150C (>150C as heat shield)
- Low warpage/dimensional stability over operating range
- Good aesthetics, No discoloring
- Chemical resistance to underhood and underbody fluids
- Impact resistance

ECU Enclosures

Process: Injection Molding, Compression Molding

Material: BMC 300, 304, 605 Polyester Composites

Benefits of BMC over Die Cast Aluminum:

- ✓ Piece Price Savings: 30-50%
- ✓ No Machining Operations
- ✓ Tooling Cost Reduction (3-4X)
- ✓ Weight Savings: 20-30%
- ✓ Feature Integration

Potential Applications:

- Air bag control modules
- Stability control modules
- Roll over sensor modules
- Telematic/infotainment control modules
- Powertrain control modules (engine, transmission)

Typical application requirements

- Interior, Chassis, Engine Compartment
- Temperature Range:-40 to 120C
- Tight tolerances and dimensional stability over operating range
- High stiffness/rigidity to meet resonant frequency requirements and prevent PCB flex
- Torque/Creep resistance
  - No compression limiters
- EMI Shielding
- Low Moisture Absorption
- Chemical Resistance

Motor End Caps/Brush Holders/Housings

Process: Injection Molding

Material: BMC 600, 605, 604, 620, 3001H, 1901 Polyester Composites

Benefits of BMC

- ✓ Low Cost/Piece Price Savings
  - HPP's,Phenolics
- ✓ Excellent Dimensional Stability/Tolerances
- ✓ Low Moisture Absorption
- ✓ Low Mold Shrinkage
- ✓ Low CLTE
- ✓ Excellent Dielectric Properties
- ✓ High Temperature Resistance (>180°C)
- ✓ Reduced noise

Potential Applications

- Starter Motors
- Alternator (Start/Stop Motors)
- Wiper Motors
- Lift Gate Motor
- HEV Motors
- Turbo Actuator Housings

Typical application requirements

- Tight tolerances and dimensional stability over operating range
- 150°C continuous use temperature
- Excellent Resistivity/High dielectric strength
- Flammability resistance (UL94V-0)
- High mechanical strength/stiffness
- Chemical resistance

Automotive Pump Housings (Mech/Elec)

Conversion from Die Cast Aluminum Housings to BMC Thermoset Composites

Potential Applications:

- Engine lubrication pumps
- Transmission fluid pumps
- Vacuum pumps
- Fuel transfer Pumps
- Gerotor, Gear, Vane, Lobe, etc.

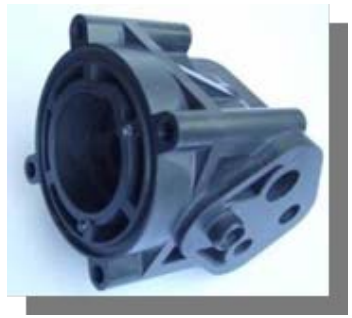
Typical application requirements

- Temp : -40C to 150C
- Tight tolerances and dimensional stability over operating range
- High thermal/mechanical strength requirements
  - Internal Pressures >200psi
- Wear resistance to maintain pump efficiency
- Long term fluid/chemical resistance

Why BMC Composites

- Piece Price Savings: 30-40%
  - Net shape molding/no machining
  - Feature/component integration
- Tooling Cost Reduction
- Weight Savings: 25-30%

- Strong/rigid material at high temps (150°C)
- Withstands high oil pressure/cycling
- Self lubricating formulations for low wear
- Tight/repeatable print tolerances
  - 20 micron clearances
- Very low CTE, similar to metal
- Very low creep



Transmission Shift Linkage

Process: Injection Molding

Material: BMC TDV 510

Benefits of BMC over Aluminum:

- ✓ Piece Price Savings: 40%
- ✓ No Machining Operations
- ✓ Tooling Cost Reduction
- ✓ Weight Savings: 25-30%
- ✓ Feature Integration - Overmolded rubber grommet
- ✓ Wear Resistance/Self Lubricating

Typical application requirements

- Very tight tolerances and dimensional stability over operating range
- 150°C continuous use temperature
- High mechanical strength/stiffness
- Chemical resistance
- Good wear resistance

Exterior Spoilers/Air Vents

Process: Injection/Compression Molding

Benefits of BMC over Aluminum:

- ✓ Cost Reduction
- ✓ Weight Reduction vs. Metal
- ✓ Class A Paintable Surfaces
- ✓ Vehicle In-Line Painting
  - ✓ High Temperature >120C
- ✓ Low CLTE – Similar to mating metal components
- ✓ Design Freedom
- ✓ Systems Integration
  - ✓ Lighting Components/Housings
  - ✓ Telematics/antenna systems

Typical application requirements

- Class A Surface
- Primer/Paint Compatible
- High mechanical strength
- Low thermal expansion
- High Temperature Resistance (120-180C)
  - Paint/Clear Coat Process

Body Structural Inserts

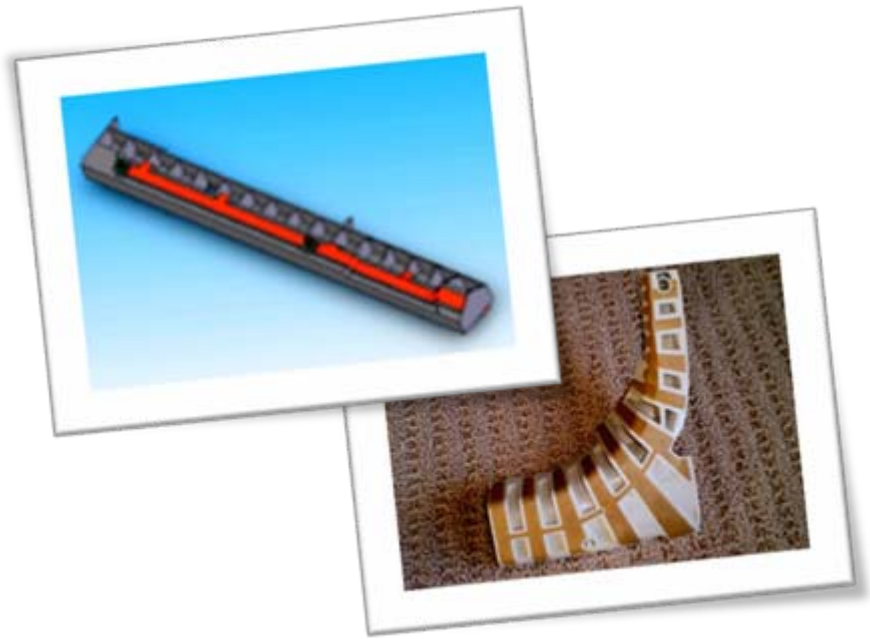
Process: Injection Molding, Compression Molding
Material: BMC 304, 675 GF Polyester Composite

Benefits of BMC Structural Inserts:

- Mass Reduction, Downgaging of Steel
- Cost Reduction
- Improved Vehicle NVH
- Improved Crash Behavior - Safety
- High Flex Modulus/Stiffness
- High Glass Transition Temp's
- Low Moisture Absorption
- BMC vs. High Glass Nylon
    - High flex modulus/stiffness
    - Lower Cost
- High Flexibility in Formulation
    - Material properties can be tailored to specific application requirements
- Design Flexibility vs. Metal inserts
    - Complex shapes
- Very Good Adhesion to Structural Adhesives

Typical application requirements for structural inserts/adhesive carriers:

- High Mechanical Strength/Rigidity
- Impact Resistance
- High Thermal Stability/Heat Resistance
- Low Moisture Absorption
- Corrosion Resistance



Air Valve (Brakes)

Process: Injection Molding

Material: BMC TD 690

Benefits of BMC over Aluminum:

- ✓ Piece Price Savings: 53%
- ✓ No Machining Operations
- ✓ No fixturing
- ✓ Tooling Cost Reduction
- ✓ Weight Savings: 25-30%

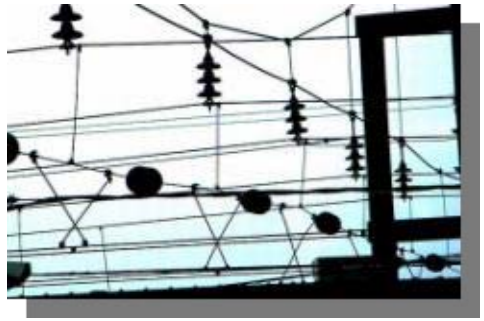
Typical application requirements

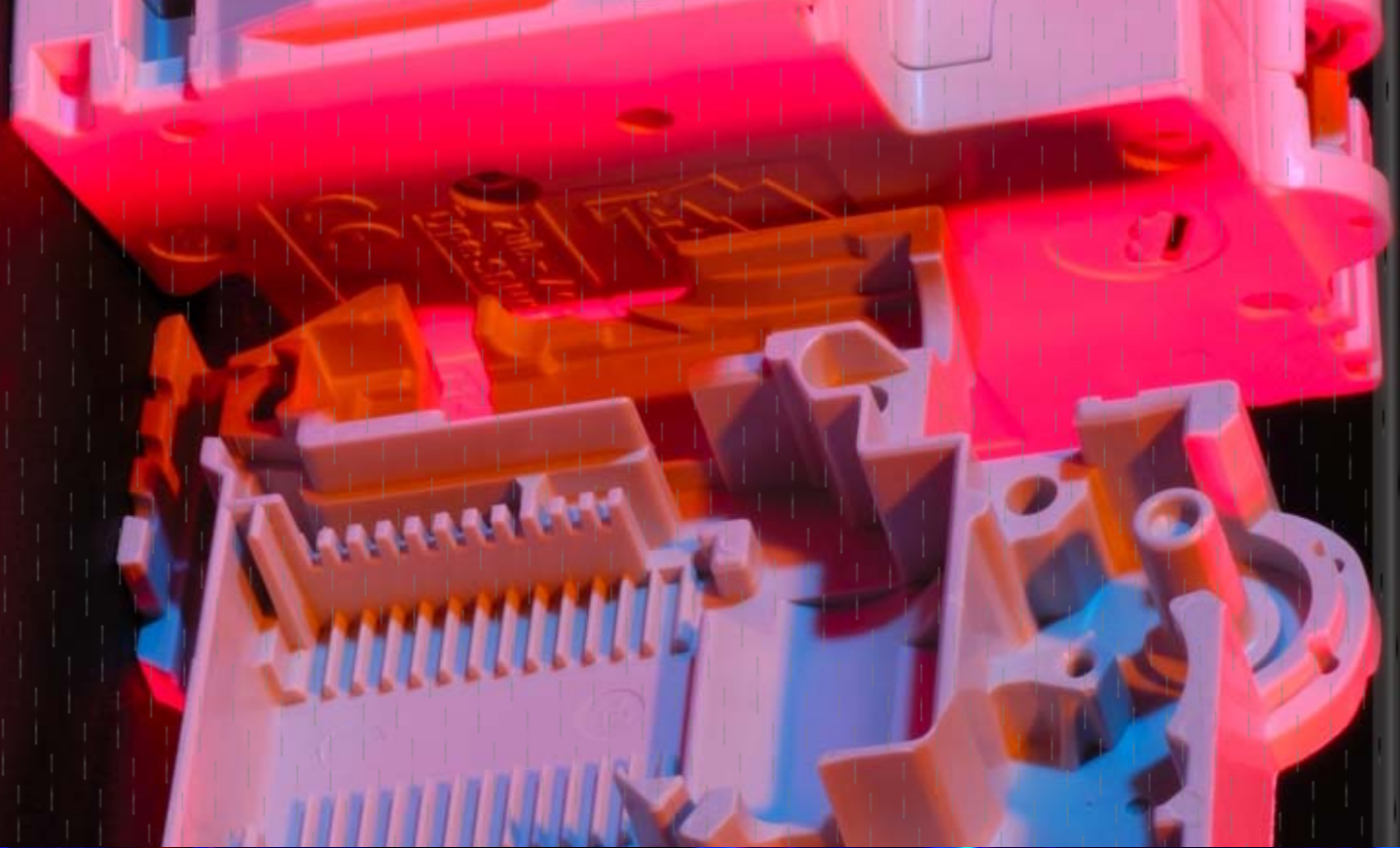
- Extremely Tight tolerances and dimensional stability over operating range
- < 0.05mm Flatness
- High mechanical strength/stiffness
- Chemical resistance

BMC FOR HYBRID ELECTRIC VEHICLES

BMC for Hybrid Electric Vehicles

- Long history in high voltage applications
- High Dielectric Strengths (>15 kv/mm)
- High UL Relative Temp. Index (RTI) rating (160˚C)
- High volume resistivity retention with humidity exposure (1E+14 Ωcm)
- High Comparative Tracking Index to prevent carbon tracking (>600 Volts)
- Inherently flame resistant (UL-94-HB/V0)
- Low CLTE – Excellent for over-molding and insulating metal components



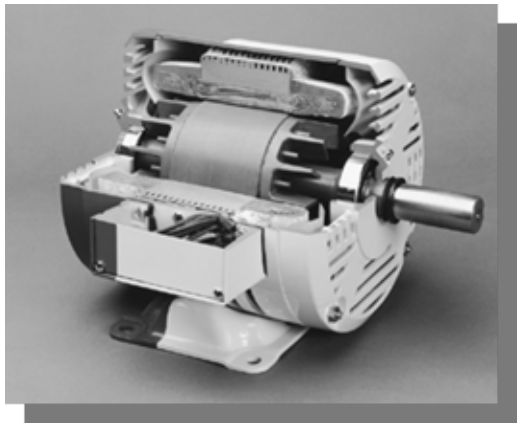



SIEMENS
15
ON
OFF
TYPE HOM
TIPO
10 kA
120/240 V~
Al/Cu
Cu
LISTED
C.B.

BMC HEV Target Applications

- Power distribution module boxes
- Inverter/converter boxes/frames
- Traction motor coil encapsulations
- Battery pack frames
- Thermal management system components
- Over-molded electrical lead frames/bus bars
- High voltage connectors
- Heat shielding/thermal barriers
- Auxiliary pump housings
- ICE Front Covers

BMC Electrical Encapsulations



BMC Composites are used for encapsulated/over molded coils in a variety of different applications and difficult environments and industries including:

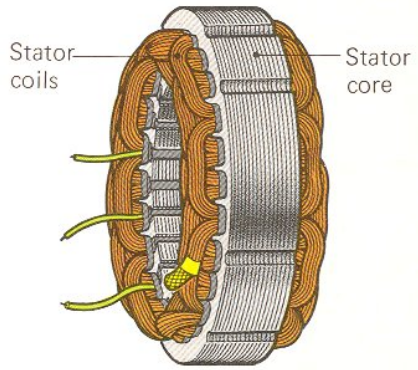
- Solenoids, transformers, electric motor stators, armatures, commutators, sensors, etc
- Extreme temperatures, moisture and humidity, chemical and solvent exposure, etc

BMC Encapsulation Benefits

(HEV Traction Motor Stator Coils)

Manufacturing and assembly make up ≈ 40% of current motor costs

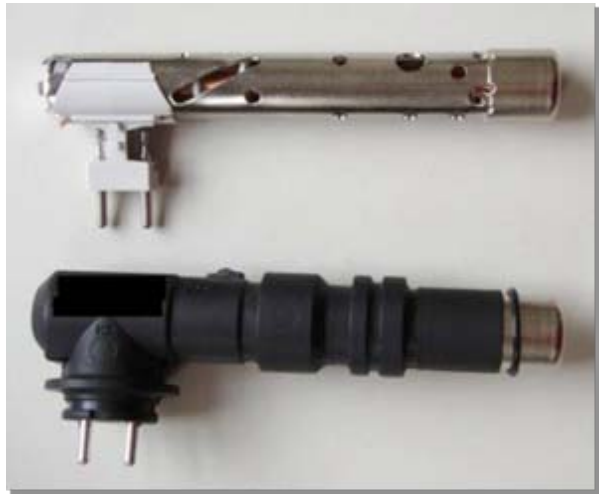
Encapsulation with BMC enables cost reduction vs. alternative methods of construction



- **Cycle time and processing step reduction**
  - Faster cycle times (5-10 minutes vs. 4-8 hours)
  - Eliminate trickle varnish, taping, tying, machining
- **Component reduction and feature integration**
  - Housings/covers, mounting features, termination features, connectors and bearing housing integration are possible with BMC encapsulations.
- **Over-molding of sensitive electronics (PCB's etc)**
  - High flow/low pressure molding (2-10MPa)
  - Reduced cure temp materials (<130C)

Sensor/PCB Encapsulations

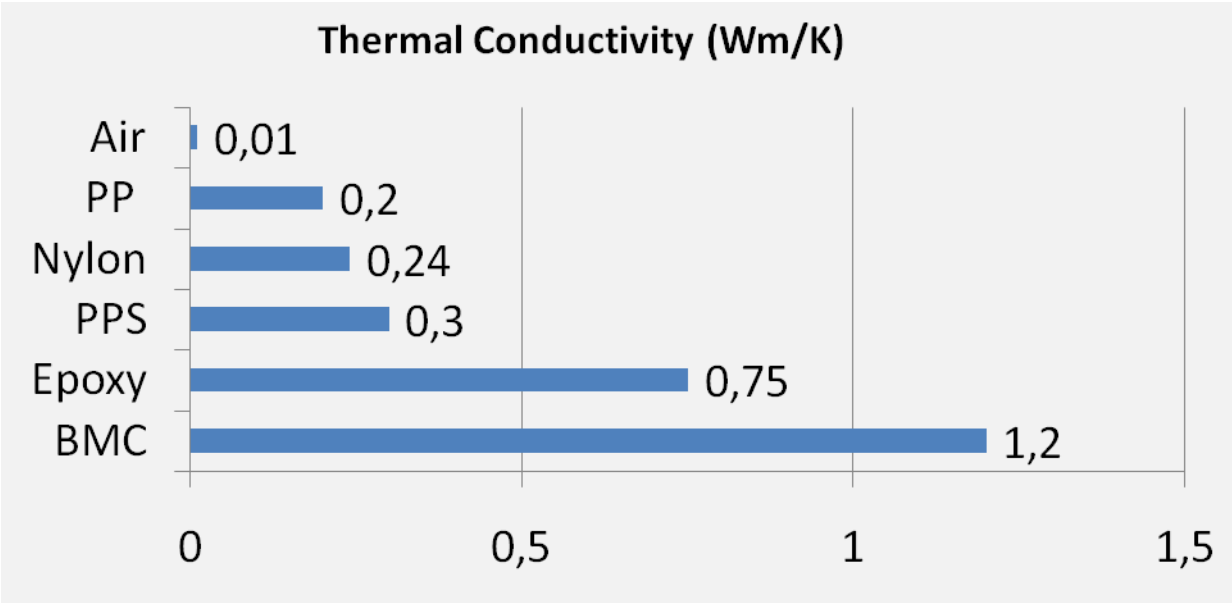
- Proliferation of various electrical systems in automotive has increased the demand for sensors in vehicles
  - i.e. speed, position, temperature, fluid level, etc.
- Encapsulation is employed to provide insulation and to protect them against moisture, dirt or mechanical damage.
- BMC offers low cost encapsulation materials capable of meeting the demands in many sensor applications especially in extreme environments.
- BMC sensor encapsulation materials are also able to be used for highly sensitive sensors including “Hall Effect” where avoiding damage and/or displacement of integrated circuit chips and other delicate electrical components is critical.



BMC Encapsulation Benefits

(HEV Traction Motor Stator Coils)

- **Improved thermal dissipation**
  - Thermally conductive BMC's > 1 W/m K vs. 0.01 for air
  - Higher power motors = higher heat
  - Improved efficiency, higher specific power and power density
  - Longer life



BMC Encapsulation Benefits

(HEV Traction Motor Stator Coils)

- **Improved reliability**
  - Protect and strengthen the coil windings
  - Protection from harsh automotive environment (moisture, chemicals, abrasives, etc.)
  - Reliable performance at high temperatures
  - Homogenous and mechanically stable structure
    - Tight tolerances
    - Reduced stack up tolerances through integration (i.e. bearing)
  - Low mold shrinkage (zero possible)
  - Low CLTE, similar to metal mating components
  - Reduced mechanical stresses
  - Tighter process control vs. other insulating methods

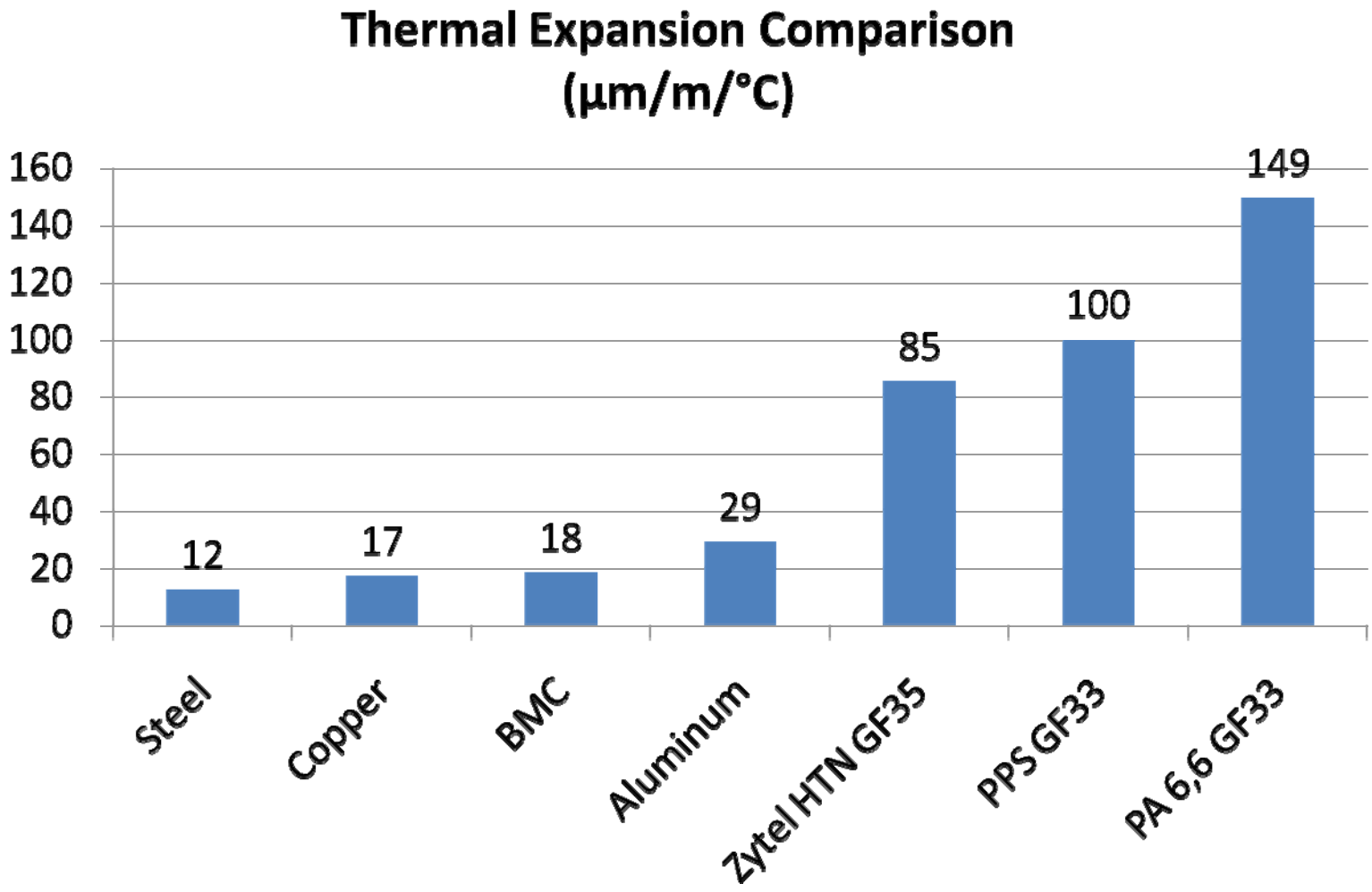
BMC Encapsulation Benefits

(HEV Traction Motor Stator Coils)

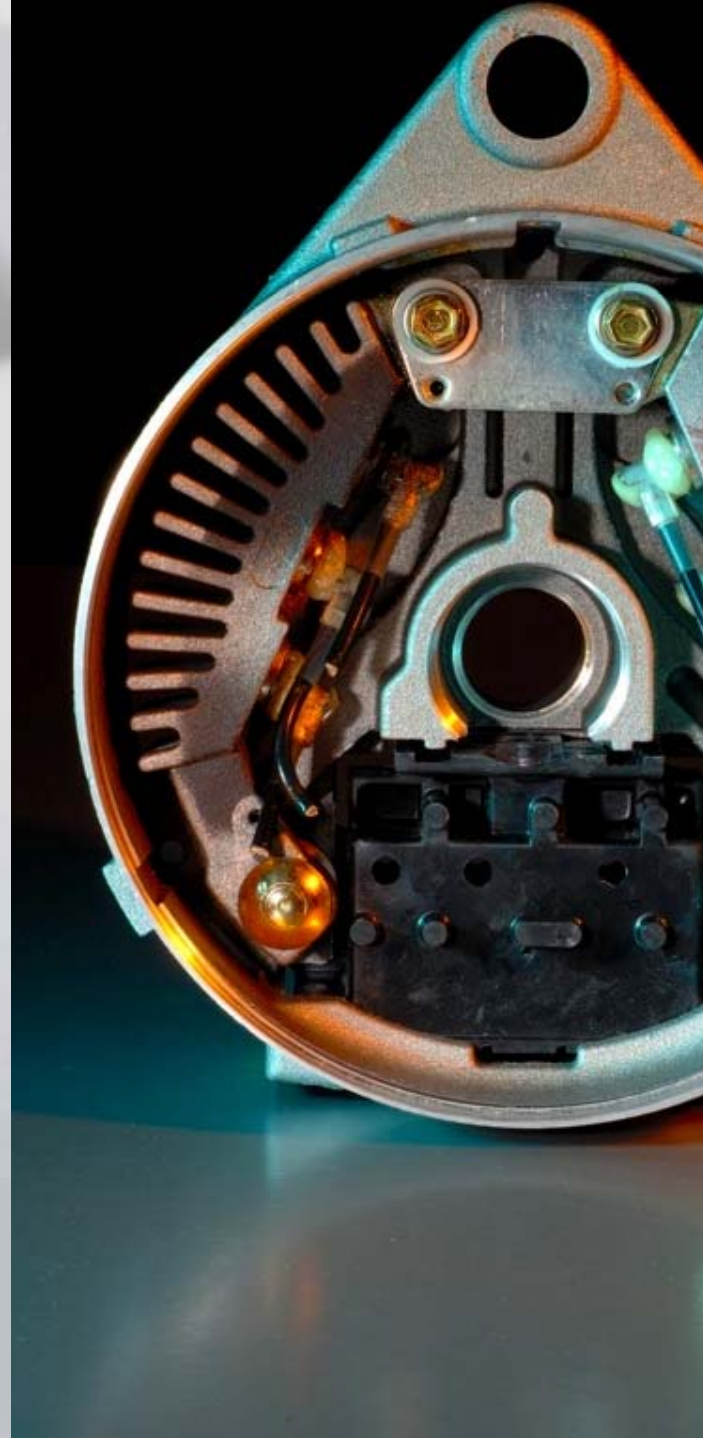
- **Improved vibration damping /acoustics**
  - Homogenous and mechanically stable structure
  - Higher overall stiffness/rigidity
  - Reduced stator deformation
  - Tailored mechanical properties

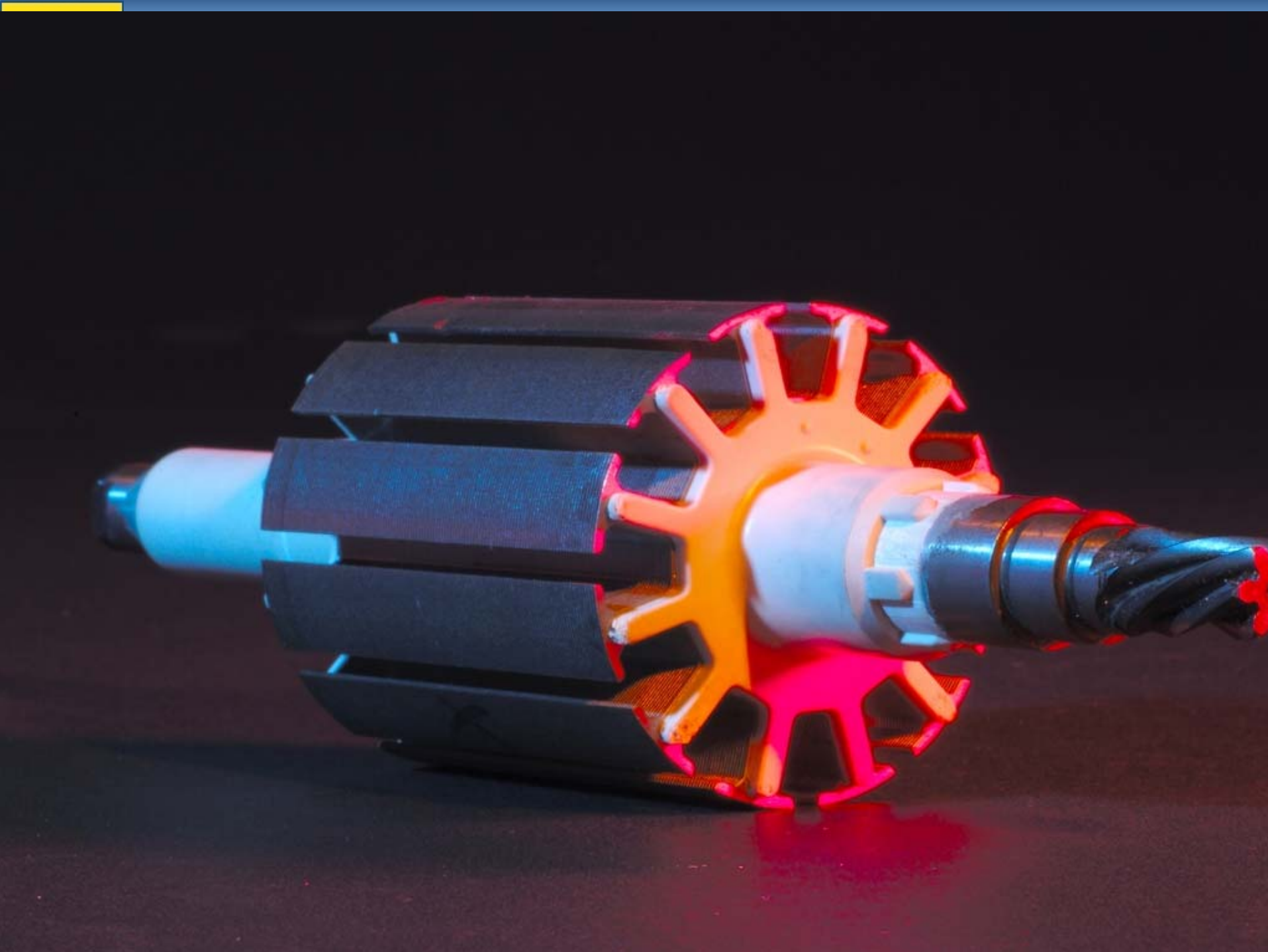
- **Improved dielectric insulation characteristics**
  - Increased breakdown strength
  - Excellent penetration between windings
  - Low molded in stresses (zero shrink)
  - Low stresses during thermal cycle (low CLTE)

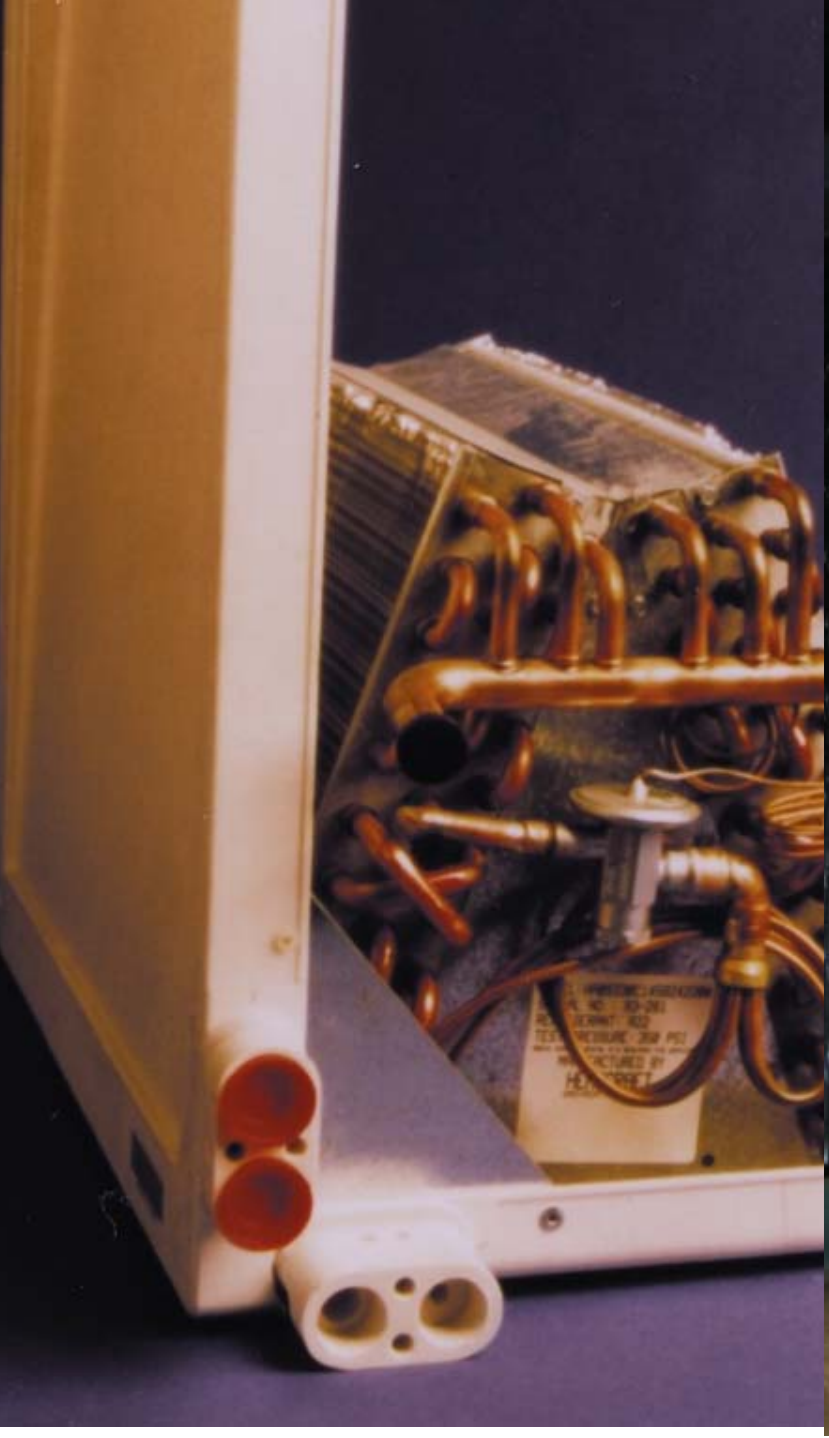
Coefficient of Thermal Expansion Comparison

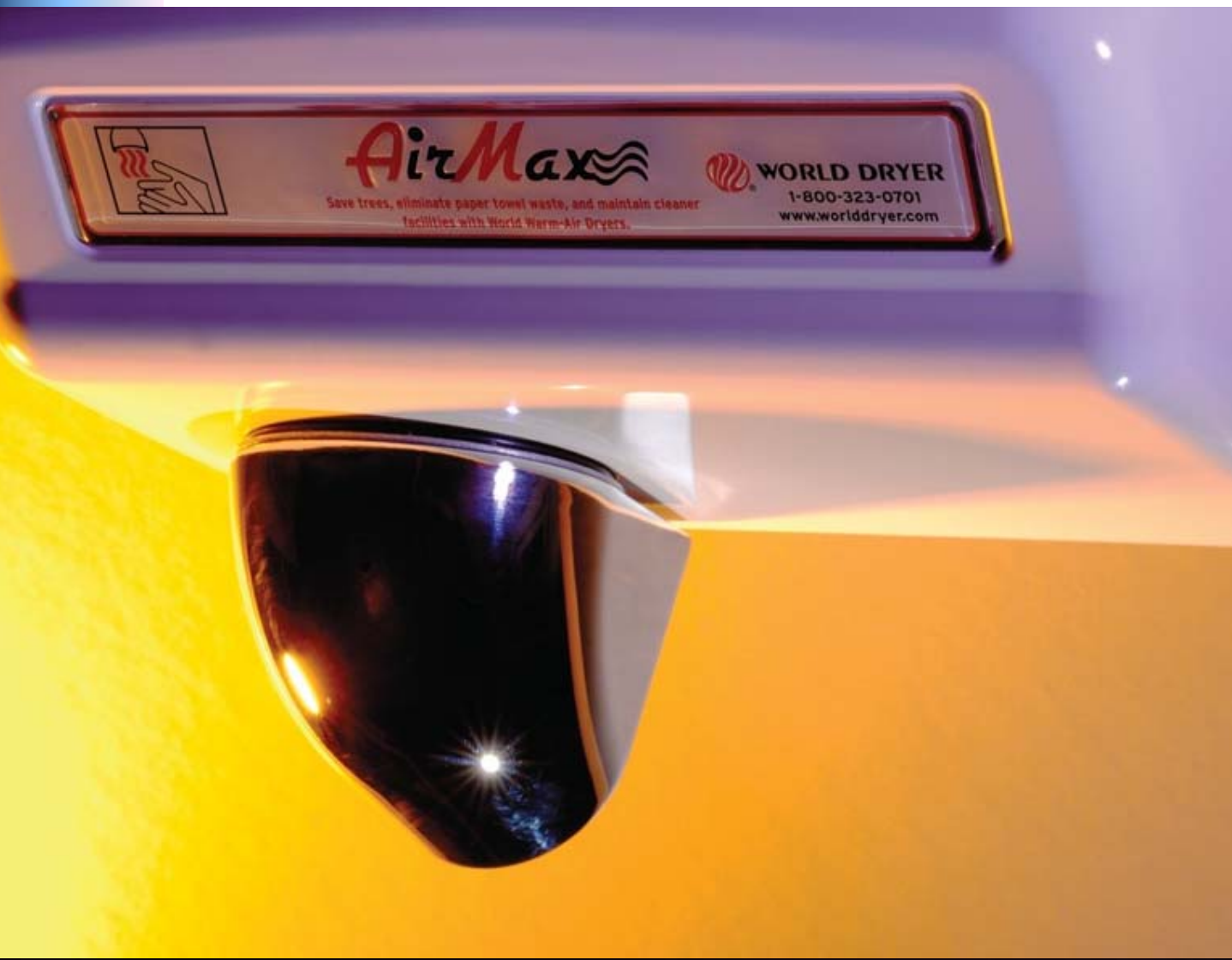



OTHER
APPLICATIONS
Sorocaba
Jundiaí
São Paulo
S. Vicente
Santos
Mogi
Juquiá





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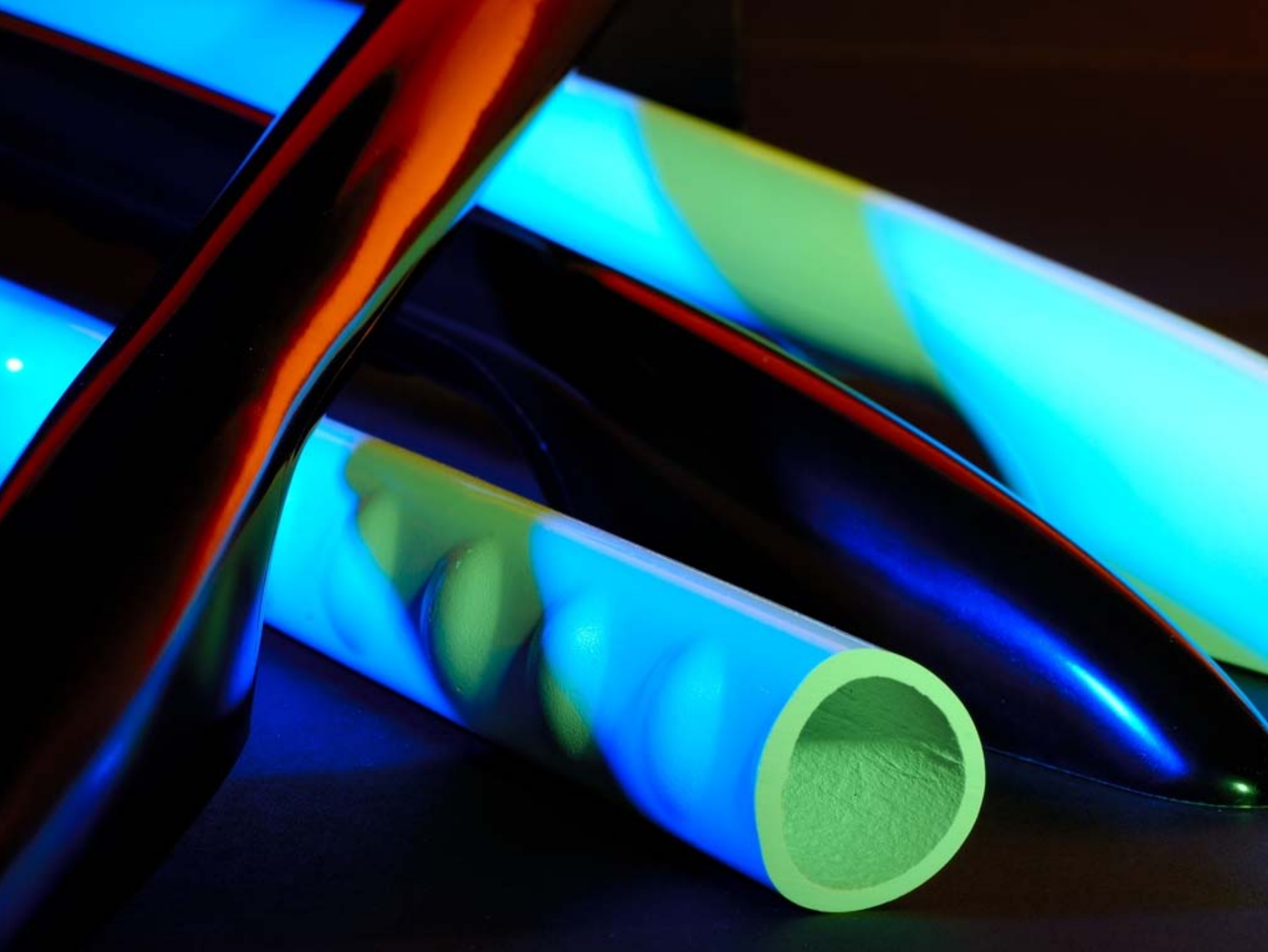
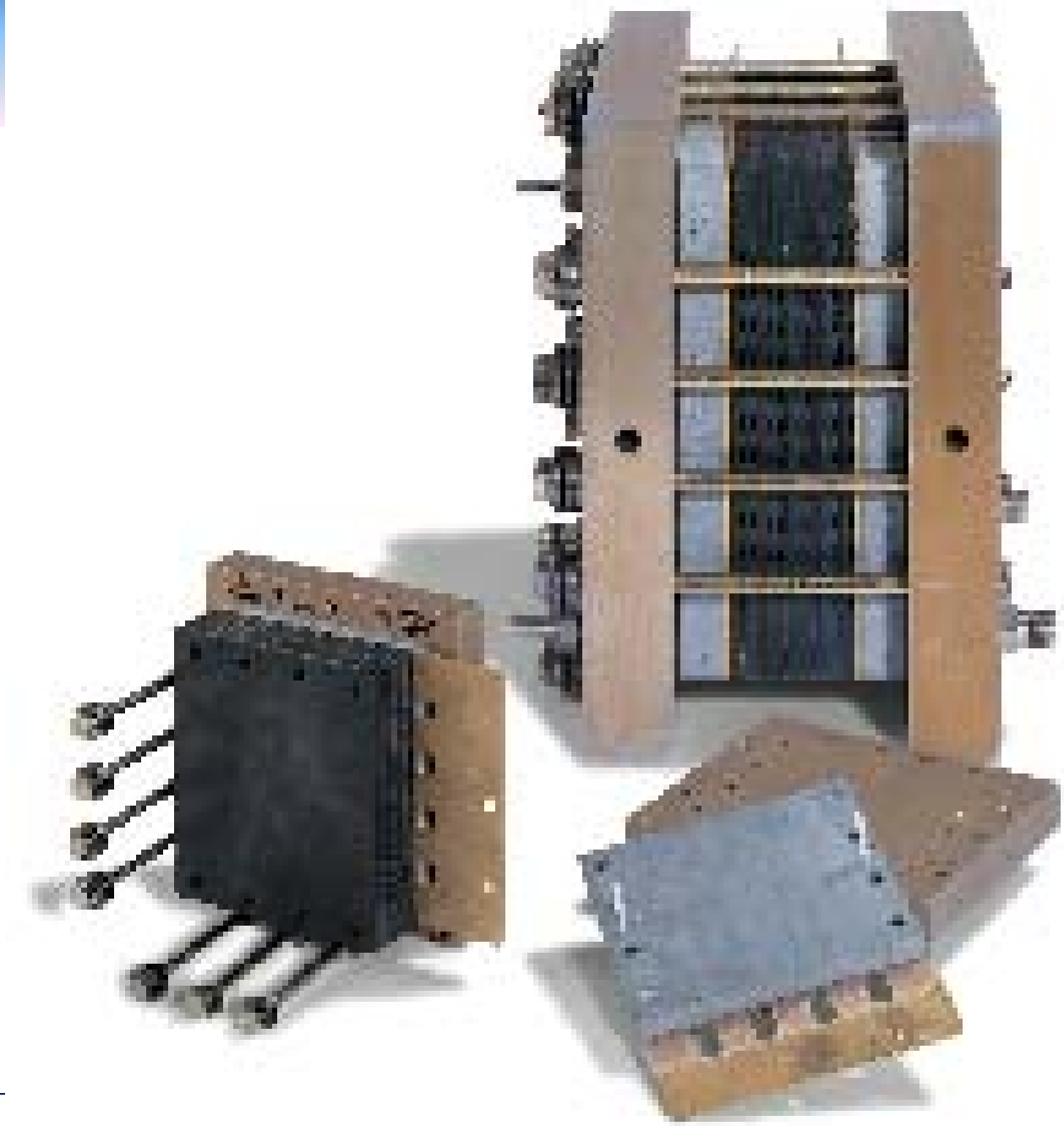
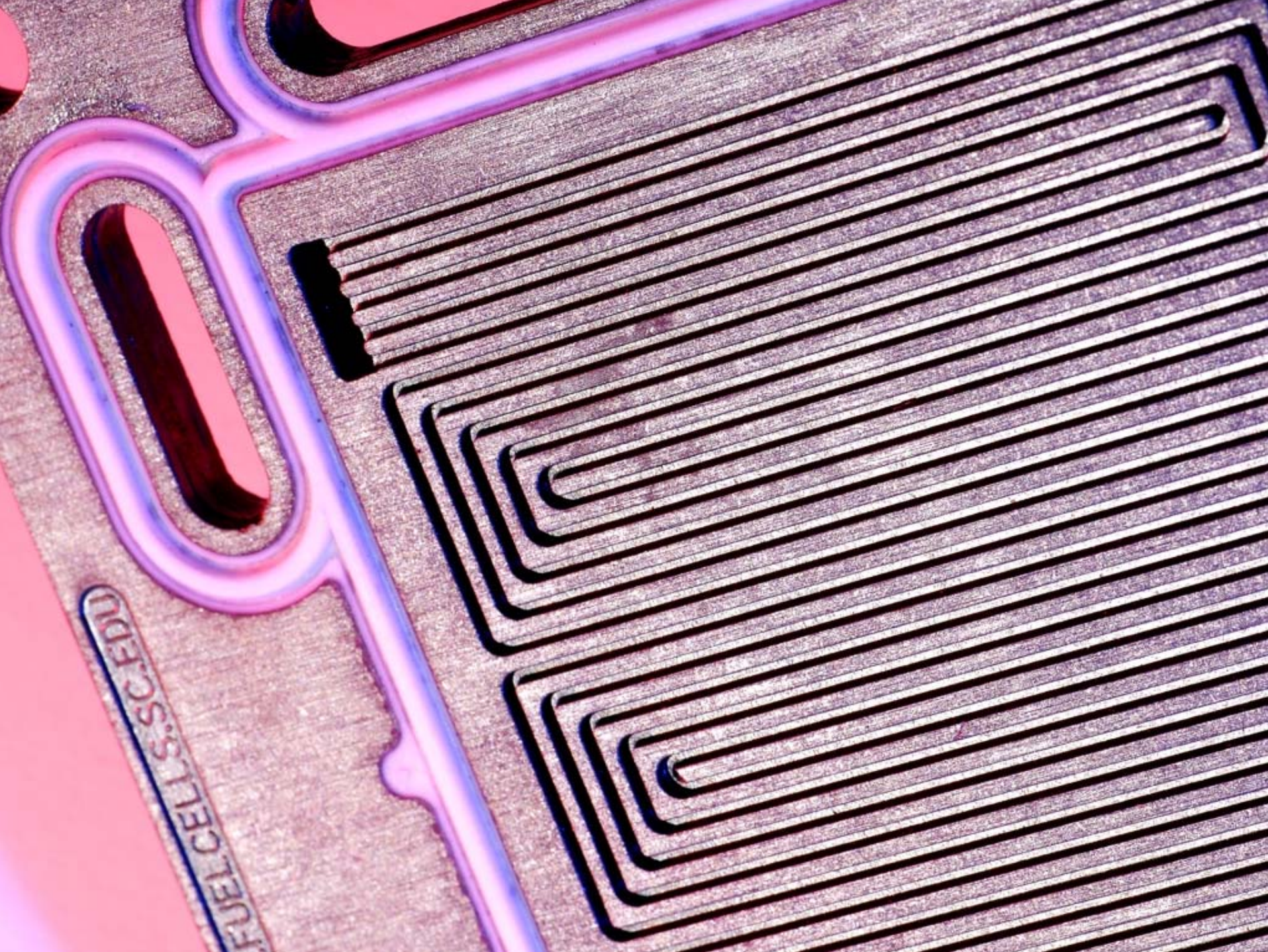


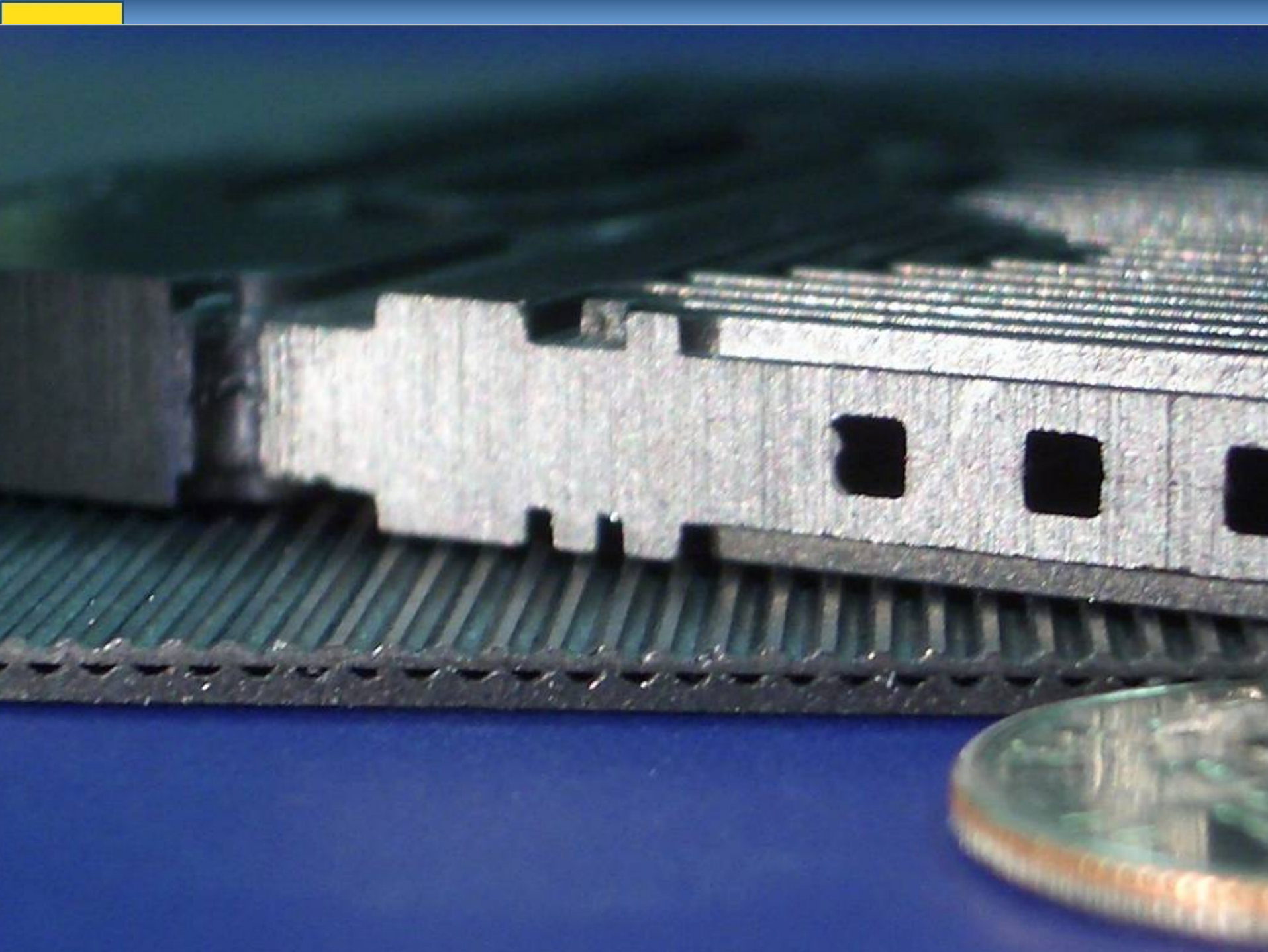

Electrolux


Rowenta


DentalEZ




FUEL CELLS SCEDU

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CONCLUSION
Thank You
Sorocaba
Jundiaí
São Paulo
S. Vicente
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Mogi
Juquiá