TENCATE ADVANCED COMPOSITES

Compression Molded Parts

Product Selection Guide





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TenCate Compression Molded Parts

TenCate is a world leader in the design and development of composite materials for the aerospace, satellite, high performance industrial and consumer products industry. TenCate's CCS Composites, a group within TenCate, is a leading designer and fabricator of compression molded parts made with advanced, fiber reinforced composites. TenCate's compression molded parts are used on a variety of commercial aircraft, helicopters, jet engines, nacelles and satellite structures.

Compression molding overview

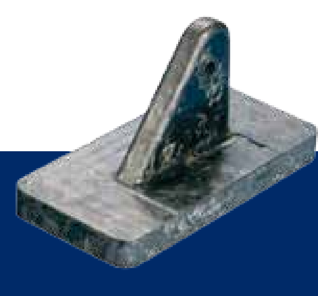
TenCate's CCS Composites compression molded composite parts can provide an alternative to metal parts while delivering lighter weight, higher strength, and/or higher stiffness. TenCate designers can optimize a metal part into a more efficient composite design. For example, designers can easily add integrated ribs for localized stiffness, vary cross sections for weight savings, and select specific fiber types for optimal part performance in the end use application. Additionally, TenCate can integrate fasteners, gaskets and cut outs, and can provide specially designed surfaces such as lightning strike foils or glass isolation plies. TenCate's CCS Composites can also mold parts out of syntactic thermoset pastes where low dielectric strengths are desired or where very high service temperatures are needed.

Materials used in compression molding

Compression molding is a highly controlled process using precise resin infused fiber reinforced tape made with standard, intermediate or high modulus fibers. Resins can be thermoset or a thermoplastic (PEEK or PPS) resin. Bulk molding compounds are made by chopping these unitapes into fiber lengths ranging from 1/4" to 2" (3 to 50 mm). Longer fiber lengths generally provide higher strengths, while smaller length fibers allow more complex structural details to be molded into the part.

Once the tape has been chopped, the material is placed into a mold, heated and compressed under high pressure to form the part. A significant amount of expertise is required to design the tool, optimize the part shape to meet the loading requirements of the part, and minimize post-molding machining operations. With so many material and processing options, TenCate's CCS Composites can help to ensure that the correct selections are made for the application to meet the cost, performance and weight requirements of the specific application.

Bulk molding compound



TYPICAL PROPERTY COMPARISON

		3AL-2.5V Titanium Alloy	6061-T6 Aluminum Alloy	MS-1A	MS-1H	MS-4H
Density (g/cc)		4.5	2.7	1.55	1.52	1.52
Tensile Strength	**psi**	100,000	44,000	42,000	37,100	43,800
	MPa	689	303	290	256	302
Compressive Strength	**psi**	100,000	44,000	41,000	32,800	47,900
	MPa	689	303	283	226	330
Flexural Strength	**psi**	100,000	44,000	67,000	63,700	108,800
	MPa	689	303	462	439	750
Tensile Modulus	**msi**	15.5	10	19	10	6.2
	GPa	107	69	131	69	43
Compressive Modulus	**msi**	15.8	10.2	16	9.2	7.3
	GPa	109	70	110	63	50
Flexural Modulus	**msi**	15.5	10	13	10	9.3
	GPa	107	69	90	69	64

Photo by U.S. Air Force

Photo by Gail Hanusa, Boeing

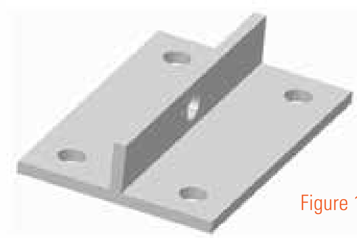


Figure 1

The case for compression molded parts

The comparison chart above shows many of the typical properties of TenCate's compression molding compounds compete directly with common metals. But this is only part of the advantage.

Figure 2

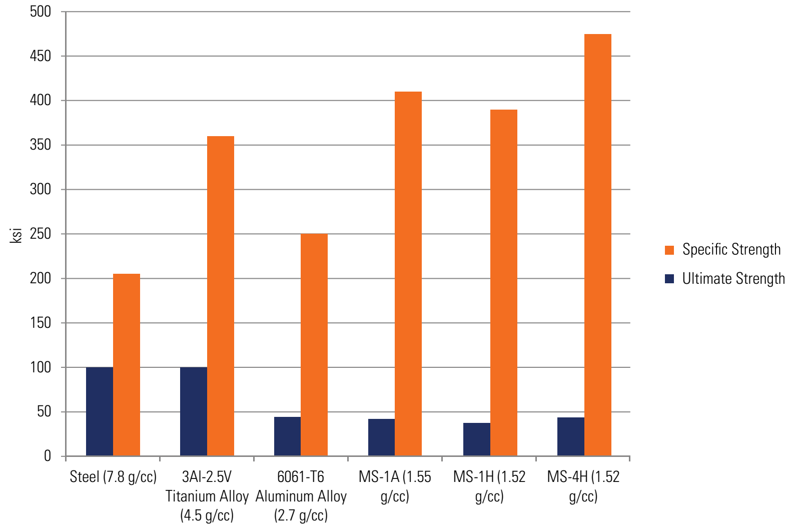
In figures 1-3, the three designs show a progression from a simple metal part to an optimized compression molded composite part. Figure 1 shows a simple metal bracket. The second figure demonstrates that the new composite bracket can be net molded thicker overall at the same weight, including even thicker support areas near the holes and with rounded edges. The last shape (bottom) shows additional reinforcements options made with molded in spars and additional weight taken out on the underside through the design of a narrow channel.

Figure 3

This design flexibility allows a simple geometry to be modified to make a higher performance and lighter weight part, all molded directly. In comparison, metals would generally require complex machining, continuous fiber composites would be extremely difficult to fill into such complex shapes, and injection molding compounds do not have the mechanical properties to provide equal performance.

Metal vs Composites

Though steel and titanium have a greater ultimate tensile strength, bulk molding compounds far exceed these metals in both specific strength, a measure of strength that accounts for density, and stiffness, allowing for the creation of strong part at a fraction of the weight of metal.

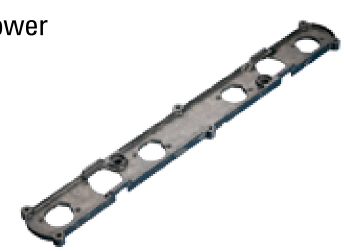


Compression molded aircraft access doors with lightning strike outer surface.

See the CompositesWorld focus on design, "Redesigning for Simplicity"application article on our website.

Typical advantages of compression molded composites.

- Lower part labor content through
  - Reduced kitting, layup, final trim, post machining, and inspection steps
  - Consolidated part count and reduced post assembly times
  - Molded in attachment features
  - High yields
  - Reduced scrap via high pressure molding processes
  - Mold controlled dimensions
  - Quick molding times
- Replace multiple simple parts into one complex part
- Lighter weight, higher performance and/or lower cost than metal parts
- Dimensionally stable
- Non-corrosive benefits (galvanic protection, chemical resistance)



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Applications where compression molded parts excel

- Metal/Composite parts that have changing cross-sectional thicknesses or material tailoring requirements
- Complex geometries that limit the ability to use continuous laminate composites (i.e. long process or high cost)

Some other factors to consider when moving to a compression molded part.

Cost – There is typically a non-recurring tooling cost.

GENERAL DESIGN GUIDELINES

Feature	Tolerence
Part Weights	0.25 - 12 lbs (10g - 5+ kg)
Dimension Tolerence	± 0.007 in. (0.18 mm)
Features Tolerence	± 0.005 in. (0.13 mm)
Iterative Tool Mods	± 0.003 in. (0.08 mm)
Wall Thickness - Minimum	~ 0.05 in. (~1.3 mm)
Draft Required	1 - 3°
Transition Radii	0.025 - 0.05 in. (0.6 - 1.2 mm)

Typical compression molding process steps.

TENCATE COMMERCIALLY AVAILABLE MOLDING COMPOUNDS

Matrix	Tg °F (°C)	Product		Typical Tensile Modulus (Msi)
		Name	Fiber Modulus	
Epoxy	375°F (190°C)	MS-4H	SM	6
		MS-1H	IM	10
	327°F (164°C)	MS-1A	HM	19
MC1100 PPS	194°F (90°C)	MC1100	SM or IM	TBD
MC1200 PEEK	290°F (143°C)	MC1200	SM or IM	TBD

SM - Standard Modulus, IM - Intermediate Modulus, HI - High Modulus

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For more information about Bulk Molding Compounds, please visit us online and download our latest datasheets:

WWW.TENCATE.COM/CompressionMoldedParts

PRODUCTS

- Thermoplastic composites
- Thermoplastic laminates
- Thermoset composites
- Parts manufacture

QUALIFICATIONS

- ISO 9001
- AS 9100

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iPad / iPhone / Android Apps

Photos courtesy of the respective companies. Printed in USA.

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