

GREENE, TWEED'S AWARD-WINNING THERMOPLASTIC COMPOSITE COMPONENTS

Greene, Tweed produces composite components for the world's leading commercial aircraft, manufacturers of down-hole equipment and vertical pumps, and suppliers of semiconductor wafer fabrication equipment.

Greene, Tweed maintains ISO9001 and AS9100 compliant facilities around the world, allowing us to provide global engineering, sales and manufacturing services. From design and development through manufacturing and testing, Greene, Tweed offers an in-depth range of in-house capabilities:

- Composites design and FEA (finite element analysis)
- Materials and process development (including physical/mechanical testing)
- Prototype development and evaluation
- Waterjet cutting and high tolerance 5 axis CNC machining
- Quality assurance (CMM, X-ray and ultrasonic)
- Dedicated material test lab
- Product qualification to full scale production

We bring our extensive knowledge of the markets we serve to each composite component we engineer. We also bring a commitment to partner with our customers to solve the structural application challenges in today's aerospace, oilfield, semiconductor, solar, petrochemical and power generation industries.

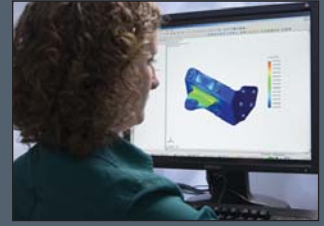
Xycomp® high-performance thermoplastic composites ... present an **80 percent lower density** than steel, **60 percent lower** than titanium and **40 percent lower** than aluminum.



Xycomp® composite containment shell

DELIVERING HIGH PERFORMANCE WITH XYCOMP® THERMOPLASTIC COMPOSITES

Xycomp high-performance thermoplastic composite components provide significant weight savings, exceptional mechanical performance and fatigue life, corrosion resistance, and improved wear, helping customers reduce energy cost and minimize operational downtime. Greene, Tweed's knowledge of materials and our proprietary process capabilities enable us to manufacture Xycomp products in complex shapes to meet all of your component needs.



FEA



Material testing



Bearing & holder assembly



Wafer handler



Aerodynamic filler panels

XYCOMP THERMOPLASTIC COMPOSITES

BUILDING ON EXPERIENCE

Greene, Tweed has been providing custom solutions for over 145 years. Our understanding of customer needs has focused our efforts in three key areas: Properties, Performance, Processing.

PROPERTIES

Greene, Tweed's Xycomp® composites have excellent mechanical properties to meet the performance requirements of metal replacement applications. Xycomp products use thermoplastic resins that are tougher and more chemically resistant than thermoset resins used in traditional composite materials. Several different thermoplastic resin families are utilized in the Xycomp product line, including: PEI, PEEK and PEKK.

Utilizing of multiple resins allows us to engineer high-performance solutions that most effectively meet the customer's specific needs. We match the appropriate resin with either carbon or glass reinforcement fibers in a variety of product forms to create components that are customized for the customer's structural applications. Xycomp thermoplastic composite material forms include proprietary long-fiber materials, woven fabrics, braided sleeving, and unidirectional tape, all with a high reinforcement fiber content for optimum performance. In addition, our innovative, award-winning Xycomp DLF (discontinuous long fiber) material allows us to create complex geometries previously impossible to mold from composites.

PERFORMANCE

Composites are becoming the material of choice for many applications due to ever-increasing performance requirements. Xycomp composites provide a number of benefits, including:

- **Energy savings due to weight reduction.** Carbon-fiber-reinforced Xycomp composites have 80 percent lower density than steel, 60 percent less than titanium and 40 percent less than aluminum—resulting in efficiency gains for aircraft components or rotating parts.
- **High-temperature performance.** Xycomp composites have good high-temperature stability and can be used in higher continuous service temperature environments than most plastics, resulting in an extended life for high-temperature applications.
- **Excellent FST capability.** Xycomp products have outstanding FST (flame, smoke and toxicity) performance, making them the best choice for structural commercial aircraft interior components and other applications that need to meet stringent fire performance requirements.



Nacelle contact pads



Landing gear spacer ring

- **Reduced operational downtime.** Xycomp composites are resistant to corrosion and chemical attack, reducing or eliminating the need for periodic component inspection or replacement.
- **Exceptional durability.** Xycomp thermoplastic composite components have improved toughness compared to conventional thermoset components, providing increased resistance to impact and improved thermal cycling performance.
- **Longer life.** Xycomp components have improved fatigue life compared to metal or thermoset composites, extending product life by reducing material deterioration and eventual failure due to crack propagation.

PROCESSING

Greene, Tweed has developed unique processing capabilities for manufacturing complex-shape parts and tubular components from Xycomp materials to deliver exceptional performance for a wide range of structural applications.

- **ProFusion™** compression molding process produces complex net or near-net shape components such as brackets, fittings, covers, doors, or housings. Utilizing our Xycomp DLF material, molded-in inserts and reinforcement ribs or bosses can be incorporated, providing high performance with increased part complexity compared to conventional thermoset composites.
- **Techna3™** is a unique process with the capability to produce complex tubular-shape parts with flanges, reinforcement ribs and closed ends using high-performance thermoplastic materials—suitable for pressure sleeves, pump housings and parts for fluid/gas containment and transport.
- Specialized thermoplastic fiber-placement processes allow us to manufacture thick-wall tubular parts up to 12 inches (30 cm) in diameter and 6 feet (1.8 m) in length for applications such as bushings, bearings, sensor housings and structural tubing.



Techna3 component



ProFusion compression molding



Fiber placement

XYCOMP®—OUTSTANDING IN ANY FIELD



AEROSPACE

Greene, Tweed has more than 40 years of experience developing a range of aircraft components for landing gear and brakes, flight control and utility actuation, fuel and lube oil systems, environmental systems and aircraft engines. This broad industry knowledge has enabled the development of Xycomp® products that are ideal for aerospace applications such as brackets and fittings, fairings, access covers, enclosures and housings.

Xycomp components offer a wide variety of benefits to the aerospace industry, such as weight reduction, excellent impact and fatigue resistance, and superior FST performance. Our high-performance thermoplastic composite components also offer broad resistance to aerospace fluids—including aviation fuels, hydraulic fluids, lubricating oils, cleaners and solvents, and de-icing fluids.



PETROCHEM & POWER

Greene, Tweed has experience developing elastomers and wear-resistant products for pumps and compressors in refineries, chemical plants and power generation facilities around the world. We leveraged this experience to ensure that Xycomp thermoplastic composites could improve process reliability, increase energy efficiency and withstand the demanding environments found in petrochemical and power generation industries.

Xycomp's ductile properties help absorb shock and vibration, and the low co-efficient of friction reduces heat build up. The increased chemical and wear resistance extends product life and, when used as the containment shell in magnetic couplings, improves the energy efficiency of pumps—for significant savings and a positive impact on the environment. Xycomp materials are a good fit for petrochemical and power generating applications such as sealing components, bushings and bearings, containment shells and tubing components.



OILFIELD

Greene, Tweed provides a variety of sealing solutions for high-pressure, high-temperature elastomers and connectivity products, giving us the industry knowledge necessary to design composite components that can handle the demanding conditions found in downhole environments.

Xycomp composite tools can be drilled faster than metal saving time and cost. Debris is non-damaging, eliminating the need for removal. In addition, Xycomp thermoplastic composites are transparent to RF (radio frequency) and are suitable for use as enclosures for RF measurement devices. Their excellent wear/abrasion performance means less downtime and overall life-cycle savings. Xycomp composites perform well as sealing components, pressure sleeves, sensor and electronic control enclosures, structural tubing components, and components for fluid/gas containment and transport.

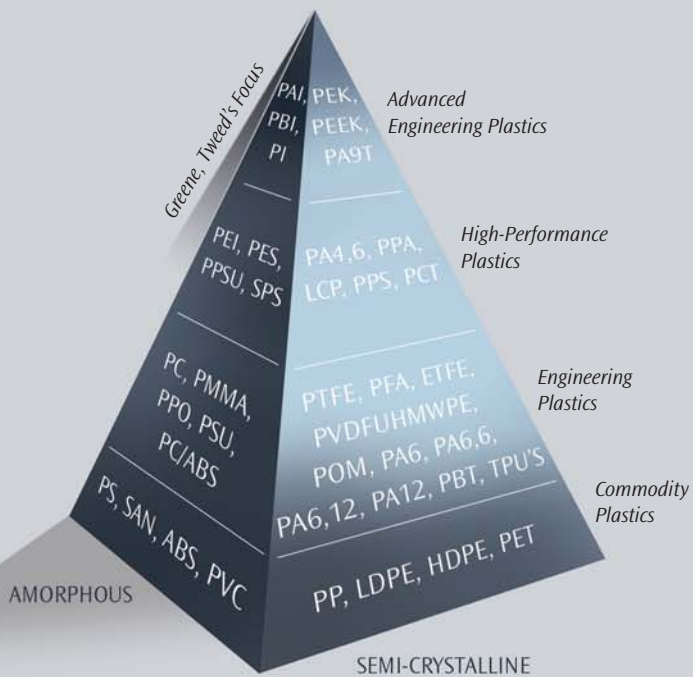


SEMICONDUCTOR & SOLAR

Greene, Tweed's experience providing innovative solutions for the semiconductor and solar industries led us to develop Xycomp composite components that meet industry requirements for cleanliness and chemical resistance while maintaining required stiffness.

Xycomp components resist particulation, helping minimize contamination. Low moisture absorption and minimal outgassing maintain the purity of the environment, while resistance to plasma extends operating life. Xycomp's reduced weight and good vibration damping properties make it an excellent material for wafer-handling components, while good strength and stiffness address large substrate handling in solar manufacturing. Greene, Tweed can manufacture Xycomp components such as handling devices, end effectors, structural components, brackets and spinner chucks.

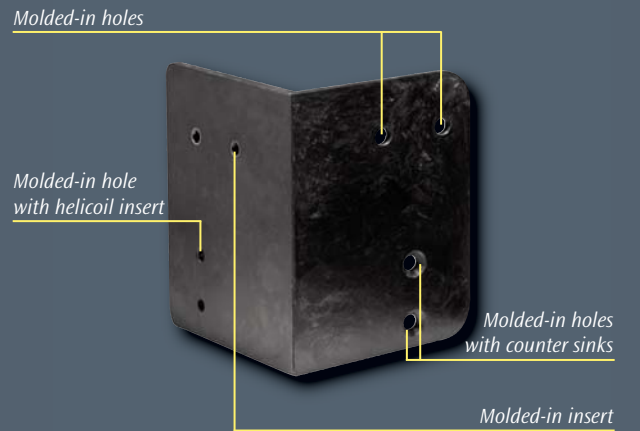
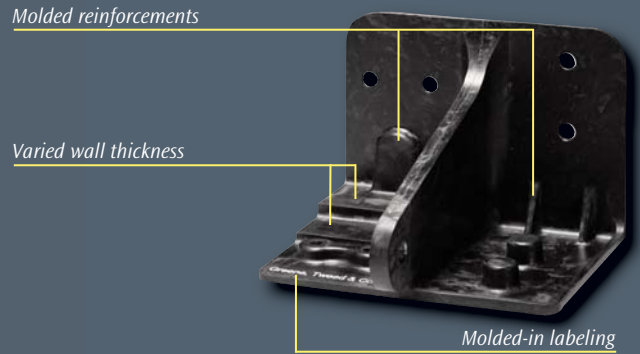
THE THERMOPLASTIC PERFORMANCE HIERARCHY



PROFUSION™

Our innovative ProFusion™ molding process enables molded-in features for increased component complexity and reduced part counts.

Xycomp Brackets with Molded-in Features



GREENE, TWEED— THE INSIDE ADVANTAGE

Greene, Tweed partners with customers to provide reliable, efficient solutions to their application needs. As a world-class leader in the design and manufacture of high-performance materials and custom-engineered components, we leverage our expertise in a variety of markets and products to give our customers the most innovative solutions to their demanding applications.

To learn more about what the Inside Advantage has to offer, visit our website at www.composites.gtweed.com.

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