

## Filament Winding: Fibercompositi's Technology for High-Modulus Carbon Fiber Cylinders and Tubes



Fibercompositi (Cerete, BG – Italy) has long been a reference in composite materials innovation, focusing on the engineering and production of high-performance carbon fiber components for demanding industrial environments.

Among our core technologies, filament winding stands out as a highly efficient and repeatable process for manufacturing high-modulus carbon fiber cylinders and tubes characterized by superior mechanical properties, dimensional stability, and long-term reliability.

Our approach combines engineering analysis, material selection, and advanced CNC-controlled production, enabling customers to achieve performance levels that are difficult or impossible to reach with traditional metallic solutions.

---

### What is Filament Winding?

Filament winding is an advanced composite manufacturing process in which continuous carbon fibers, pre-impregnated or resin-impregnated in-line, are precisely wound onto a rotating mandrel following computer-controlled trajectories designed to resist specific mechanical loads. After curing, the mandrel is removed, leaving a lightweight, high-stiffness composite structure with highly engineered mechanical performance.

The process is particularly suited for high-modulus carbon components because it maximizes fiber alignment — the primary factor governing stiffness — while minimizing unnecessary resin content and excess weight.



At Fibercompositi, our filament winding technology is capable of producing tubes and cylinders with diameters from approximately 70 mm up to 300 mm and lengths up to 7 meters, providing solutions for long-span and large structural applications that require high stiffness, low weight, and precise mechanical performance.

### Core Process Principles

- **Controlled Fiber Placement** – Fibers are laid at predefined angles (e.g., hoop, helical, axial, or hybrid patterns) to tailor bending, torsional, and axial rigidity.
- **Resin Matrix Integration** – Thermoset or thermoplastic resins bond the fibers into a unified structure, ensuring load transfer, environmental resistance, and dimensional stability.
- **Mandrel-Based Geometry** – The internal tool (mandrel) defines the final internal shape and dimensional accuracy of the component.
- **Curing and Consolidation** – Heat and pressure cycles optimize fiber-to-resin ratio, reduce voids, and achieve consistent mechanical properties.

### Geometrical Flexibility

Although commonly associated with cylindrical tubes, filament winding is not limited to simple round sections. With appropriate tooling and machine kinematics, it enables the production of:

- **Cylindrical tubes and rollers** – constant diameter components for rotational or structural applications.
- **Conical or tapered shapes** – variable diameter structures such as transition shafts, aerospace ducts, or load-optimized beams.
- **Rectangular or non-circular sections** – structural beams, frames, and hybrid geometries where bending stiffness in one axis is prioritized.
- **Hybrid profiles** – combinations of cylindrical and prismatic segments within a single monolithic structure.

This geometric adaptability allows engineers to optimize material distribution exactly where loads occur, rather than relying on uniform wall thickness typical of metallic parts.

### Technical Advantages Over Traditional Processes

Compared to pultrusion, roll-wrapping, or machined metal solutions, filament winding provides:

- **Optimized stiffness-to-weight ratio** through continuous fiber orientation aligned with real load paths.
- **Custom winding architectures** tailored to bending, torsion, vibration damping, or combined stress states.
- **High repeatability and automation**, ensuring dimensional precision and batch-to-batch consistency.
- **Efficient material usage**, reducing scrap and enabling localized reinforcement without full-part overdesign.
- **Scalability in length and diameter**, making it suitable for long structural elements and large rollers.

- **Surface and wall-thickness control**, enabling tight tolerances and predictable dynamic behavior.

### Functional Outcomes

The result is a composite component that combines:

- Exceptional axial and bending stiffness
- High torsional rigidity
- Low thermal expansion
- Corrosion resistance
- Superior vibration damping

For high-modulus carbon cylinders, conical structures, or rectangular beams, filament winding enables **engineering-driven performance rather than geometry-driven compromise**, delivering lightweight yet extremely rigid components suitable for precision industrial, aerospace, automation, and energy applications.

---

## Key Applications of High-Modulus Carbon Cylinders and Tubes

Fibercompositi's filament-wound high-modulus carbon cylinders and tubes are engineered for maximum stiffness-to-weight ratio, dimensional stability, corrosion resistance, and vibration damping within medium-to-large diameter geometries. These properties make them ideal in sectors where precision, speed, and durability are critical, especially for long spans and structural or rotating elements that fall inside the indicated dimensional envelope.

### 1. Flexographic Industry

#### Typical Uses

- Anilox or Idle rollers in wide-web presses
- High-stiffness printing rollers



#### Why Carbon Cylinders

- Minimal deflection at high rotational speeds ensures print accuracy on wide formats.
- Low inertia enables faster start/stop cycles and higher throughput.
- Excellent balance and vibration control improve registration quality and reduce maintenance.

#### Existing Application Context

Label printing, flexible packaging, and film converting lines where long, small-diameter shafts operate at high RPM and require micron-level precision.

## 2. Paper & Converting Industry

### Typical Uses

- Press and calender rollers
- Core tubes and transport rollers for webs and sheets



### Why Carbon Cylinders

- High bending stiffness under heavy nip loads prevents deformation.
- Wear and corrosion resistance in humid or chemically aggressive environments.
- Lightweight structure reduces bearing stress and energy consumption.

### Existing Application Context

Tissue converting, corrugating, coating, laminating, and slitting lines where wide spans and continuous loads would normally cause steel rollers to sag.

## 3. Automation, Robotics & Linear Systems

### Typical Uses

- Linear actuator tubes
- Robotic arm structural sections
- Structural beams for pick-and-place systems



### Why Carbon Cylinders

- Exceptional stiffness with minimal weight.
- Reduced motor torque requirements.
- Increased positioning accuracy and cycle speed.

### Existing Application Context

Industrial automation, semiconductor handling, packaging robots, and precision assembly equipment.

## 4. Energy & Light Mechanical Transmission

### Typical Uses

- Power transmission shafts
- Lightweight torque tubes
- Structural tubular elements in nacelles or auxiliary systems



### Why Carbon Cylinders

- Exceptional stiffness-to-weight ratio reduces drivetrain mass.
- Weight reduction improves efficiency and acceleration.
- High torsional rigidity for precise power transfer.
- Reduced rotational inertia for high-speed applications.

### Existing Application Context

Electric motors, auxiliary power units, laboratory machinery, and precision mechanical systems.

## 5. Energy & Fluid Handling

### Typical Uses

- Hydraulic or pneumatic tubes
- Cylinders and rollers exposed to chemicals or controlled temperatures



### Why Carbon Cylinders

- Pressure resistance with low weight for mobile or robotic systems.
- Chemical compatibility with aggressive fluids.
- Thermal stability for heated or cooled processes.

### Existing Application Context

Automation lines, chemical processing, and specialty equipment requiring non-metallic, non-corrosive conduits or rotating components.

## 6. Aerospace & Defense

### Typical Uses

- Structural tubes and rollers in actuation or guidance systems
- Lightweight support elements in UAVs, aircraft interiors, and radar assemblies



### Why Carbon Cylinders

- Outstanding stiffness-to-weight ratio for flight-critical components.
- Dynamic load resistance and vibration damping.
- Low thermal expansion for precision assemblies.

## Existing Application Context

Aerospace subsystems, satellite ground equipment, and defense platforms where reliability, repeatability, and mass optimization are mission-critical.

---

## Advantages of Fibercompositi High-Modulus Carbon & Filament Winding

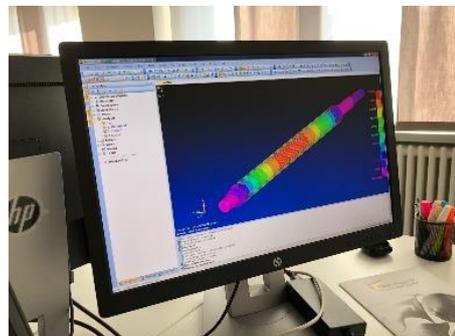
- **Superior stiffness and strength:** High-modulus fibers deliver outstanding mechanical performance even for large diameters and extended lengths.
  - **Lightweight performance:** Up to 70% weight reduction compared to equivalent metallic structures, enabling higher efficiency and easier handling.
  - **Dimensional accuracy:** Tight tolerances and excellent concentricity ensure compatibility with precision machinery.
  - **Process repeatability:** the process is performed by a CNC machine driven by a program that ensures consistency of the components produced.
  - **Durability:** excellent resistance to deformation.
  - **Chemical and environmental resistance:** Suitable for aggressive fluids, humidity, and temperature fluctuations.
  - **Design flexibility:** Diameter, wall thickness, fiber orientation, and resin systems can be fully customized.
  - **Integration capability:** Possibility to include metallic inserts, end fittings, or hybrid structures within the composite design.
- 

## Fibercompositi: Technology, Expertise, and Industrial Partnership

Located in Cerete (Bergamo, Italy), Fibercompositi combines engineering expertise, advanced manufacturing technologies, and deep material knowledge to support customers from early design phases through final production.

Our workflow typically includes:

- **Technical consulting and feasibility analysis**
- **Material and laminate engineering**
- **Prototype development and testing**
- **Serial production with quality control protocols**
- **Continuous process optimization**



From small-series prototyping to high-volume industrial supply, Fibercompositi provides a flexible, performance-oriented approach focused on reliability, precision, and long-term collaboration.

---



For companies seeking high-performance carbon cylinders, rollers, or structural tubes, Fibercompositi delivers innovative, lightweight, and durable solutions designed for critical and demanding industrial applications.