



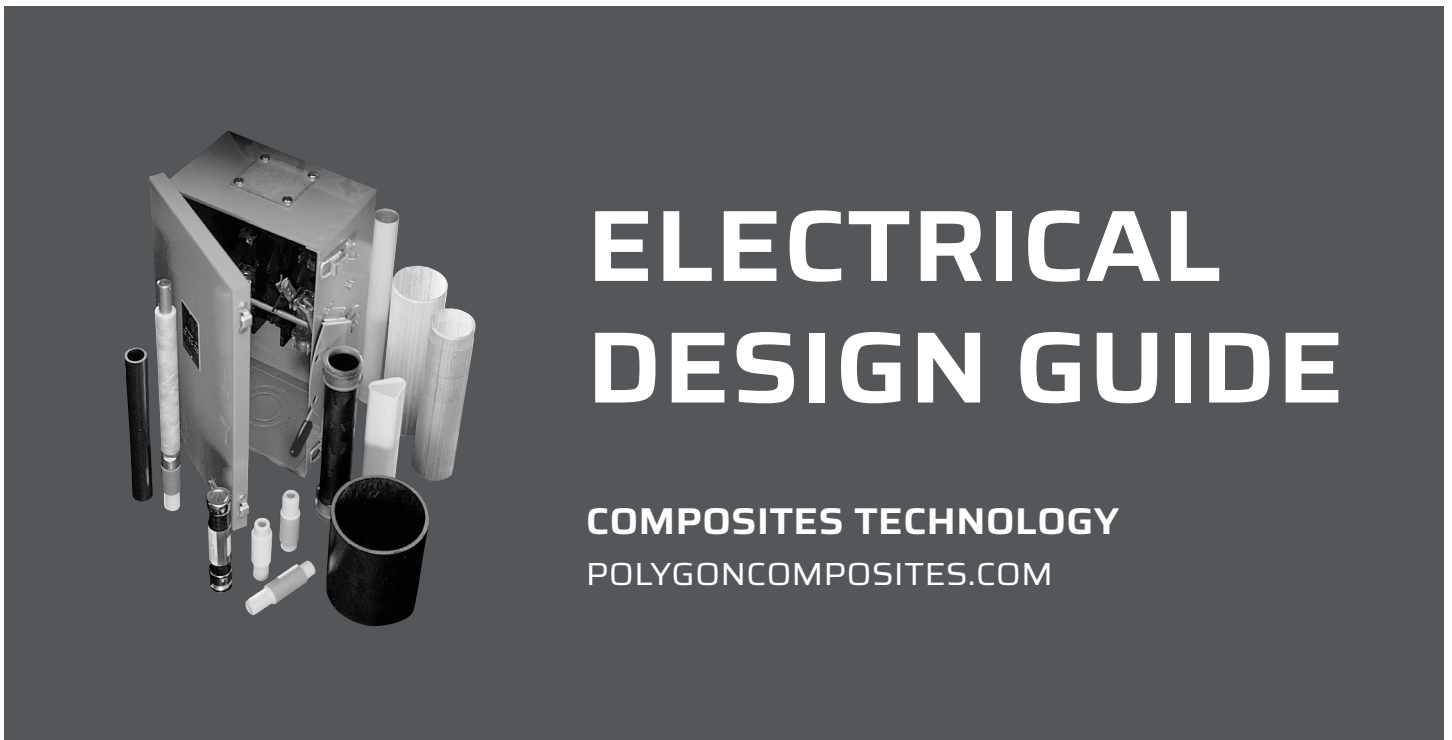
POLYGON
COMPOSITES TECHNOLOGY



composite dielectric tubing

PROTECTS YOU

from danger



ELECTRICAL DESIGN GUIDE

COMPOSITES TECHNOLOGY
POLYGONCOMPOSITES.COM

INTRODUCTION

Since its establishment in 1949, Polygon Company has stood as one of the world's premier leaders in the development of advanced composite materials for many electrical insulative applications. Polygon's production capabilities are among the widest in the world and range from the pultrusion process to filament winding, braiding and circ-winding. In addition, Polygon is known as the world's leading fabricator of composite materials. From advanced CNC lathes, to multiple automated milling machines and tight tolerance centerless grinding, Polygon can meet a wide variety of component fabrication requirements. But Polygon's service doesn't stop at fabrication—we also provide painting, sub-assembly and contract manufacturing services.

PRODUCT DESCRIPTION

The Polygon Tube® is the insulation sleeve that provides armatures of electric motors a secondary layer of insulation. This secondary insulation is needed to provide increased protection for operators of electrical appliances from shock. The use of the additional layer of insulation allows the appliance to be rated "Double Insulated" and the need for grounding of the appliance is eliminated. Even though an appliance is grounded by means of a three-wire power cord, it is still a good practice to provide a secondary layer of insulation. The information provided is to assist in the design and assembly of the Polygon Tube into armatures of electric motors.

MANUFACTURING PROCESS

Polygon utilizes two bonding processes to manufacture tubes that provide optimum physical and dielectric performance. These processes capitalize upon the individual chemical and mechanical strengths of both resin chemical bond and structural interlocking of reinforcement maximizing the total strength of the Polygon Tube. These insulating composite tubes utilize their inherent modulus of elasticity to ensure a permanent press fit on the armature shaft.

Polygon Tube provides high torque strengths and is a yellow carded UL Certified material (AFW-G-10). These patented manufacturing techniques produces double insulated tubes with unparalleled physical properties and unmatched electrical insulation.

STANDARD TOLERANCES

In comparison to conventional molding or paper tube assemblies, the implementation of the Polygon Tube into the motor assembly enables the manufacturer to reduce production costs. Standard tolerances have been established that allow these composite tubes to be press-fit into the motor laminations. The armature shaft is then pressed into the assembly, securely locking the laminations and the shaft.

QUALITY CONTROL

To ensure each double insulated Polygon Tube surpasses all electrical insulation requirements we have implemented an uncompromising inspection process. Each tube is tested at 5000 volts to guarantee its dielectric integrity. Polygon Tube carries approval by Underwriters' Laboratories, Inc. to grade AFW-G-10. Certification and SPC controlled processing ensures "just in time" deliveries and eliminates inspection on the customer's end. The anisotropic properties composite materials are often misunderstood. Therefore, it is helpful to review some of Polygon Tube's basic material features as they relate to armature insulation.



Polygon has a long history of providing electrical insulation products.



Polygon Tube® provides double insulation in high torque motor armatures.

"Leading the electrical industry for 60 years with over one billion tubes in production."

THE COMPOSITE TUBE CONSISTS OF TWO DIELECTRIC MATERIALS

REINFORCING MATERIAL

Consisting of continuous fiber bundles of electrical grade “E-Glass” woven together at a specific helix angle with respect to the tube axis and thermoset epoxy resin, property retention (both in-dielectric and structural) electrical temps.

EPOXY: THAT HAS A TG OF APPROXIMATELY 120°C [266°F]

Properties in the axial, hoop, and through the wall in a composite are anisotropic and are controlled with fiber orientation. The composite’s physical properties are not less consistent in ultimate strength or elasticity.

TRANSFORMER AND DISTRIBUTION PRODUCTS

Any composite company that’s been around for over 60 years has, as part of their heritage, a family of products related to either the recreational or electrical markets, and Polygon is no exception. Polygon Company has been a major force in supplying insulating products for the electrical transformer and distribution market since the early 1950’s. Many of the applications in existence today were designed and developed by Polygon engineers.

As the originator of the fiberglass winding pin used in the production of fractional horsepower motors as an insulating turn point for the copper coils. Polygon pioneered the replacement of convolute wound fuse tubes by incorporating the braiding process, then

followed closely by filament winding technology. Polygon developed a proprietary product and process that replaced molded steel core cross bars used in 3-pole switches. This application was especially demanding because we had to match the torque requirements of the steel core while at the same time providing high voltage insulating properties with the same strength characteristics.

Polygon Company has designed and made fuse tubes, transformer fuse tubes, draw out tubes, lightening arrester tubes, fuse holders, stand offs, stabbers and various other products longer than most composite manufacturing companies have been in existence. We stand alone in our ability to manufacture products for the electrical industry using the processes of filament winding, pultrusion, braiding or combinations of all three. We are a true manufacturer, not just a fabricator or distributor of electrical products. This allows us to control both our raw material inputs as well as the finished products. Most of our competitors must rely on outside sources to make their composite or laminates that they then fabricate. This additional step creates a hidden supply chain issue that contributes to quality problems or extends lead times. We make the composites, and then finish them to print, which can also include secondary processing such as metallic end attachments, painting, certification or any type of subassembly that might be required.

Polygon Company is very diverse in product size range offerings as well. Making a variety of electrical products, from products that require a magnifying glass to visualize to tubing structures that an individual could actually crawl through. We create, manufacture and produce tubes, rods, solids, sheets and even electrical torque products. Our depth of knowledge in the electrical market is unsurpassed.

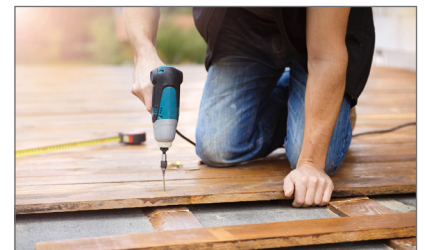
GENERAL SPECIFICATION OF POLYGON TUBE®

STANDARD TOLERANCES

Concentricity Standard	TIR	0.004" (0.10mm)
------------------------	-----	-----------------

PHYSICAL PROPERTIES

Compressive Strength		20,000 psi
Tensile Strength		20,000 psi
Shear Strength		6,500 psi
Water Absorption	2 hours	0.12%
Water Absorption	24 hours	0.16%
Specific Gravity		1.8



Polygon is a leader in double insulation solutions in the consumer power tools market.

“We are a true manufacturer, not just a fabricator or distributor, of electrical products.”

GENERAL SPECIFICATION OF POLYGON TUBE® (CONTINUED)

ELECTRICAL PROPERTIES

Insulation Resistance	ohm/8" length	2.38×10^{12}
Volume Resistivity	ohm/cm	2.41×10^{18}
Surface Resistivity	ohms	3.93×10^{15}
Time, volts/mil		200
Dielectric Constant	60 cps	4.15
Dissipation Factor	60 cps	0.0094

ALL COMPOSITE CROSS BAR

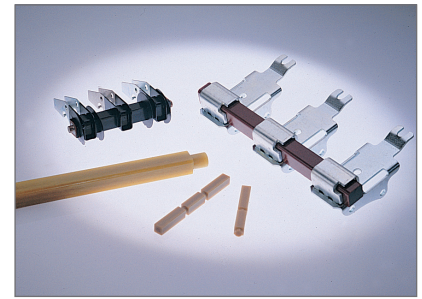
PRODUCT DESCRIPTION

The all composite cross bar from Polygon utilizes an engineered composite structure that results in excellent retention of mechanical and physical properties at elevated temperatures. This all-composite cross bar eliminates the need for traditional metallic cross bars that are a combination of a metallic shaft encapsulated with epoxy impregnated glass fabric.

GENERAL SPECIFICATION

Tensile Strength (Axial)	175 KSI
Compressive Strength (Axial)	175 KSI
Compressive Modulus (Axial)	6.1 MSI
Shear Strength	7.0 KSI
Shear Modulus	0.5 MSI
Modulus of Elasticity (Axial)	6.1 MSI
Poisson's Ratio	0.28
Young's Modulus	5.5×10^6 PSI
Yield strength	100,000 PSI
Thermal Conductivity	2.0 BTU/hr./sq.ft./°F/in.
Specific Heat	0.26 BTU/lb./°F
Dielectric Strength	400 volts/mil
Material Composition	Epoxy/Fiberglass
Listed Under UL Number	E81911
CREEP:	
100°C with 14 lbs. Load-deflection	None at 12 days
80°C with 5 lbs. Load-deflection	None at 5 days
65°C with 14 lbs. Load-deflection	None at 14 days

"Why have a metallic strength member in an electrical insulating product?"



Composite cross bars are rigid and insulate through the entire material, not just via a layer of laminate.

"Polygon is universally known as the most vertically integrated supplier in the electrical market."

EPOXY FIBERGLASS FILAMENT WOUND GENERAL PURPOSE FUSE TUBING

PRODUCT DESCRIPTION

A general "E" glass fiber reinforced composite tubing material, with an epoxy resin as matrix.

PHYSICAL PROPERTIES**

All calculations based on an 40° wind angle

Hoop Strength (Fy x 10 ³)	60
Tensile Strength (Ft x 10 ³ PSI)	60
Flexural Strength, Axial (Fbx x 10 ³ PSI)	55
Poisson's Ratio, Axial	0.3
Shear Modulus (Gxy x 10 ⁶ PSI)	0.8
Elastic Modulus (Ex x 10 ⁶ PSI)	2.5
Elastic Modulus, Transverse (Ey x 10 ⁶ PSI)	1.8

THERMAL PROPERTIES**

Thermal Conductivity (BTU/hr/sq ft/°F/in)	1.8 to 2.3
Specific Heat (BTU/lb/°F)	0.27
Coefficient of Thermal Expansion (in/in/°F)	5.0 to 7 x 10 ⁻⁶
Heat Resistance, Continuous	200°C

ELECTRICAL PROPERTIES**

Insulation Resistance (ohm/8" length)	2.38 x 10 ¹²
Volume Resistivity (ohm/cm)	2.41 x 10 ¹⁵
Surface Resistivity (ohms)	2.92 x 10 ¹⁵
Dielectric Strength, Short Time (volts/mil)Minimum	200
Dielectric Constant (60 cps)	4.15
Dissipation Factor (60 cps)	0.0094
Impulse (1 1/2 -40u Wave (Axial) volts/mil)	400 to 550
POWER FACTOR AT 60 cps (100v pct mx)	
As Received	5.0
at 100°C	10.0
After 24 hours at 100°F at 98% rel. hum.	10.0



Composite materials combine structural strength with dielectric capability.

"Filament winding, braiding, pultrusion and fabrication- all in one organization."





POLYGON
COMPOSITES TECHNOLOGY



MEDICAL



BEARINGS



CYLINDERS



ELECTRICAL