MATERIAL GUIDE FOR MEDICAL GRADE POLYMER TUBING
High-performance catheters start with high performance PTFE etched liners and these start with TE Connectivity.

Our state-of-the-art manufacturing processes ensure a consistent, reliable, and high-quality product delivered to you with unrivaled speed.

A unique OD etching process provides a better bond to the outer jacket of the delivery catheter.

Our closed-loop manufacturing approach precisely controls the amount of “active” ingredient in the etchant to optimize bonding ability.

TE’s PTFE etched liners are applied in applications requiring thin-walled, lubricious tubing for catheters with the most demanding performance profiles.

Starting your catheter design with TE Connectivity means a better etch, better bond and better performance.

We offer next day delivery on samples for your R&D project needs.

**Dimensional capabilities**

- Diameter range: ID .020” - .250” (.508 mm - 6.35 mm) Tolerance from +/- .001”
- Wall thickness: From .001”-.002” (0.025 mm-0.050 mm) Tolerance from +/- .0005”
- Length: Custom lengths, max 96” (2438 mm)

**PTFE ETCHED LINERS**

(Polytetrafluoroethylene)

TIGHT TOLERANCES, TRACEABILITY, AND CUSTOM DESIGN SERVICES ARE THE CORE OF WHAT WE DO. PTFE ETCHED LINERS HAVE OUTSTANDING LOW FRICTION PROPERTIES, NON-STICK CHARACTERISTICS, AND EXCELLENT RESISTANCE TO AGING. TE CONNECTIVITY’S PROPRIETARY OD ETCHING SYSTEM ENABLES A FULLY CONTROLLED ETCH PROCESS WITH CONTACT ANGLE MEASUREMENTS CONFIRMED WITH EVERY LOT.

**PROFILE**

- One of the lowest coefficients of friction of any polymer (0.05-0.10)
- Outstanding chemical resistance
- Very inert and biocompatible
- Excellent dielectric properties
- EtO sterilization compatible
- High percentage of elongation prior to failure
- Etching on the OD of the PTFE liner allows for adhesion with other top layers
- Ability to extrude wall thicknesses as low as 0.001” with tight tolerances

**ABOUT**

Etched PTFE tubing is an excellent solution for providing a lubricious lining to catheters that require a very thin wall with a low-friction ID. TE offers extremely tight tolerances with off-the-shelf product at ± 0.0005”.

**QUALITY & PROCESS CONTROL**

All product is manufactured in a controlled environment certified to ISO Class VIII.
Our Production

Our production is completed in an ISO 13485 certified (ISO 8 Cleanroom) environment providing components for Class II and Class III end-use medical devices. We are dedicated to delivering consistent quality combined with innovation, tight tolerances, traceability and design service.

FEP (Fluorinated Ethylene Propylene)

AT TE CONNECTIVITY, WE DON’T JUST MANUFACTURE HEAT SHRINK TUBING, WE DESIGN AND OPTIMIZE. WE UNDERSTAND THE DIFFERENCE ADVANCED POLYMERIC ENGINEERING CAN MAKE TO REFLOWING YOUR COMPLEX CATHETER OR PROTECTING AND INSULATING YOUR ELECTROSURGICAL DEVICES AND LAPAROSCOPIC INSTRUMENTS.

PROFILE

• Shrink ratio ≤ 1.6:1
• Full recovery at 210°C (410°F) minimum
• Tight longitudinal change control as low as ± 2%
• Manufactured to ISO 10993 standards
• Custom sizing, finishing options available
• Translucent for high optical clarity
• Color blending option available

ABOUT

MT-FEP is a fluorinated ethylene propylene heat shrink tubing. FEP offers excellent consistency, high dielectric strength, and is chemically inert. MT-FEP is lubricious and semi-rigid with shrink ratios up to 2:1*.

FEP is the industry gold standard for reflowing catheter shafts and bonding joints. For our MT-FEP, we can control longitudinal growth ± 2% ensuring consistency on lot to lot, reducing cost and waste.

*Upper limit offering depends on product size. Optimal expansion ratio is 1.6:1.

APPLICATIONS

Process aid for catheter shaft reflow.
Process aid for reflowing catheter shafts.
**THERMOPLASTIC EXTRUSION CAPABILITIES**

**Custom Thermoplastic Extrusions**

Single Lumen Development Run (300-500ft) using in house material and tooling ship in 6-7 business days.

Custom precision extrusion tubing for medical application capabilities:

- OD: .006” - .500” (0.15-12.0 mm)
- Wall: ≥.0015” (≥0.04 mm)

Large assortment of tooling in-stock, braiding, cut to length or spooled, rods, beading, profiles, co-extrusion, multi-layer, multi-lumen.

ISO 13485 certified – providing components for Class II and Class III end-use medical devices.

TE Connectivity is committed to supplying extrusion needs from development phases through production.

**Thermoplastic “in house” materials**

350 Resins in stock and stored in a climate controlled environment.

- TPE (thermoplastic elastomers), trade names PEBAX, Rilsan
- Polyurethanes, trade names Pellethane, Tecothane, Arnitel
- Polyamides (nylon), trade names Hytrel, Vestamid
- Polyethylenes (LDPE, MDPE, HDPE)
- Polycarbonate
- PEEK

**Common fillers in medical applications**

Barium sulfate, BaSO4, Bismuth trioxide Bi2O3, Bismuth Subcarbonate, Bi2O2(CO3) or Tungsten (W). The level of loading (% by weight) will improve visibility of the component in the body under fluoroscopy (X-ray).
THERMOPLASTIC POLYMERS

Thermoplastic polymers are commonly regarded as “plastics”. They are subgrouped into amorphous and semi-crystalline. The crystalline amount of the polymer depends on the original molecules and the thermal history of the polymer. Amorphous polymers are often transparent and semi-crystalline polymers are opaque. Amorphous polymers melt over a wide temperature range contrary to semi-crystalline polymers that have distinct melting temperatures. One characteristic of thermoplastic polymers is that they return to their original physical structure when cooled after melting.

**PE (Polyethylene)**

PE is categorized by the density of the polymer, LDPE (low density), MDPE (medium density) and HDPE (high density). A higher crystallinity will produce a higher density, higher melt temperature, higher strength, and a lower permeability to gases and moisture. Polyethylene is a relatively inexpensive polymer that is widely used in medical applications.

- Low friction properties (HPDE)
- Good chemical resistance
- Service temperature up to +100°C (HDPE)

**PP (Polypropylene)**

PP is a semi-crystalline polymer with wide versatility. PP is rather rigid and is frequently used when slightly better mechanical characteristics than HPDE are required.

- High fatigue resistance
- Good chemical resistance
- Service temperature up to +100°C

**EVA, EMA, EBA (Ethylene Vinyl Acetate, Ethylene Methyl Acrylate, Ethylene Butyl Acrylate)**

Copolymers of ethylene and polar monomers (vinyl-ac-etae, methylacrylate or butylacrylate), are used to produce materials with various properties of stickiness, toughness and impact resistance.

- Flexible
- High impact resistance
- High toughness

**POM (Polyoximethylene)**

POM is a highly crystalline polymer commonly named “acetal”. POM is a very hard, strong, dimension stable, opaque polymer, which is an effect of high crystallinity.

- Low friction properties
- High strength and hardness
- High wear resistance
- Low absorption and permeability of water

**PET, PBT (Polyethylene Terephthalate, Polybutylene Terephthalate)**

PET and PBT are two of the most commonly used polyesters. PET has a slow crystallization process compared to all other polymers. PBT is more flexible and tougher than PET.

- High strength and hardness
- High dimension stability
- Good chemical resistance

**PC (Polycarbonate)**

PC is a polyester of carboxylic acid that has an amorphous structure to provide transparency. PC is used for its toughness and strength.

- High strength and toughness
- Good transparency
- High dimension stability
- Extreme impact resistance

**PA (PolyAmide)**

PA is a group of semi-crystalline thermoplastics often referred to as Nylon®. The number of carbon atoms between the functional amide groups in PA produces different properties of this polymer with names such as PA6, PA11 and PA12 indicating these numbers. Absorption of water decreases with increasing numbers of carbon atoms.

- High strength, stiffness and hardness
- Good wear resistance
- Service temperature up to +150°C
THERMOPLASTIC ELASTOMERS

Thermoplastic elastomers consist of hard polymer segments in a matrix of soft amorphous polymers. These segments are physically bound to each other, giving the elastic properties. In contradiction to rubber and thermostets, the binding between the molecules is reversible by melting and cooling. Changing the ratio of hard segments in the copolymer will increase or decrease the strength, stiffness, and hardness of the polymer.

TPE-E (Thermoplastic Elastomer Ester)

Ester based thermoplastic elastomer, is a copolymer of polyether-esters or polyester-esters.

- Hardness ranges from Shore 35D to 74D
- Excellent chemical resistance
- High fatigue resistance

TPE-A (Thermoplastic Elastomer Amide)

TPE-A are copolymers of polyamide with either polyether, polyester or polyether ester. The hard segments in the copolymer are formed by the semi-crystalline polyamide segments in the copolymer. PolyEtherBlock- Amide (PEBA), often referred to as PEBAX®, is a commonly used TPE-A in medical applications.

- Hardness ranges from Shore 75A to 75D
- Good biocompatibility
- Softens in vivo
- Excellent abrasion resistance

TPE-U (Thermoplastic Elastomer Urethane)

TPE-U is a group of polymers often referred to as PUR, with a very wide range of properties. The two main types of PUR are polyester-based (aromatic) and polyether-based (aliphatic). The polyether-based TPE-U is more elastic, and has a higher resistance to hydrolysis and micro-organisms. The hard segment in the copolymer is of a crystalline nature.

- Hardness ranges from shore 75A to 75D
- Good biocompatibility
- Softens in vivo
- Excellent abrasion resistance

TPE-O (Thermoplastic Elastomer Polyolefins)

TPE-O is a group of polymer blends mainly comprised of polyethylene, polypropylene and rubber. The TPO is semi-crystalline polymer blend, where polypropylene and polyethylene part constitute the crystalline phase and the rubber for the amorphous phase.

- Hardness from 40A to 62 D
- High impact resistance
- Good chemical resistance

TPE-S (Thermoplastic Elastomer Styrenic Block Copolymer)

TPE-S are compounds based on SBS or SEBS. Styrene-butadiene-styrene is based on two-phase block copolymer with hard and soft segments. The styrene end blocks provide the thermoplastic properties and the Butadiene mid-blocks provide the elastomeric properties. SEBS is modified SBS by hydrogenation.

- Hardness from 45A to 65D
- Good scratch resistance
since all values are indicative and for guidance only. TE takes no responsibility for data given in the table. Excellent:
The property data are taken from different sources and are not necessarily typical for any specific grade. This table is unsuitable for specification.

**Notes:**

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Capability Highlights

- PTFE etched liners
- FEP heatshrink
- Beadings & monofilaments
- Single- & multi-lumen extrusions
- Balloon tubing
- Balloon & stent protectors
- Braided shafts
- Secondary operations, tip-forming, flaring, printing, etching, fabricated tubing, etc.

Our experiences range from research and development to small, medium, and automated high volume production. We serve markets in the fields of infusion technology, cardiovascular, and delivery devices.