



Heat Shrink Tubing Types and Recovery Characteristics

Introduction

Heat shrink tubing is a versatile and critical component in electrical and electronic systems, providing insulation, strain relief, environmental protection, and identification for wires and connectors. Its utility spans across aerospace, defense, automotive, and industrial applications, where reliability under harsh conditions is paramount. Choosing the correct type of heat shrink tubing and understanding its recovery characteristics, how it contracts and conforms to the underlying substrate when heat is applied, is essential for assuring both performance and longevity. This whitepaper explores the types of heat shrink tubing, their material properties, and key recovery behaviors, guiding engineers in selecting the right solution for their applications.

Heat Shrink Tubing Types

Heat shrink tubing is primarily classified based on the material composition, presence of adhesive, and specialized shapes. Each type has distinct performance characteristics, temperature ratings, and chemical resistances.

Polyolefin Tubing

- **Overview:** Polyolefin is the most common and widely used heat shrink material, valued for its excellent electrical insulation properties, flexibility, and ease of use.
- **Recovery Characteristics:** Polyolefin tubing generally has a shrink ratio of 2:1 or 3:1 (expanded diameter to recovered diameter) and recovers rapidly when heated, conforming tightly to irregular shapes.
- **Applications:** Wire harness insulation, strain relief, color coding, and protection in moderate temperature and chemical exposure environments.

Fluoropolymer Tubing

- **Overview:** Fluoropolymer-based tubing (e.g., PTFE, FEP, PFA) provides superior chemical resistance, high-temperature performance, and low friction surfaces.



- **Recovery Characteristics:** Fluoropolymer heat shrink tubing typically requires higher temperatures to activate, has slower recovery, and offers lower shrink ratios, but it provides precise and durable encapsulation.
- **Applications:** Aerospace, automotive engine compartments, chemical processing, and areas exposed to solvents or extreme heat.

Molded Shapes

- **Overview:** Molded heat shrink shapes are pre-formed to fit connectors, splices, or terminals, eliminating the need for uniform tubular expansion.
- **Recovery Characteristics:** These shapes shrink selectively, conforming only to designated areas, providing a neat and precise fit with minimal handling.
- **Applications:** Connector boots, cable junctions, strain relief for terminals, and specialized electrical assemblies.

Adhesive-Lined vs non-adhesive

- **Adhesive-Lined (Dual Wall) Tubing:** Contains a thermoplastic adhesive layer inside the tubing. When heated, the tubing shrinks, and the adhesive melts to bond with the substrate, providing superior sealing against moisture, dust, and chemicals. Ideal for harsh environments.
- **Non-Adhesive Tubing:** Provides mechanical protection and insulation but does not offer sealing. Suitable for internal wiring, color coding, or strain relief where environmental sealing is not critical.
- **Recovery Characteristics:** Adhesive-lined tubing may require slightly higher temperatures to activate the adhesive fully, while non-adhesive tubing recovers faster due to the absence of the adhesive layer.

Vital Recovery Characteristics

Understanding the recovery behavior of heat shrink tubing is vital to establish proper application and long-term performance:

- **Shrink Ratio:** Defines the ratio between the expanded diameter and the final recovered diameter. A higher ratio allows a single tubing size to accommodate a wide range of substrates.



- **Recovery Temperature:** The minimum temperature at which the tubing begins to shrink and conform to the surface. Polyolefin typically shrinks at 90–120°C, while fluoropolymer types require 200–300°C.
- **Recovery Speed:** How quickly the tubing contracts after reaching its recovery temperature. Faster recovery is useful for production efficiency, while slower recovery can improve conformance to complex shapes.
- **Memory and Elasticity:** Tubing retains “memory” of its original size and shape, guaranteeing a tight, secure fit. Proper selection prevents premature loosening or cracking under stress.

Selection Guidelines

When selecting heat shrink tubing, consider the following criteria:

1. **Environmental Conditions:** Temperature extremes, chemical exposure, moisture, and UV radiation.
2. **Electrical Requirements:** Voltage rating, dielectric strength, and insulation needs.
3. **Mechanical Protection:** Abrasion resistance, strain relief, and flexibility.
4. **Application Type:** Internal wiring, external harnesses, connector sealing, or specialized shapes.
5. **Adhesive Requirement:** Determine if environmental sealing is necessary for the application.

Conclusion

Heat shrink tubing is an indispensable tool for electrical and electronic system protection, offering insulation, strain relief, and environmental resistance. Selecting the appropriate material, polyolefin for general applications, fluoropolymer for high-temperature or chemical environments, or molded shapes for precise coverage, promotes optimal performance. Understanding recovery characteristics, shrink ratios, and adhesive options allows engineers to achieve reliable, long-lasting assemblies. By carefully matching tubing type to application requirements, manufacturers can improve system reliability, reduce maintenance, and enhance safety across diverse industries.