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## Sleeving Options for Abrasion, EMI, and Thermal Protection

### Introduction

In mission-critical systems across aerospace, defense, automotive, and industrial applications, the integrity and longevity of wiring and cabling are paramount. Harnesses are routinely exposed to harsh mechanical, electromagnetic, and thermal environments. Without proper protective measures, cables can suffer from abrasion, electromagnetic interference (**EMI**), and excessive heat, leading to failures, system downtime, or safety hazards.

Cable sleeving provides a critical line of defense, shielding conductors while maintaining flexibility, ease of installation, and system performance. Selecting the right sleeving solution requires a careful balance of mechanical protection, thermal resistance, EMI suppression, and adaptability to the operating environment.

This paper explores the most widely used sleeving options: **expandable braid**, **convoluted tubing**, **fiberglass**, **aramid**, and **hybrid solutions** highlighting their key performance characteristics and application suitability.

### Expandable Braid

#### Overview

Expandable braid sleeving is typically woven from metal or polymer fibers and designed to expand over cable bundles while maintaining a snug fit.

#### Benefits

- Excellent abrasion resistance, protecting cables from chafing and rubbing.
- Flexible and conformable, allowing installation over connectors and complex geometries.
- Can provide EMI shielding when made from metallic fibers.
- Lightweight and cost-effective for large bundles.

#### Limitations

- Limited thermal resistance compared to high-performance composites.



- EMI performance depends on fiber material and weave density.

## **Convolute Tubing**

### **Overview**

Convolute tubing, usually made from polymers such as polyethylene or polyamide, features a spiral or ribbed structure that can accommodate bending and expansion.

### **Benefits**

- Good abrasion and impact resistance due to ribbed design.
- Easy installation and removal, ideal for maintenance-intensive applications.
- Provides cable separation, reducing stress in tight bundles.

### **Limitations**

- Minimal EMI shielding unless metallized.
- Thermal resistance varies with polymer type; not suitable for extreme temperatures without reinforcement.

## **Fiberglass Sleeving**

### **Overview**

Fiberglass sleeving is composed of woven or braided glass fibers, offering exceptional thermal resistance.

### **Benefits**

- Extremely high-temperature tolerance, often exceeding 550°C (1022°F).
- Resistant to chemicals, flames, and harsh environments.
- Lightweight and electrically insulating.

### **Limitations**

- Limited flexibility compared to polymer-based solutions.
- Poor abrasion resistance unless coated.



- Minimal EMI protection on its own.

## **Aramid Sleeving**

### **Overview**

Aramid fibers provide high tensile strength and cut resistance while maintaining flexibility.

### **Benefits**

- Outstanding abrasion and cut resistance.
- High strength-to-weight ratio, suitable for dynamic applications.
- Moderate thermal resistance and self-extinguishing properties.
- Can be used in hybrid solutions for EMI shielding.

### **Limitations**

- EMI protection requires combination with conductive layers.
- More expensive than standard polymer sleeving.

## **Hybrid Solutions**

### **Overview**

Hybrid sleeving combines materials; such as aramid, fiberglass, and metallic fibers, to deliver multi-functional protection tailored to specific system requirements.

### **Benefits**

- Can simultaneously address abrasion, EMI, and thermal needs.
- Customizable flexibility, strength, and weight.
- Often used in aerospace and defense where environmental conditions are extreme.

### **Limitations**

- Higher cost and complex installation.
- Availability may be limited depending on specifications.



## Comparison Table

Sleeving Type	Abrasion Resistance	Thermal Protection	EMI Shielding	Flexibility	Typical Applications
Expandable Braid	High	Moderate	High	High	Aerospace, Automotive, Electronics
Convoluted Tubing	Moderate	Moderate	Low	High	Cable routing, Maintenance access
Fiberglass	Low	High	Low	Low	High-temp environments, Chemical resistance
Aramid	High	Moderate	Low	Moderate	Abrasion-prone, Dynamic applications
Hybrid Solutions	High	High	High	Moderate	Multi-threat environments, Aerospace, Defense

## Selection Considerations

When selecting sleeving for a particular application, engineers should evaluate:

- **Mechanical stresses:** Flexing, abrasion, and impact.
- **Thermal environment:** Continuous operating temperatures and transient spikes.
- **EMI requirements:** Shielding effectiveness for sensitive electronics.
- **Installation constraints:** Bundle size, routing complexity, and maintenance access.
- **Cost vs. performance:** Balancing lifecycle costs with mission-critical reliability.

## **Conclusion**

Protective sleeving is a critical component in safeguarding wiring and cable systems against mechanical, thermal, and electromagnetic hazards. Each sleeving option; expandable braid, convoluted tubing, fiberglass, aramid, and hybrid materials, offers unique advantages and limitations. Selecting the optimal



solution requires a comprehensive understanding of environmental conditions, electrical requirements, and mechanical stresses.

Hybrid solutions are increasingly favored in high-performance applications, offering a tailored approach to multi-threat environments. By leveraging the right combination of materials and construction methods, engineers can assure cable longevity, system reliability, and operational safety across diverse and demanding platforms.