



HOW TO CHOOSE INSULATION MATERIALS FOR ELECTRICAL WIRING

What Is Cable Insulation?

Insulation is a non-conductive material that separates the conductive material within a cable from other conductive materials and from the environmental effects that would degrade the conductor’s performance if exposed to them. Both electrical and transmission cables make use of insulation to protect their enclosed conductors from temperature extremes, abrasion, current/signal loss, and moisture. Three types of insulation materials are in frequent use today include:

- Thermoplastic insulation refers to the petroleum-based plastic material that softens when heated and hardens when cooled
- Thermoset insulation refers to the petroleum-based materials that are heated to form permanent plastic- or rubber-like material

- Natural-based insulation refers either cotton- or wood-based paper impregnated with an oil or synthetic fluid; rubber; or silicone materials

Is All Insulation Created Equal?

Within the three types of insulation, there are several unique varieties that bear consideration when determining the best insulation material for a specific application.

Included in the table below are the most common insulation types compared by their type (i.e., thermoplastic, thermoset, or natural-based), mechanical properties (i.e., operating temperature range, abrasion resistance, flexibility), electrical properties (i.e., dielectric losses), other properties (i.e., thermal expansion, moisture resistance), cost, and any other noteworthy considerations. Use the data to choose the best insulation material for your application.

Cable Insulation Materials

Insulation	Insulation type	Mechanical properties	Electric properties	Other properties	Cost	Comments			
		Operating temperature range	Abrasion resistance	Flexibility	Dielectric losses	Thermal expansion	Water resistance		
Paper/oil	Natural-based	95°C–110°C	Low	High	Low-medium	None; oil will expand slightly	Low	High	Used for high-voltage cables, long history of reliability; requires hydraulic pressure for insulating fluid; additional lead sheath recommended; difficult to repair



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Rubber	Natural-based	Varies	High	High	Low-medium	None	High	Medium-high	Thermoplastic rubber improves colorability and temperature range and can be used in applications for which rubber are preferred
Silicone	Natural-based	Up to 180°C	Medium	High	Low-medium	None	High	Medium-high	Extremely flame resistant; good bonding properties; suitable for long-term storage life
Polyvinylchloride (PVC)	Thermoplastic	-55°C-105°C; up to 160°C for <300mm²	High	Low, brittle at low temperatures	High	None; melts at high temperatures	High	Low	Widely available; durable; not suitable for use in confined areas because of toxic smoke produced when burned; resistant to other solvents (e.g., gasoline, ozone, and acids); suitable for food and medical applications; semi-rigid PVC is flame resistant; plenum PVC can be used in dropped ceilings/raised floors
Polyethylene (PE)	Thermoplastic	-65°C-80°C	High	Low	Low	High; flammable; breaks down at high temperatures	Medium-low; low for high voltages	Low	Used in coaxial and low capacitance cables; can be foamed for higher electric qualities required in high-speed transmission cables
Polypropylene (PP)	Thermoplastic	-30°C-80°C	High	Medium	Low	High	Medium-low	Low	Used for thin-wall insulations; can be foamed for higher electric qualities
Chlorinated Polyethylene (CPE)	Thermoplastic	-55°C-105°C	High	Medium	Low	Medium-high	High	Low	Used for power and control cables and industrial power plants
Thermoplastic Elastomers (TPE)	Thermoplastic	Varies	Low	High	Varies	Varies	High	Varies	Properties vary based on mix of polymers; can be molded, extruded, recycled, and foamed; usually poor chemical/solvent resistance
Fiberglass	Thermoset	Up to 482°C	Medium	Low	Low	Low	High	Medium	Chemical resistant; used in heat treating, kilns, foundries, and aluminum processing



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Cross-linked PE (XLPE)	Thermoset	-90°C-110°C	High	Low-medium	Low	High; cross-linking prevents melting and separating at high temperatures	Medium	Medium	Considered on improvement of PE
Ethylene propylene rubber (EPR)	Thermoset	-90°C-110°C; up to 250°C	Medium	Medium-high	Medium-high	Low-medium	Medium-high	Medium	Requires inorganic filler; used in high-voltage cables; susceptible to tears, soft, and requires special handling during installation
Polychloroprene (Neoprene)	Thermoset	-55°C-90°C	High when vulcanized	High	Medium	Low	High	Medium-high	Resistant to oil and solvents; suitable for long-life applications; flame resistant and self-extinguishing
Chlorosulfonated Polyethylene (CPSE)	Thermoset	Varies	Medium	Medium	Medium	Medium	Low-Medium	Medium-high	Works well in low-voltage applications; solvent and UV ray resistant

Questions: Contact CMA

If you have questions or are interested in speaking with us about a custom cable assembly, we are happy to help. Please contact us by email or phone.

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