

**CHEMISTRY OF POLYMER MATERIALS IN THE ELECTRICAL ENGINEERING
INDUSTRY**

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Annotation: This article discusses the importance of polymer materials in the electrical engineering industry, their chemical structure, properties, and fields of application. Additionally, the role of polymers in the production of electrical insulation, cables, microelectronics, dielectric devices, and composite materials is examined from a scientific perspective.

Keywords: polymer, insulation, dielectric, composite material, electrical engineering, plastic, polyethylene, epoxy resin.

Modern electrical engineering is one of the fastest developing industries. The use of high-quality materials is essential in the processes of generating, transmitting, distributing, and consuming electrical energy. Among these materials, polymer materials hold a special place due to their high dielectric properties, corrosion resistance, lightweight structure, and low cost. The development of polymer chemistry makes it possible to increase the reliability and service life of electrical products.

Chemical Nature of Polymer Materials

Polymers are large molecules formed through polymerization or polycondensation reactions of monomer compounds. They are high-molecular organic substances consisting of numerous repeating structural units. The properties of each polymer depend on its chemical structure, monomer composition, macromolecular length, and molecular bonding nature.

Molecular Structure of Polymers

Polymer molecules exist in several forms:

- Linear — e.g., polyethylene, polyamide
- Branched — e.g., polypropylene
- Network (three-dimensional) — e.g., epoxy resin, phenoplasts

Main Types of Polymers

- Thermoplastics — PE, PP, PVC
- Thermosets — epoxy, phenol-formaldehyde resins
- Elastomers — rubber, silicone

Applications in the Electrical Engineering Industry

Polymer materials play a critical role in insulation, microelectronics, capacitors, composite materials, semiconductors, and more.

Electrical Insulation Materials

Polymers such as PE, PVC, polystyrene, and epoxy resins are widely used in insulation due to high dielectric properties and resistance to moisture and temperature.

Cable and Wire Production

PE, XLPE, PP, silicone elastomers, and PVC are used for insulation and sheathing, enhancing cable flexibility, heat resistance, and durability.

Microelectronics and Semiconductor Technology

Polyimides, PTFE, and epoxies are used in microcircuits, PCBs, chip packaging, and protective coatings due to their heat resistance and low dielectric constant.

Dielectric Elements and Capacitors

Polymers such as polypropylene films are used in high-frequency and high-voltage capacitors.

Composite Materials

Glass-fiber, carbon-fiber, and aramid-fiber composites provide high strength and insulation for electrical equipment.

Protective Coatings and Encapsulation

Epoxy, polyurethane, and silicone coatings protect devices from moisture, dust, corrosion, and mechanical impact.

Modern Polymer Innovations

- Conductive polymers — polyaniline, polypyrrole
- Nanocomposite polymers — graphene, nanotubes
- Self-healing polymers
- 3D-printing polymers
- Biopolymers — PLA, PHA
- High-temperature polymers — PEEK, PTFE
- High-dielectric polymers
- Energy-storing polymers

Conclusion

Polymer materials are an essential part of modern electrical engineering. Their chemical structure, mechanical properties, and functional capabilities directly influence industrial

development. Innovations in polymer chemistry continue to enhance the safety, durability, and efficiency of electrical products.

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