Celanese
The chemistry inside innovation™

DRIVING FUTURE MOBILITY

INTRODUCTION TO MATERIAL SOLUTIONS & EXPERTISE

Thermoplastic Innovations

FOR INCREASED ELECTRIFICATION, INTERCONNECTIVITY AND AUTONOMOUS DRIVING

With the broadest portfolio of thermoplastic solutions, Celanese is a leader in polymer selection, testing, design and application development in the automotive sector. Our solutions are **in production on thousands of components for 300+ automotive applications,** backed by **2,900+ automotive and color specifications**.

Regulatory and market pressures to identify reliable, cost-effective solutions to address vehicle range, energy usage and charging time, as well as the associated charging infrastructure, pose unique material challenges for electric powertrain systems and components including:

- Battery Systems
- High-Voltage Connectors
- Electric Motors
- On-Board Charging System
- Electric Vehicle Supply Equipment & Connectors

With the evolution to increasingly autonomous, interconnected and electric vehicles (EV), our material expertise enables automakers to exceed their energy efficiency targets. From improving electric motor performance to light-weighting battery systems to optimizing thermal management, our complementary portfolio of high-performance polymer solutions meets these wide-ranging demands, including recyclable and renewably-sourced materials to improve the environmental profile of vehicles.

FLAME RETARDANCY

To meet higher voltage and CTI requirements, Celanese offers high-performance resins, including halogen-free polymers, that enable superior mechanical and electrical properties for flame retardant high-voltage connectors with excellent resistance to moisture, chemicals and fluids while maintaining color consistency.

ELECTRIC PROPERTIES & ELECTROMAGNETIC SHIELDING

Celanese offers a broad portfolio of solutions suitable for the electrical and electronics industry that can apply to application requirements for EV. From thermoplastic polyesters to polyamides to high performance liquid crystal polymers, our materials meet the most stringent specifications and processing conditions of the electrical industry, including flame retardancy, mechanical strength and electrical insulation at wall thicknesses as low as 0.3 mm.

To protect sensitive electronic devices against malfunction caused by electromagnetic waves and radio interference Celanese delivers tailormade compound solutions enabling electromagnetic shielding of enclosures and housings.

DIMENSIONAL STABILITY & PRECISION

Ongoing miniaturization and higher packaging density require materials with increased dimensional stability, meaning material mass and performance resist change caused by temperature and fluid exposure. Reliable performance through numerous conditions, from chemical exposure to high heat, is critical for precision parts. Celanese materials provide excellent dimensional stability for meeting the most stringent requirements of the automotive and electronics industry.

THERMAL MANAGEMENT

Celanese offers a diverse portfolio of thermally-conductive polymers, available with either electrically conductive or insulative properties. This enables metal replacement and passive heat dissipation for power electronics, battery and charging systems and active driver assistance systems. Where fluid cooling supports active heat management for power electronics, battery and motor, Celanese delivers high heat, hydrolysis and chemically-resistant thermoplastics with improved dimensional stability.

LIGHT-WEIGHTING

Celanese materials enable reduced weight and complexity with thin-walling and parts consolidation. This process creates more space for energy storage systems and powertrain components, while enabling extended vehicle range and potential cost efficiencies.

Battery Systems

Application Requirements

Battery Cell Holders (Cylindrical) & Frames (Pouch)

- Electrical Insulation
- Dimensional Stability
- Low CLTE
- Hydrolysis Resistance (Coolant and Electrolyte)
- Thermal Management

Battery Module (Housings, Covers & Trays) & Pack (Top Cover, Trays)

- Hydrolysis Resistance (Coolant and Electrolyte)
- Impact Strength
- Tensile Modulus
- Dimensional Stability

Lithium-ion Battery Separator

- High Mechanical Strength
- High Permeability, High Porosity
- Pore Distribution and Pore Size Uniformity
- Excellent Processability

Lead Acid Battery Separator

- Cost-Effective
- Allows Rapid Fabrication of a Pocket
- Consistent Quality
- High Puncture Strength
- Resistance to Sulfuric Acid and Oxidation

Celanese Materials

CoolPoly® D-Series TCP

Celstran® LFRT

Frianyl® XT PPA

Frianyl® PA and Celanyl® PA

Fortron® PPS

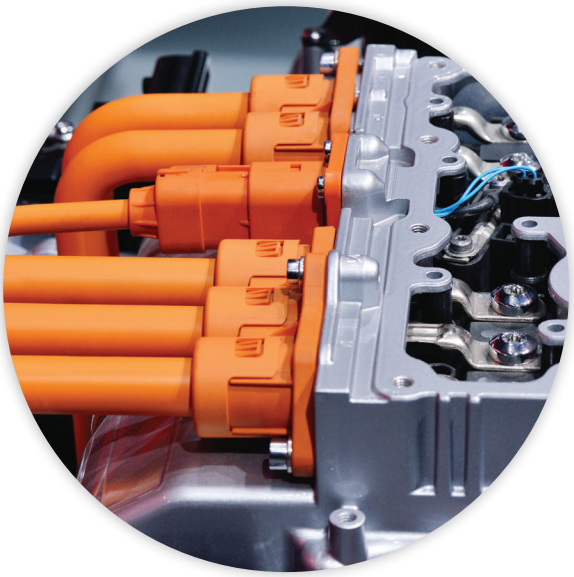
GUR® UHMW-PE

Battery applications like module end plates require chemically-resistant materials such as **flame retardant** (V0) **Fortron® polyphenylene sulfide** which enables reduced wall thickness and reduced weight, while maintaining tensile strengths of at least 160 MPa.

CoolPoly® thermally conductive plastics enable heat management in **cell holders and frames**.

For **housings, covers and trays** for an EV battery module, **Celstran® long fiber reinforced thermoplastics** offer the ideal solution to replace aluminum. The **Stainless-steel fiber equipped Celstran® compounds** further provide **EMI shielding** to deliver significant weight reduction and freedom of design.

Ideal for **battery separators,** our range of **GUR® ultra-high molecular weight polyethylene** grades separate the positive and negative electrodes' excellent flow of lithium ions. Its porosity enables processing ease and excellent mechanical properties of the membrane. These membranes also act as a fire and explosion hazard **safety mechanism** by separating the reactive materials and closing the pores when the battery reaches elevated temperatures.



High-Voltage Connectors

Application Requirements

- Flame Retardant V0
- Hydrolysis Resistance
- Electrical Isolation
- Color Stability
- Dimensional Stability
- Temperature Stability (-45 °C to 125°C)

Celanese Materials

Celanex® PBT

Vectra®/Zenite® LCP

Thermx® PCT

Frianyl® PA

Fortron® PPS

Celanese delivers special orange- (RAL 2003) colored grade **Frianyl® polyamide compounds** that retain color stability in automotive aging tests and offer high thermal resistance and halogen-free flame retardancy.

Where extensive media resistance is required, we offer semi-crystalline thermoplastics like Fortron® resins with inherent hydrolysis resistance and Celanex® polyesters providing strength, rigidity and toughness, dimensional stability in humid environments and low creep even at elevated temperatures.

Electric Motors

Application Requirements

- Electrical Isolation
- Dimensional Stability
- High Dielectric Strength
- High Mechanical Performance (at 220°C)
- High Electrical Resistance (up to 150°C)
- Thin-walling (<0.5 mm)
- High Precision: Low CLTE, Low Warpage, Low Shrinkage

Celanese Materials

CoolPoly® TCP

Fortron® PPS

Vectra®/Zenite® LCP

Celapex™ PEEK

Celanese materials can improve **stator package** part lifetime and reliability, while significantly thin-walling even in extreme temperatures and eliminating secondary finishing operations to reduce process costs.

Enhanced material flow delivered by our **Celapex™ PEEK high-flow solutions** enables thin-wall, long-flow parts with high precision and tight tolerances for electric motor applications like **rotor end caps** and **bus bar rings.**

Vectra® liquid crystal polymers, which function up to 175°C while retaining 100% tensile strength and modulus after a 1,000 hour aging test, can enable 0.3mm wall thickness in these applications. **Fortron® polyphenylene sulfide** can reduce to 0.5mm with a service temperature up to 240°C.

Onboard Power Electronic Systems

Application Requirements

- EMI Shielding
- Chemical Resistance
- Hydrolysis Resistance
- Thermal Management

Celanese Materials

CoolPoly® TCP

Celanex® PBT

Fortron® PPS

Frianyl® PA/PPA

Forprene® TPV

For **power electronics**, Celanese CoolPoly® thermally-conductive plastics enable advanced thermal management and potential EMI shielding.

Our **Forprene® vulcanized thermoplastic elastomers** deliver good electrical insulation properties, UV-resistance, good thermal resistance and low density for **cables** and other applications requiring elastomeric properties.

Developments in Charging Technology

Charging options for plug-in hybrid and battery electric vehicles range from 120 V residential AC charging that produces 1.4 kW of power requiring 8-12 hours for full charge to 500 V commercial DC fast charging that produces 50 kW and can fully charge most vehicles in only 20-30 minutes. Celanese delivers material solutions that address the range of stringent electrical and mechanical requirements associated with the different levels of charging. With over 12 million charging stations anticipated to be deployed over the next 5 years to meet the growing global infrastructure demand, Celanese advises on material selection for improved cost efficiencies to enable mass scaling.

Electric Vehicle Supply Equipment & Connectors

Application Requirements

- Electrical Isolation
- High-Voltage Resistance
- High RTI
- Hydrolysis Resistance
- Impact Resistance
- UV Resistance
- Flame Retardant
- High CTI
- Temperature Stability (-45 °C to 120°C)

Celanese Materials

Celanex® PBT

Thermx® PCT

Frianyl® PA & Frianyl® XT PPA

Celstran® LFRT Celanese offers multiple UL-listed unique color grade polymers for **charging stations**.

These, as well as our hydrolysis-resistant high temperature grade polymers, such as **Frianyl® flame retardant polyamide compounds**, are used in **charging plug connectors** around the world.

Solutions for Autonomous Transportation Evolution

Increasingly autonomous vehicles require multiple cameras, sensors, flash LIDAR, short-range and long-range RADAR to assist the driver and eventually guide the operations of automated driving control units that remove the need for driver involvement entirely. Head-up displays and infotainment units will accompany these innovations, seamlessly connected with devices throughout the vehicle and wirelessly communicating with the surroundings. These technologies introduce many performance requirements for materials, and Celanese can advise on the optimal thermoplastic grades for addressing these demands.

Multi-Function & Surround View Cameras

Application Requirements

- High Precision: Low CLTE, Low Warpage, Low Shrinkage
- Increased Miniaturization, Extreme Thin-walling
- Dimensional Stability
- Antistatic
- Surface Smoothness
- Thermal Management

Celanese Materials

Fortron® PPS

CoolPoly® TCP

Vectra®/Zenite® LCP

Celanex® PBT

Celanese materials enable high weld-line strength, low flash and excellent mechanical properties, as well as improved injection molding processability, for **lens barrels** and other plastic components in mounted cameras.

Vectra®/Zenite® liquid crystal polymers enable extremely complex part designs with high precision molding, critical factors for miniaturization and the increased demand for **higher resolution cameras**.

Flash LIDAR, Short & Long Distance RADAR Sensors

Application Requirements

- Dimensional Stability
- Flatness without Warpage
- Consistent Wall Thickness
- Radar Transmissibility
- Tangent Delta Dielectric Properties

Celanese Materials

Celanex® PBT

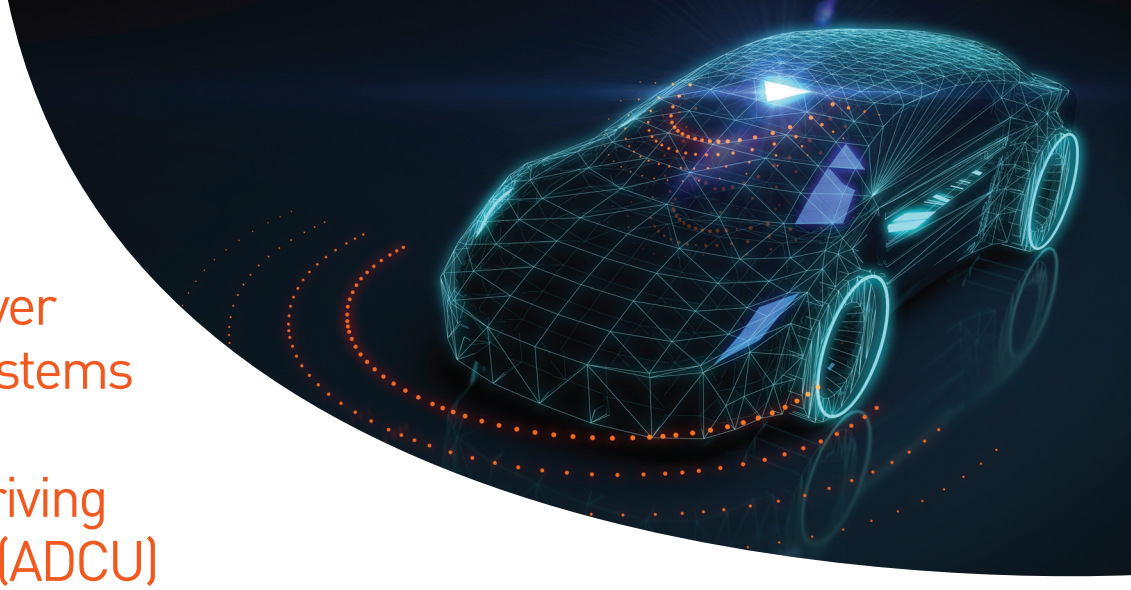
Vectra®/Zenite® LCP

CoolPoly® TCP

Electrical applications like **radar emitter covers** require the outstanding uniformity of wall thickness delivered by **Vectra® liquid crystal polymers** to seal the device properly and modulate the emitted signal, as deviations create inaccuracies.

Laser direct structuring (LDS) compatible Vectra® liquid crystal polymers deliver very high flow, high HDT, dimensionally stable, chemically resistant, low moisture absorbing, fast molding, non-flashing and inherently non-flammable properties for **complex circuits and smaller antennae**.

Our materials offer dielectric properties high temperature resistance in complex geometries for **surface mount technology**.



Advanced Driver Assistance Systems (ADAS) & Automated Driving Control Units (ADCU)

Application Requirements

- Good Dielectric Properties
- Dimensional Stability at High Temperatures
- Flame Retardant
- Increased Miniaturization, Extreme Thin-Walling and Complex Designs

Celanese Materials

Celanex® PBT

Vectra®/Zenite® LCP

CoolPoly® TCP

Frianyl® & Celanyl® XT PPA

Frianyl® and Celanyl® XT polyphthalamides offer high dielectric properties and high temperature resistance, necessary for **surface mount technology**. Excellent flow properties allow for complex geometries in ADAS and ADCU components.

Electromechanicals for Actuators

Application Requirements:

- High Precision: Low Creep, Low Warpage, Low Shrinkage, Low CLTE
- High Service Temperature (Up to 150˚C degrees)
- Heat Shock Behavior (-40 up to 180˚C)
- Electrical Properties
- Thermal Management

Celanese Materials

Fortron® PPS

Celanex® PBT

CoolPoly® TCP

Vectra®/Zenite® LCP

Celanese offers materials that meet the high-performance requirements of **the electromechanical** component of **actuators** in autonomous vehicles. **High quality Fortron® polyphenylene sulfide** offers excellent temperature and chemical resistance, enabling partial standardization of the motor, which enables mass production and;therefore, cost savings. Celanese also provides modified tribological grades of several materials for bearings and gears.

OTHER APPLICATIONS

Head-up Displays (HUD)

Application Requirements

- Dimensional Stability
- Design Flexibility
- Thermal Management

Celanese Materials

Fortron® PPS

CoolPoly® TCP

CoolPoly® thermally conductive plastics enable integrated heat management as an ideal replacement for die-cast aluminum **heat sinks** for HUD, reducing weight by 45-55%. Production costs decrease by eliminating secondary processes, extending tool life six times longer, and using 2/3 less energy in the molding process.

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ENGINEERED MATERIALS
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