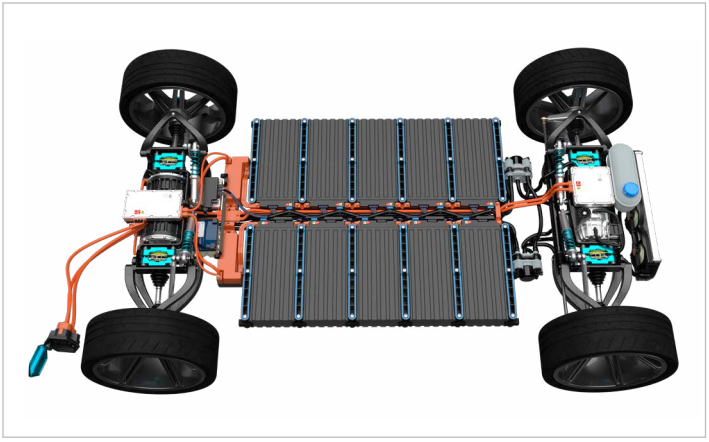
Application Sheet

DuPont™ eCool Multilayer Cooling Line Technology for EV Battery Applications



Automotive cooling lines (also known as pipes, tubes, or hoses - often combined with connectors) are a well-known application for thermoplastics and elastomers. These systems are found in all types of vehicles regardless of the type of propulsion. But in EVs, cooling requirements are elevated.* As a result, the cooling lines themselves can be up to three times the length of those needed for ICE vehicles.

Engineering EV systems to avoid overheated batteries is a top priority. If temperatures reach above 80°C, a thermal runaway event can happen. At over 140°C, fires can occur. Even milder temperatures hurt battery performance and longevity, making thermal management systems a mission-critical choice for EV makers.

A Layered Approach

Cooling systems directly affect an EV battery's longevity and charging performance. Critical performance needs include:

- Flexible and reliable materials that withstand -40°C to over 150°C
- Resistance to water/glycol, automatic transmission fluids, and immersion cooling/dielectric fluids

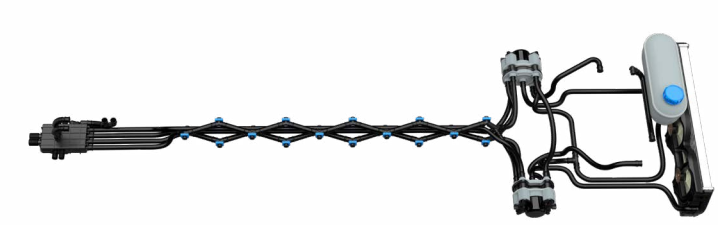
Besides resisting common fluids found in coolants and immersion cooling systems, thermoplastics used in cooling lines also need to defy degradation due to hydrolysis, zinc chloride (a corrosion inhibitor added to coolant), and stress cracking.

To meet performance needs and improve sustainability, DuPont has developed eCool Multilayer Technology. Based on Zytel® LCPA (Long Chain Polyamide), a tie layer, and a TPE (elastomeric) layer, this is an easy-to-extrude alternative to both PA12 thermoplastic systems and heavier EPDM rubber options. These multilayer tubes can be extruded smoothly or corrugated, and thermoplastic elastomer placement can be customized to make tubes bend in all the right places. This adds greater design freedom.

OEMs are looking for more sustainable options given the longer lengths of cooling tubes in EV cooling lines. Of course, sustainability has many facets. One of the first and most commonly used measures in Life Cycle Analysis (LCA) for sustainability is GWP (Global Warming Potential), which measures CO_2-equivalent emissions. Most cooling lines currently are made of PA12, so DuPont looked at the amount of CO_2 created in producing a kilogram of each material.

Design Flexibility
Flexible Thermoplastic and Thermoplastic Elastomer

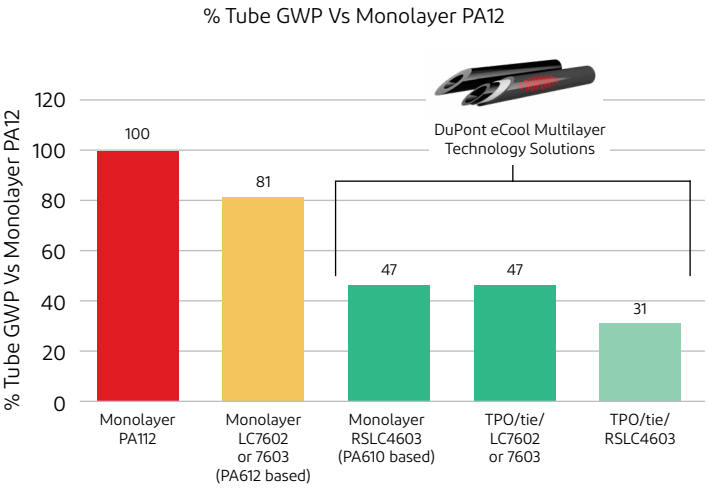
Zytel® LCPA with TPE Layer



Durability
Hydrolysis + Coolant Fluid Resistant Materials for Quick Connector & Sealing Components

Zytel® PA, Zytel® HTN, Zytel® LCPA, Vamac AEM®

GWP for Mono & Multilayer Tube Constructions



Values based on DuPont LCA estimations using cradle-to-gate material contributions to the tube assembly's GWP. Actual values may vary based on specific grade, tube material content, and tube dimensions. (Source: DuPont)

Sustainable and Cost-Effective

The chart on this page shows that the new DuPont™ eCool solution excels in reducing GWP. Moreover, it runs at essentially the same line speed and has a comparable system cost to monolayer solutions.

In addition, customers can take advantage of a range of technical and production-level support, including:

- Design expertise (CAE/FEA simulation)
- Extrusion trials, including multilayer
- Support for post-processing such as welding, thermoforming, and more
- Testing for burst pressure, tensile strength, air and chemical aging, stress cracking, and bend testing

With a range of processing equipment, we offer customers the ability to manufacture cooling lines under near-commercial conditions, then do the testing to dial in the process and post-processing required.

* More cooling lines are needed in an EV because energy and heat management are crucial to maximizing battery range. Every bit of heat available for winter driving needs to be scavenged and directed into the cabin for heating, for battery cell conditioning, and to keep batteries operating at an optimum temperature. In addition, power electronic components such as inverters, chargers, or DC/DC converters, while very efficient, operate at high temperature and need precise temperature control. Coolant circulates through heat sinks in such components, carried by advanced tubing.

Proven Performance

The Zytel® LCPA portfolio is the basis for DuPont's eCool technology. These long chain polyamide products are well-recognized and comply with automotive OEM specifications. Designers and engineers rely on this family of innovative thermoplastics for demonstrated performance, including:

- Hydrolysis-resistance to a spectrum of liquids – transmission fluid, water-glycol, and dielectric fluids
- Electronic and electrically friendly solutions to prevent metal corrosion and pollution of coolant fluids
- Elevated mechanical properties at low and high temperatures
- Resistance to thermal shock and impact for extended component life
- Laser welding grades
- Laser marking capability for easy part traceability

Six Reasons to Consider DuPont eCool Technology for EV Cooling Lines

- **Lightweighting:** Weight reduction versus rubber
- **Sustainability:** Lower GWP (global warming potential) than alternative thermoplastics
- **Coolant/Hydrolysis Resistance:** Barrier and stress resistance to coolant chemistries
- **Customization:** Ability to test and customize solutions at DuPont Automotive Electrification Centers of Excellence
- **Cost:** Cost-effective solution for the increased amount of cooling lines for EVs
- **Design Freedom:** Placement of elastomer layer can be customized to improve the flexibility of tubes/pipes

For more information, contact your DuPont representative.

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