Stanyl®

# Automotive Electrical & Electronics

## Innovative resin solutions for every application

One of the primary goals of today's automotive industry is to make vehicles lighter and more efficient for improved fuel economy. Increased electronics inside the vehicle enable tighter control over the various systems to ensure they run as efficiently as possible, yet also place additional stress on the electrical system or make direct changes to electronic components. The main trends in automotive electrical and electronics systems are mass reduction for cost savings, miniaturization, design flexibility to convert metal parts to plastic and the use of more environmentally responsible materials.

As a global specialist in materials sciences, DSM Engineering Plastics has created a complete portfolio of plastic materials that offer the mechanical properties needed for the wide range of applications in vehicle electrical systems. From connectors, cable jacketing and control modules to actuators and solenoids, our portfolio includes a grade that's ideal for every application. Should you require a customized grade that we don't currently offer, we will commit our brightest minds across multiple disciplines to develop the best possible solution.

### A resin solution for every application

We've spent extensive time in research and development to create a cost-competitive portfolio of resin solutions for automotive electrical and electronics systems. Enhanced flow materials with better dimensional stability enable the design and realization of more compact and thinner-walled parts while maintaining the strength, durability and high temperature performance needed for automotive environments. These materials offer increased flexibility in design, save weight and ultimately save costs through the use of less material and faster cycle times due to increased cavitation. We also offer a full range of Eco+ halogen-free flame retardant solutions that maintain high safety performance with less environmental impact.

### Our portfolio of resin solutions delivers:

- Best-in-class range of operating temperatures (-40˚C to 220˚C)
- Toughness after aging to improve the performance of hinge designs and assemblies
- Thin-wall production capabilities (to 0.1mm)
- High-speed molding to reduce production costs by up to 25%
- Low-pressure molding to prevent wire, contact or component dislocation during over-molding or encapsulation techniques
- Thin-wall cable jacketing capabilities.

### Cut costs with component mass reduction

With close to 30,000 parts in a single vehicle, mass reduction has a cumulative effect where every little bit helps toward the goal. That's why we work in partnership with our customers to ensure that they have the right plastic grades needed to make lighter parts that work to improve vehicle efficiency without compromising strength or safety. Our enhanced flow materials enable the design and processing of thinner-walled parts with the same strength and stiffness. This results in two types of cost savings at the manufacturer level: reduced weight of the materials used, as well as a 25 to 40% reduction in production cycle times versus standard flow materials. An example of an application where our materials would be extremely effective is control modules with unvented designs that have a high build-up of internal temperature and pressure. To maintain a balance of stiffness, warp resistance and part performance, a high-performance resin is needed.

At the same time that walls are becoming thinner, the voltage demands within vehicle electrical systems are on the rise. Thinner insulating walls and shorter path lengths between contacts require improved performance materials with a high comparative tracking index (CTI). The test method for CTI is specified in IEC standard 60112, and measures the electrical breakdown or tracking properties of an insulating material. The higher the CTI, the thinner the insulating walls and shorter the path length can be while still containing the voltage.

Stanyl® ForTii offers a best-in-class CTI value, making it more suitable for higher voltage applications, including those within hybrid electric and electric vehicles. It also performs across a wide temperature range and can be molded into very thin wall sections, making it an ideal material for use in high-voltage automotive electrical systems. Using Stanyl ForTii, we have successfully demonstrated a 33% reduction in wall thickness (from 1.8 millimeters to 1.2 millimeters) for vehicle control modules while improving flexibility by 25%. With more than 40 control modules in a traditional vehicle and easily double that number in an electrical vehicle, you begin to see how small weight savings accumulate to reduce the overall vehicle weight.

ISO 6722 - Thermal Classification

| | Class D | Class E |
|---|---|---|
| 3000 hr | 150 | 175 |
| 240 hr | 175 | 200 |
| 6 hr (thermal overload) | 200 | 225 |

Wire cables, conductor sizes and jacket thickness is another area where mass reduction can have a large cumulative effect. To date, most suppliers have not transitioned to ultra-thin wire insulation because it requires re-designing connectors. Instead they are down-sizing conductors, for example replacing 16-gauge wire with 20-gauge, which saves money on copper and makes the cable and harness lighter. When the conductors are made smaller, however, it creates a higher resistive load, resulting in more heat in the wire itself. This puts additional temperature demands on the insulation material, easily raising a 105°C temperature environment to 125°, or 125° to 150°. Arnitel C can help resolve many of the issues with down-sizing conductors and moving to ultra-thin wire insulation as it is a proven Class D (150C) material with the capability to produce ultra-thin insulation (8 mil per SAE 1678, ISO 6722), and is approved in Class E for convoluted tubing. Arnitel C maintains its flexibility even after heat aging, and it also exhibits good heat-aged color stability, including high-voltage applications where a stable orange color is needed for identification purposes.

Heat also plays a key role in attempts to reduce vehicle mass. In addition to smaller engine compartments driving under-the-hood temperatures up, car manufacturers are making greater use of turbo-charged engines in order to deliver higher fuel economy without compromising performance. Turbo-charged engines run at much higher temperatures, which has caused some component conversion back to metal from plastic in order to withstand the high heat. Since this plastic-to-metal conversion goes entirely against the push to make vehicles lighter in order to improve fuel economy, DSM Engineering

Flame Retardant Products and Applications

| Family | Grade | CUT | CTI | UL 94 Flamability | Applications |
|---|---|---|---|---|---|
| PA6 | Akulon K222 KMV5/B | 130 | 600 | V2 | Heavy Duty Systems |
| PA46 | Stanyl 46 TE250 F6 | 163 | 225 | V0 | Heavy Duty Wire Wire Systems |
| PA4T | Stanyl ForTii F11 | 180 | 600 | V0 | SMT Reflow Headers |
| PBT | Arnite TV4 260Sn | 140 | 275 | V0 | SMT Reflow Headers |
| | | | | | |
| TPC | Arnitel CM622 / UM622 | 150 | <600 | V2 | Convolute Tube, Wire Jacketing |

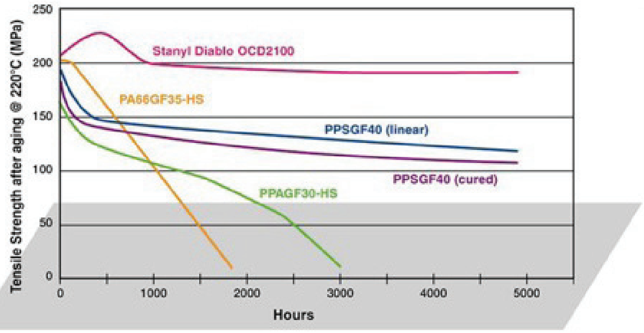
Plastics has also developed a number of materials that maintain their durability at higher temperatures.

We measure the temperature performance of our products according to the absolute real operating (ARO) temperature concept. This is defined as the absolute value of strength or stiffness at the real operating temperature after aging at that same temperature. This provides a better measure of the material's performance since the actual strength of the material after aging at the elevated temperature is derived experimentally. Our portfolio includes a number of products – including Stanyl, Stanyl Diablo, Akulon Diablo and Stanyl ForTii – that perform well at high temperatures, which means there's no need to convert these components from plastic back to metal in order to guarantee durability in high-heat environments.

## Miniature yet durable

In addition to mass reduction, there is a general trend toward making automotive components smaller. In addition to the temperature increase that comes with having more wires and contacts in the same space, it also creates a higher contact density on the PC board of the intelligent device of the vehicle.

This has created a shift in soldering process from pin through hole and wave bath soldering to increased use of surface mount techniques (SMT). SMT allows for a lower stack height and higher pin density on the board to save space. At the same time, it demands much more from the plastic material used in the PC board, since it is exposed to a soldering temperature of 265°C for lead-free soldering during assembly. The plastic material used for the PC board must resist melting, stress relaxation and warp to prevent dimensional changes, ensure contact retention and maintain optimal performance of the device.



Our materials are able to fill very thin wall sections while maintaining the strength required to survive durability testing of the connection system and the individual contact isolation necessary for automotive environments. In addition, they exhibit strength in walls as thin as 0.1 millimeters and at weld lines.

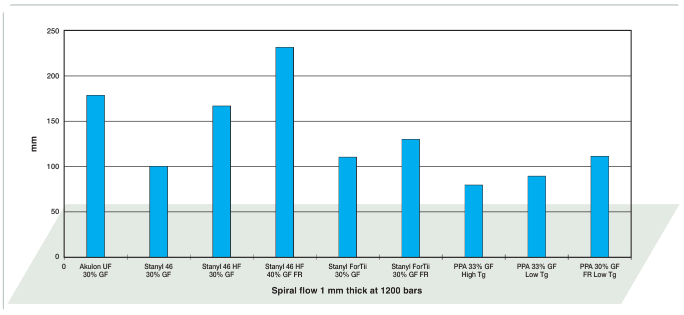
To test the stability of our materials at high processing temperatures (or the modulus at elevated temperature), we test the heat distortion temperature (HDT) at 1.8 megapascals loading. This is the temperature at which a 1 millimeter thick molded bar will distort 1 millimeter under a 1.8 megapascal load. For semi-crystalline materials, a higher melting point generally means a higher HDT.

| | | Stanyl ForTii 30% GF HS | Stanyl ForTii 30% GF FR | PPA 30% GF FR |
|---|---|---|---|---|
| Tensile modulus no weldline 1mm (DAM) | [MPa] | 10000 | 10000 | 9000 |
| Tensile modulus weldline 1 mm (DAM) | [MPa] | 8000 | 9000 | 8000 |
| Stress at break no weldline 1 mm (DAM) | [MPa] | 211 | 165 | 150 |
| Stress at break weldline 1 mm (DAM) | [MPa] | 103 | 65 | 72 |
| Strain at break no weldline 1 mm (DAM) | % | 2.7 | 2.2 | 2.5 |
| Strain at break weldline 1 mm (DAM) | % | 1.3 | 0.75 | 0.95 |

Our Stanyl polyamide 46 and Stanyl ForTii grades withstand service temperatures from -40˚C to 180˚C continuous use temperature (CUT), while satisfying the requirements for lead-free SMT electronics applications. Akulon® Ultraflow® is designed for service temperatures ranging from -40˚C to 140˚C. Like all of the polyamides in our portfolio, they remain tough even at higher service temperatures, with superior resistance to automotive fluids. These materials are also suitable for high density wire harness connectors and devices, depending on the service temperature range of the application.

## Freedom to design

Ultimately, what DSM Engineering Plastics seeks to offer our customers is a sense of design freedom. Our materials provide more flexibility in component design creating the opportunity to create components with thinner walls while maintaining part integrity, converting components in high-heat environments to plastics that can withstand high service and processing temperatures, and creating reduced form factor components with high impact strength to prevent failure in the demanding environment of under-the-hood applications. Our dynamic portfolio of resins for automotive electrical and electronics systems ensures that design engineers have the freedom to create intelligent




components that work toward the goal of making vehicles run more efficiently, without the need to worry about costly recalls from part failure. We believe in working very closely with our customers to understand their product needs and issues so that we can make the best material recommendation, and even create custom grades when required.

Experience has shown that halogen-based heat stabilizers are extremely corrosive to metal contacts and the circuitry in electrical systems. Maintaining a contaminant-free environment is critical to a system that functions well. Our broad range of halogen-free heat stabilized grades prevent the contamination and corrosion of metal contacts, and avoids the formation of a shorting path within the electrical system.

These materials also work in the new applications being created by plug-in electrical vehicles, which require charging stations both at home and in the public domain. Governed by Underwriters Laboratories, the safety of these systems is paramount with a real need for flame retardant compounds. Our halogen-free flame retardant products have a low environmental impact, which is much better aligned with the design philosophy behind electric vehicles.

## Partnering for a brighter future

At DSM Engineering Plastics, we actively seek to partner with customers to improve their components for automotive electrical and electronic systems in a cost-competitive way. Our portfolio includes a wide offer of grades that exhibit high-flow capabilities that enable thinner walls for reduced mass, that perform well in extreme temperature and high-voltage environments, that are strong and durable, and that last. We back all of our material sales with extensive research and development, as well as a collaborative partnership where we work with you to solve any technical issues along the way, including the creation of customized grades. With manufacturing facilities on three continents and vertical integration in the monomer precursor to polyamides, we offer a security of stock that buys our customers peace of mind, comfortable in the knowledge that supply will never be an issue with DSM.

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## DSM Engineering Plastics

Contact us today to learn how
DSM Engineering Plastics can
help you improve your automotive
electrical and electronics systems:
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