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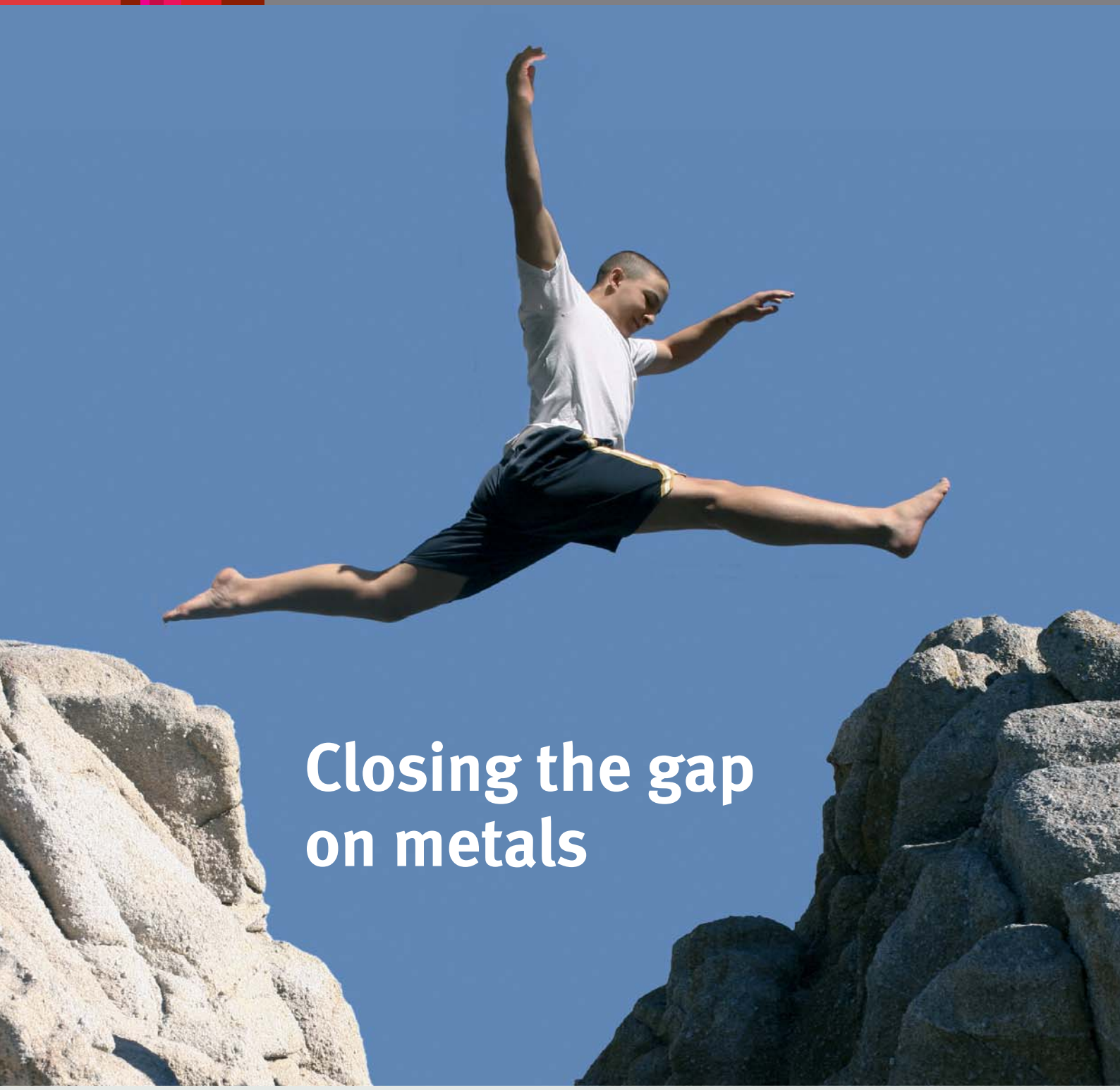


Closing the gap on metals

MetaFuse™ nanometal/polymer hybrids combine the strength and stiffness of metals with the design flexibility of high-performance plastics

Read more on pages 2 + 4

DUPONT®

The miracles of science™

Closing the gap on metals

By Clive Robertson, business development manager, DuPont Engineering Polymers

An impressive demonstration of new technology at K 2007: Clive Robertson points at a hybrid test bar, using Zytel® HTN PPA and MetaFuse™ technology, which is able to carry 5 kg (11 lbs) of weight. Also in the picture is a metallic-looking ping-pong ball, also treated with MetaFuse™, supporting 80 kg (176 lbs) of weight

As frequent readers of Engineering Design will know, the DuPont Engineering Polymers business is founded upon application development based on high-performance materials and technology aimed at helping customers deliver high-quality, cost-effective systems and components. Our engineering thermoplastics have consistently been used in industry to provide material solutions that optimize cost, mass, performance and aesthetics in the manufacture of products used around the world in applications that range from consumer goods to heavy industry. The wide use of these materials as alternatives to metals is based on many advantages including low mass and excellent strength to weight ratio, corrosion resistance, design flexibility, low processing costs and minimal added manufacturing steps.

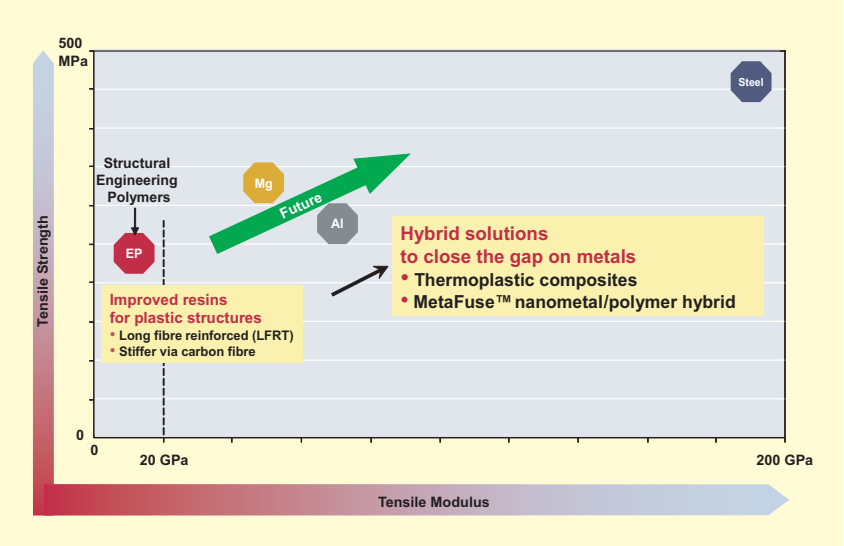
Recent developments in high performance polymers and advanced reinforcing systems have allowed further use of engineering polymers as viable alternatives to metals in very demanding applications. However, even with the latest developments in polymer technologies, there is still a significant gap in mechanical properties that limit the use of engineering polymers in some applications. It is in these cases that product and component designers have been limited by the materials at their disposal: While metal offers strength and high stiffness, it is limited in its ability to enable integration and to cost-effectively create complex shapes. Thermoplastic, on the other hand, offers tremendous freedom to create shapes and to integrate functions, but it has suffered from some limitation in combining strength and stiffness.

Research and development in alternate technologies have explored materials solutions to further bridge the gap in material properties. Some new technologies involve combining metals and plastics together in hybrid systems that take advantage of the properties of both materials. More traditional methods of overmolding sheet metals and other formed metal pieces have been advanced, but are limited by the reliance on mechanical joining of the two materials and limitations on design and tooling complexity, and sub-optimum placement of the metal in many cases.

An Advanced Metals Replacement portfolio

It is against this background – particularly with regard to the discrepancy in terms of stiffness between its own engineering polymers and metal – that DuPont has built its own portfolio for Advanced Metals Replacement, which today includes two differentiated offerings. Our SuperStructural Monolithic Solutions consists of an array of glass-, carbon- and long-fiber reinforced thermoplastics for very high stiffness and strength combined with excellent creep and fatigue resistance. New launches include high-stiffness carbon/glass reinforced resins for our DuPont™ Zytel® HTN 51 and 53 series, whereby tensile modulus, or stiffness, has been increased by 50% or more versus our existing glass-fiber reinforced grades.

The second, most recent addition to our portfolio of advanced metal replacements are MetaFuse™ nano-metal/ polymer hybrids. Launched in the last quarter of 2007, and described in more detail in this issue of ED, MetaFuse™ is a logical extension of our SuperStructural offering that combines the best of polymers with the



New and upcoming products and solutions to replace metals

best of metals. The new technology employs a proprietary process that precisely applies ultra high-strength nanometal to components made of DuPont engineering polymers to create lightweight components in myriad, complex shapes with the stiffness of magnesium or aluminum and higher strength. MetaFuse™ has already been received with great excitement by product and component designers because it truly allows freedom to design with fewer limits.

A third, complementary, offering is currently still under development: Thermoplastic Composite Solutions from DuPont foresee the overmolding of a continuous fiber reinforcement in a finished part to combine very high stiffness and strength with high part functionality and complexity, while offering energy absorption up to and during failure which is similar to, or higher than, levels for metal components. Further announcements on this technology, and candidate applications, are scheduled for the first half of 2008.

With most of our advanced metals replacement technologies, initial developments will focus on selected applications in the automotive, consumer electronics and sporting goods markets that offer the maximum benefit. DuPont Engineering Polymers, with global development, R&D and customer-support centers, will provide application development leadership in the drive to bring these innovative technologies to market and to the benefit of its customers. At the same time, the business will continue to implement scientific expertise and the latest polymer advances to further close the gap on metals.

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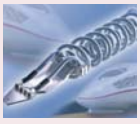


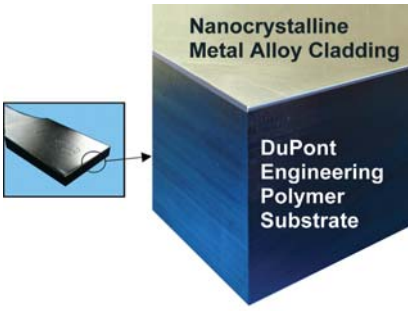
DuPont™ Hytrel® insulates at high speed
The thermoplastic polyester elastomer meets functional and electrical requirements and is well-suited to extrusion jacketing.

Design with new freedom

By Mike Day, DuPont Engineering Polymers, USA

During the recent K show (October 2007), DuPont officially launched MetaFuse™ nanometal/polymer hybrids. The new technology is used to manufacture extremely lightweight components with the strength and stiffness of metal combined with the design flexibility and lightweight benefits of high-performance thermoplastics. The following article explores MetaFuse™ technology and how it turns traditional plastic/metal hybrid approaches inside-out to bring not only a step-change in performance, but also provide product designers with a technology that can shift their paradigm.

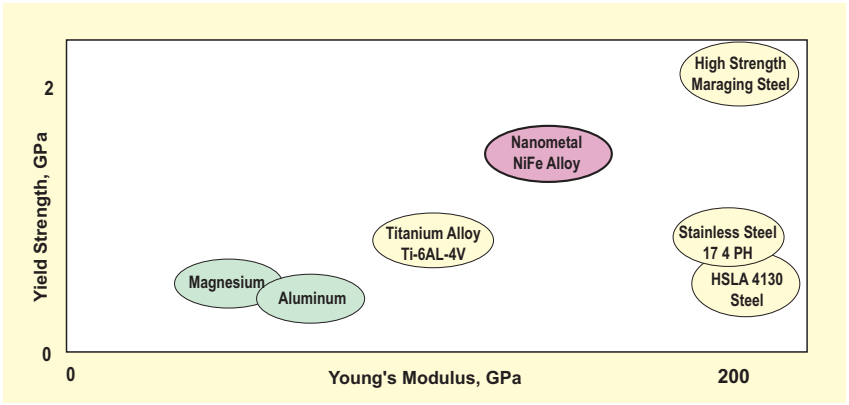
MetaFuse™ nanometal/polymer hybrid technology is a joint development between DuPont and Canadian-based Morph Technologies Inc., Integran Technologies Inc. and US-based PowerMetal Technologies. It employs a proprietary deposition process that precisely applies a thin ultra high-strength metal layer to molded components made of engineering polymers to create lightweight components in complex shapes with the stiffness of magnesium or aluminum and higher strength. The metal layer in this hybrid system is unique in that it is based on nanocrystalline microstructure in the metal, which creates high strength that cannot be matched in other traditional metal deposition processes. An illustration of this hybrid system is shown in Figure 1.



1. MetaFuse™ nanocrystalline metal/polymer hybrid

Nanocrystalline metals

The patented technology in MetaFuse™ nanometal/polymer hybrids produces nanocrystalline metals which have an average grain size of about 20 nm, which is about 1000 times smaller than conventional metals, and are 2 to 3 times stronger than typical steels and decorative nickel-chrome (see Fig. 2).



2. Comparison of nanometal alloy to high-strength and other metals

Since the nanocrystalline metal alloys have significantly higher strength than conventional metals, relatively thin layers can be applied – typically from 25 to 200 microns – to the surface of plastic materials to create hybrid constructions with structural properties, unlike other metal deposition techniques, such as conventional electroplating and vapor deposition.

An innovative metal over plastic technology

MetaFuse™ nanometal/plastic hybrids have been developed using specific proprietary DuPont engineering polymers and processes. A unique aspect of this system is that it places the metal in the optimum location to increase stiffness. For bending loads, the placement of the nanometal coating is most beneficial at the outermost edges of the part, furthest from the neutral axis. This is where the maximum tensile and compressive stresses are experienced by a part, since the stresses are directly proportional to distance from the neutral axis. The strong and resilient nanometals are well placed to support the load. The bending stiffness of the part increases as well because it is a product of the modulus and moment of inertia; the inertia of the coating is increased exponentially by moving it away from the neutral axis. Torsional stiffness and strength are also improved by moving the coating radially outwards to increase the polar moment of inertia. The outer sections experience the largest torque and this is where the

superior strength of nanometal is most beneficial.

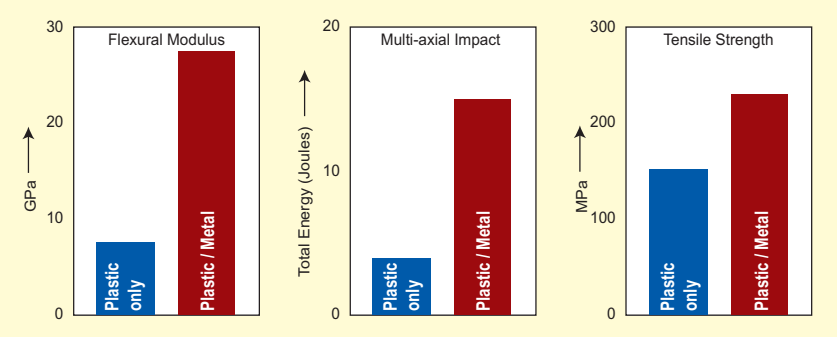
Property testing has been completed with a number of different engineering polymer substrates to characterize properties of the MetaFuse™ hybrid system. Typical improvement in physical properties is illustrated based on testing of 25% glass-reinforced Zytel® PA66 polymer, injection molded into ISO tensile bars and then clad with 100 microns of nickel/iron nanocrystalline metal alloy, encapsulating the bar.

As shown in Figure 3, typical increases in flexural modulus and impact strength of two to four times that of the plastic alone can be achieved. These properties are very dependent on the geometry of the sample, metal thickness and substrate plastic material. Tensile strength is directly proportional to the amount of metal used.

Testing has also shown that MetaFuse™ nanometal/plastic hybrids are able to maintain excellent structural properties in temperature ranges where polymers alone exhibit significant loss in properties. Data gathered by DuPont suggests that MetaFuse™ may allow the use of polymers in structural applications at elevated temperatures and extend the working temperature range of polymer parts by 50 to 75 °C (122 to 167 °F). Results will depend, however, on the properties of the plastic substrate that is used.

Design agility

In many practical applications the nanometal cladding may not be needed over the entire surface of the part. Parts can be selectively clad – strategically – to bear loads or provide other functional benefits. Complex parts are optimal challenges because making them in current metals-based technology is difficult or expensive. Figure 4 shows some concepts for selective nanometal cladding.



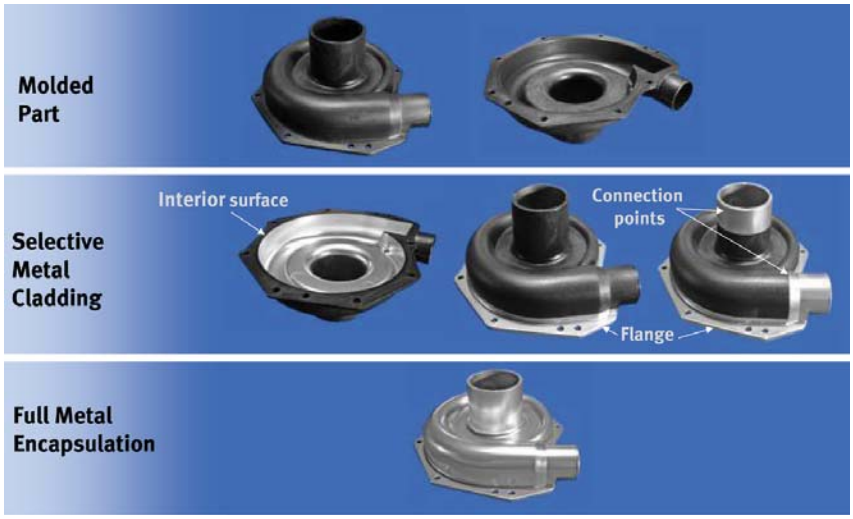
3. Comparison of physical properties at room temperature

While the primary focus of this article has been related to stiffness and strength properties, MetaFuse™ nanometal/plastic hybrids also have the capability to provide additional benefits to plastic materials, such as wear resistance, creep resistance, electrical conductivity, chemical resistance, EMI shielding, reduced gas/fluid permeability and UV and hygroscopic stability.

Application areas

There are many potential applications in automotive, consumer electronics, sporting goods and other markets. Examples include: engine oil pans, cylinder head covers, water and oil pumps, gasket carriers/gasket systems, engine timing chain tensioner arms, transmission housings and components, fuel rails, automotive electrical motors, electrical housings and covers, steering column brackets and steering system components, suspension/control arms, mobile phone frames and housings, bicycle components, fishing reels and golf club driver heads.

DuPont doesn't anticipate immediate commercial developments in large, simple, load-bearing applications because it may not be cost-effective to replace simple stamped steel parts. Instead, the company is looking at strategically applying MetaFuse™ nanometal/hybrid technology to multifunctional components that today require loads or heat too high for plastics and are costly to produce, or design-limited, in metals requiring multi-part welded assemblies or complex/machined castings.



4. MetaFuse™ nanometal/polymer hybrid multiple cladding concepts offer design flexibility

Polymer solutions for the ‘hot-end’

By Franz Spitznagel, DuPont Engineering Polymers, Germany

For the first time in Europe, a polymer bracket, molded in DuPont™ Zytel® nylon, is used to secure the ‘hot-ends’ of exhaust systems to the underside of a car. The two-component part, which uses the rubbers EPDM (black) and VMQ (red) as well as the nylon, was developed by anvisgroup in cooperation with Volkswagen. Mechanically robust and highly resistant, the polymer bracket replaces metal to deliver advantages in terms of weight and cost of manufacture.

anvisgroup of Bad Soden-Salmünster, Germany, working in cooperation with Volkswagen, has developed the first catalytic converter bracket for cars to be made from an engineering thermoplastic. Due to its position – in close proximity to the engine where temperatures of up to 175 °C (347 °F), high static and dynamic forces, moisture and chemicals combine – steel plates had previously been considered irreplaceable for such applications. Yet anvisgroup has proven the opposite by developing an innovative, two-component bracket based on glass-fiber reinforced DuPont™ Zytel® nylon and rubber. Since mid-2006, the design has proven itself at the ‘hot end’ of exhaust systems on all new vehicles belonging to Volkswagen’s so-called Golf platform (PQ35).

Manufacture of the newly-designed bracket starts with the injection-molding of the cross-bar in Zytel®. During a second production phase, the rubber bearings, either made from EPDM (for diesel and smaller petrol engines) or the more heat-resistant silicon rubber VMQ (high-performance petrol engines) are molded on. Finally the aluminum bushings, required to secure the bracket, are assembled by force fitting. Mounted between the exhaust manifold and the catalytic converter, the two-component part provides flexible and attenuating support for the exhaust system in the x-direction, while absorbing static and dynamic loads in the y- and z-directions. Thus it prevents, for example, the exhaust system from damaging the sensitive, flexible metal bellows that decouples load change movements and vibrations between the engine and the exhaust system.

Comprehensive testing, carried out by anvisgroup, showed that Zytel®

The new bracket from anvisgroup is the first polymer mounting for the ‘hot end’ of the exhaust module

70G35HSL, a hydrolysis-stabilized PA66 with 35 wt. % glass fibers, can meet OEM requirements for dependability for the entire lifecycle of the vehicle. "The component was subjected to the kind of extreme conditions that you would only experience in real life if you were to drive a car and heavy trailer uphill on a potholed road for hundreds of kilometers," comments Gerhard Heckmann, product group manager for exhaust system mountings and decouplings at anvisgroup. "Our test results confirmed that, even then, the cross-bar made of glass-fiber reinforced Zytel® continues to perform faultlessly. Indeed the new catalytic converter bracket offers high levels of safety over its entire lifetime."

In addition, the new design offers further decisive benefits: Firstly, the polymer component weighs only 165 g (5.8 oz) and is therefore considerably lighter than its metal counterpart, which comes in at 300 g (10.5 oz). Secondly, it provides the opportunity for cost-efficiencies during manufacture because, for example, surface protection is no longer required to prevent corrosion. "With the completion of this project we have been able to implement the first polymer mounting for the 'hot end' of the exhaust module. Hence there is nothing to prevent the development of a polymer alternative for the 'cold end' as well," concludes Heckmann.

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New DuPont soft thermoplastic elastomer grades for 'under-the-hood'

Extruded and molded parts made of DuPont™ ETPV engineering thermoplastic vulcanizate can withstand the rigors of automotive under-hood service

DuPont Engineering Polymers has extended its range of material to meet growing demand for soft oil- and heat-resistant elastomers delivering the cost and design benefits of thermoplastic processing.
The new offerings include:

- DuPont™ ETPV 95A02HS BK001 and 95A02 NC010 for outstanding processing stability in profile extrusion and in blow molding of air ducts, for example. ETPV 95A02HS BK001 is a black heat-stabilized grade rated for 3000 hours at 150 °C (300 °F), while ETPV 95A02 NC010 is a standard natural grade for less demanding requirements.
- Two grades of DuPont™ ETPV with hardness values of 70 and 80 Shore A. Earlier grades in the DuPont™ ETPV product line have Shore A values of 60 and 90.
- DuPont™ Hytrel® AC801 NC010, which is much softer than any other grade of Hytrel® and has improved heat resistance. Its nominal hardness is Shore A 80, and it is rated for 150 °C (300 °F) service, which is about 20 °C (68 °F) higher than most other Hytrel® grades.

The above material specifications are within acceptable ranges for most under-the-hood automotive and other high-temperature industrial environments. Typical applications include extruded hose and tubing, blow molded air ducts and injection molded seals and body plugs.

http://automotive.dupont.com

News

DuPont™ Zytel® nylon goes off-road

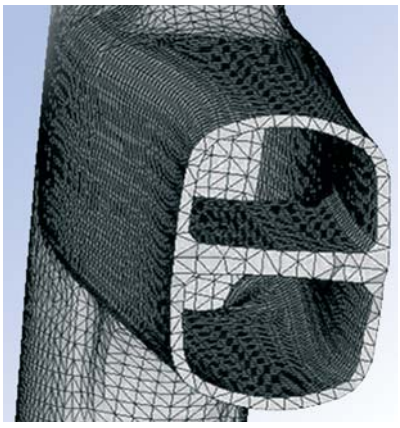
By Ricarte Rivera, DuPont Engineering Polymers, USA

The new FRX5 bike wheel has what it takes to withstand the punishment of off-road recreational biking and competition. American manufacturer TAG Wheels makes the new wheel in a single piece using DuPont™ Zytel® nylon resin delivering excellent toughness, strength and stiffness.

Made of DuPont™ Zytel® nylon, the mountain bike wheel withstands sharp impacts that cause permanent damage to conventional wire wheels

TAG Wheels of Newport Beach, California, relies on DuPont™ Zytel® 8018 to make its innovative new FRX5 bike wheels for off-road biking. Manufactured in a one-piece design, the FRX5 wheel optimizes the functional properties of the PA66 polymer, which has been modified with advanced DuPont toughening technology and reinforced with glass fibers (14 wt. %). "The wall sections of the FRX5 wheels vary in thickness to provide additional strength and stiffness where needed, while each spoke has an internal rib," explains George Kotzeff, president of TAG Wheels. "The hub shell is a robust, thick-walled construction, and it is keyed to optimize shear resistance and torque transfer."

TAG Wheels manufactures the wheels using a patented lost-core molding process that makes possible its complex geometry and strong hollow structure. The manufacturing process starts with molding a metal mandrel from a low-melt-point alloy. This mandrel is then overmolded with Zytel® 8018. The mandrel, or core, is then melted out leaving behind the hollow-formed composite wheel.



Extensive laboratory and field testing helped convince the company that Zytel® provided the right combination of impact resistance, strength, stiffness and moldability.

When using FRX5 wheels in the Hammer Fest downhill event on Vancouver Island in spring 2007, pro rider Dharma Fontaine hit a rock that flattened his rear tire early in the race. "At the finish line, after I stopped shaking and rattling, I checked the wheel expecting to find massive damage," he said. "I was stoked to see a very small insignificant ding beneath the destroyed tire. These wheels really are bombproof!" Severe impacts like that usually cause permanent rim damage to traditional wire spoke wheels, according to Fontaine.

Other advantages of the FRX5 over traditional wheels include fewer flats, reduced flat spots and less maintenance. According to TAG Wheels, it never requires truing, tension or alignment procedures needed for wire spoke wheels.

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Beyond the conventional

By Andreas Oldeweme, DuPont Engineering Polymers, Germany

DuPont™ Zytel® HTN polyphthalamide (PPA) has what it takes to deliver higher performance for today's automotive thermostat housings.

When seeking a material for the housing of a map-controlled thermostat, to be installed in BMW's N43 series four-cylinder petrol engines, Behr Thermot-tronik of Germany concluded their requirements exceeded the capabilities of conventional polyamides used in under-the-bonnet applications. "As the thermostat is next to the cylinder block, it is exposed to temperatures anywhere between -40 °C to +150 °C (-40°F to 300°F)," says Barbu Frunzetti, project leader at Behr Thermot-tronik. "In addition, the exterior surface is exposed to typical motor-compartment media, such as oils, greases, fuel and road salts. Inside the thermostat housing, coolant flows at up to 140°C (284°F) and creates an interior pressure of up to 2.5 bar. Moreover, when in operation the whole system is constantly under vibrational stress. Taken together, these parameters exceed the capabilities of conventional polyamides used in under-the-hood applications."

Processing requirements further limited the range of plastics which could be used for this part. The housing's injection-molded halves have to be welded together in a cost-efficient and reliable manner. The resultant seams must have the strength to withstand burst pressures many times higher than the nominal pressure. In addition, the material must allow other complete plastic parts—connector plugs overmolded in nylon 66 for the electronic control system—to be hermetically overmolded.

"In extensive comparative tests with other thermoplastics, DuPont™ Zytel® HTN 51G35HSLR high-performance polyamide met our demanding requirements best," Frunzetti continues. "This polyphthalamide (PPA) reinforced with 35 % glass fibre has the required high static and dynamic strength, the dimensional stability over a broad temperature range essential for this application, high chemical and hydrolysis resistance, good flowability and high compatibility with PA 66. It is also well-suited to vibration welding."

Behr Thermot-tronik worked closely with DuPont to choose and optimise the welding process. One of the first components of its kind to be vibration-welded, the preparatory work was very thorough before the start of volume production. Comprehensive tests, carried out in DuPont's European Technical Centre in Geneva, helped establish that friction-welding offered definite application-related advantages. Working together with the welding equipment manufacturer, Behr Thermot-tronik then converted DuPont's test-specimen results into practice with the real thermostat housing, and thus ensured rapid and reliable production of the part.

"As a result of DuPont's extensive application-related support and the good results we have had to date with the processing, Behr Thermot-tronik is now using Zytel® HTN for further map-controlled thermostats of which some are in development and others already in production," says Frunzetti.

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A step ahead

By Dan Curran-Blaney,
DuPont Engineering Polymers, Canada

The Niagara Foot is a new, affordable, high-performance prosthetic foot intended for active individuals who have been victims of landmines. Its novel, energy-return design relies on the stiff, yet flexible properties of DuPont™ Hytrel® thermoplastic polyester elastomer to provide user benefits in terms of stability, effectiveness and comfort.

The Niagara Foot was developed by Rob Gabourie, certified prosthetist and orthotist, and founder of Niagara Prosthetic & Orthotics International Ltd. (Ontario, Canada), with support from industry partners Hippo Design (Montebello, Québec), Précicad (Québec City, Québec), DuPont (USA & Canada) and a team of engineers from Queen's University (Kingston, Ontario).

A key aspect of its design lies in its keel – a single, S-shaped part, injection-molded from Hytrel® 8238, which acts like a spring to provide energy storage and return during the gait cycle. "The energy-return principle incorporated into the design of the Niagara Foot allows the user to walk more naturally than conventional designs," explains Rob Gabourie. "Patients are able to detect and appreciate the performance of this device, which decreases the muscular effort required for walking."

The combination of low flex fatigue and high stress resistance provided by Hytrel® was fundamental to achieving this concept – indeed Rob Gabourie is convinced that his design will not work with any other material. During static testing, whereby a force is applied to the toe and the heel of the foot and held for a period of time, the Niagara Foot exceeded the 3220 Newton (N) required for heel loading and 2790 N required for toe loading. A number of other materials, including polyoxymethylenes (POM) and polyamides, were unable to reach these milestones due to deformation or, in some cases, structural failure.

Further clarification for its exceptional performance in such a demanding application is provided by the material's processing behavior. The geometry of the current design requires abnormally thick wall sections, yet because Hytrel® flows easily to produce a well-packed part, the occurrence of voids is eliminated.

Beyond the performance of Hytrel®, Rob Gabourie cites DuPont's technical support, and its consistent quality of supply, as the reasons behind his choice of material supplier. "The technical back-up was incredible. DuPont's knowledgeable and cooperative approach meant that not only did I receive comprehensive failure analysis during initial material evaluation, but also insightful material engineering advice, which made such an effective design possible."

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Convenience in the kitchen

By Aysel Iltas, DuPont Engineering Polymers, Turkey

A patented mechanism, used to adjust the height of the upper baskets in dishwashers and developed by Turkish appliance manufacturer VESTEL, relies almost entirely on the smooth, functional performance of DuPont engineering polymers.

Turkish household appliance manufacturer VESTEL has come up with an ingenious solution that allows consumers to simply adjust the height of the upper rack of dishwashers, even when full, for greater convenience.

The patented mechanism consists of four principal parts, all made from DuPont high performance polymers. A base plate, which is securely attached to the dishwasher's upper basket using snap-fits, is molded in a particularly low-wear, low-friction grade of DuPont™ Delrin® acetal resin. It interlocks with a rail plate, molded in a strong and stiff grade of DuPont™ Minlon® mineral reinforced nylon, which has integral wheels – molded in Delrin® – that fit within the dishwasher rails and enable the basket to glide in and out for easy loading. Between the two plates, which slide above each other in a vertical motion, is a fixing plate made of Delrin®. It contains a star-shaped, rotating cog – also molded in Delrin® – which locks the basket in place at the desired height.

Orhan Hülagü (top right) and the team of designers at VESTEL spent 18 months refining the unique design

"The principal function of the adjustment mechanism is based on mechanical motion," explains Orhan Hülagü, research and development engineer at VESTEL's dishwasher factory. "In the basket's lowered position, the cog rests against a long, thin raised section on the base plate. When the basket is pulled upwards, the cog is rotated by interaction with a second, rounded raised section at the bottom of the plate, which also limits its upward movement. As the basket is released, the cog catches on the bottom of the thin section and the basket is locked in place by its own weight. As and when required, the basket is lowered by releasing the cog, through an upward movement, which allows the basket to drop to its resting position. A unique advantage of the VESTEL-developed mechanism is that the height of the basket can be adjusted regardless of the holding position."

The DuPont materials are integral to the smooth running of the adjustment mechanism due to their functional properties, which are maintained despite multiple wash cycles of up to three hours. Testing of the adjustable basket mechanism included push-pull tests with full loads. "We had previously trialed some other polymers, but had encountered problems in terms of warpage, which hindered the mechanism's operation," comments Orhan Hülagü. "The DuPont materials provided the right combination of strength and dimensional stability, as well as additional benefits such as their appealing surface finish and overall colorability. With a large degree of interaction between the two materials, their low noise and low friction performance when in contact with each other adds to the overall convenience of the system.

User-convenience: the patented mechanism from VESTEL allows users to smoothly adjust the height of the upper basket of dishwashers, regardless of where they hold it

"The patented mechanism is used on dishwashers in both the Turkish domestic market and across Europe. With this uniquely-designed mechanism, VESTEL dishwashers meet consumer demand by providing the highest convenience in the kitchen," concludes Orhan Hülagü.

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Taking the guesswork out of polymer selection

By Peter Tuschak and Debbie Lloyd, DuPont Engineering Polymers, USA

The DuPont Material Selector, available online at selector.plastics.dupont.com, has been specifically created to help designers in 'fit for purpose' polymer selection.

"There is no such thing as a bad material – just the wrong material for a particular application" is an adage which rings as true today as it did in the first literature on material selection produced by DuPont many decades ago. Bringing this material expertise well and truly into the 21st century, the DuPont Material Selector is an online support tool which has been created specifically to give designers and material specifiers access to a searchable technical database of the more than 500 grades in DuPont's engineering thermoplastics portfolio.

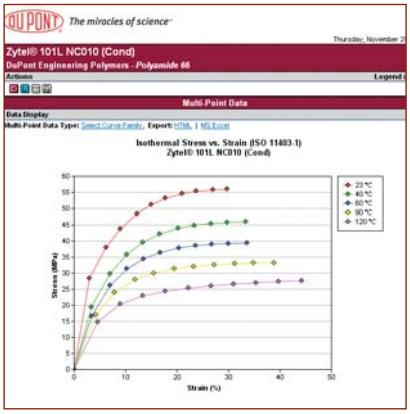
The DuPont Material Selector was developed in close cooperation with IDES, a global leader in search engine technologies for the plastics industry, with functionality and user-responsiveness in mind. Intended beneficiaries of the new tool include designers not necessarily involved with plastics on a daily basis, who will particularly appreciate the speed and simplicity with which the DuPont Material Selector can help them to identify the material that fulfils their design needs.

Available around-the-clock at selector.plastics.dupont.com, the web-based resource offers users a choice of four principal search criteria:

- **Property -** Through the definition of required material attributes, whether mechanical, electrical or others;
- **Product -** Locating material by type, filler/reinforcement and availability;
- **Quick search -** The rapid selection of materials by keyword;
- **Multi-point -** Where available, the assessment of material properties in multi-point graphs, including creep modulus versus time, viscosity versus shear rate, etc.

Of major convenience, the DuPont Material Selector allows the user to compare up to five grades, presented in the same format, and to forward the results as an e-mail to colleagues or other project partners. Hyperlinks within the tool bring the user to further reference documents such as design guides, data-sheets and case studies.

The DuPont Material Selector is the latest addition to the company's range of web-based customer services and solutions, which already include web-based seminars and collaboration rooms for online interaction with DuPont design specialists, aimed at helping cut development time and making a positive contribution to customer competitiveness.



Results of tensile tests at different temperatures – just one of the multiple datasets provided by DuPont's online Material Selector

selector.plastics.dupont.com

DuPont expands portfolio of renewably-sourced polymers

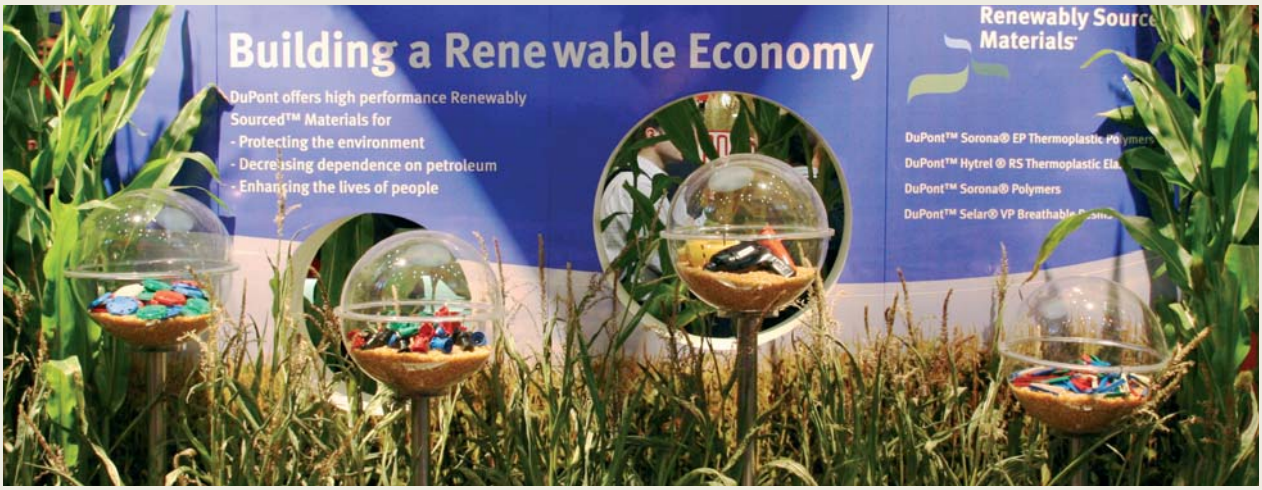
During the last quarter of 2007, DuPont announced progress in the development and launch of high-performance polymers made with renewable resources. Chief among its new offerings are DuPont™ Sorona® EP thermoplastic resins, DuPont™ Hytrel® RS thermoplastic elastomers from DuPont's portfolio of engineering thermoplastics, as well as DuPont™ Biomax® RS packaging resins and DuPont™ Selar® VP breathable films.

A key ingredient in Sorona® EP is Bio-PDO™, which replaces petrochemical based 1,3 propanediol (PDO) and/or 1,4-butanediol (BDO) in the two glass-reinforced grades of Sorona® EP that will initially be available. Sorona® EP offers performance advantages compared to polybutylene terephthalate (PBT), including improved dimensional stability and surface appearance. Sampling for targeted development programs is under way with broader availability expected in 2008.

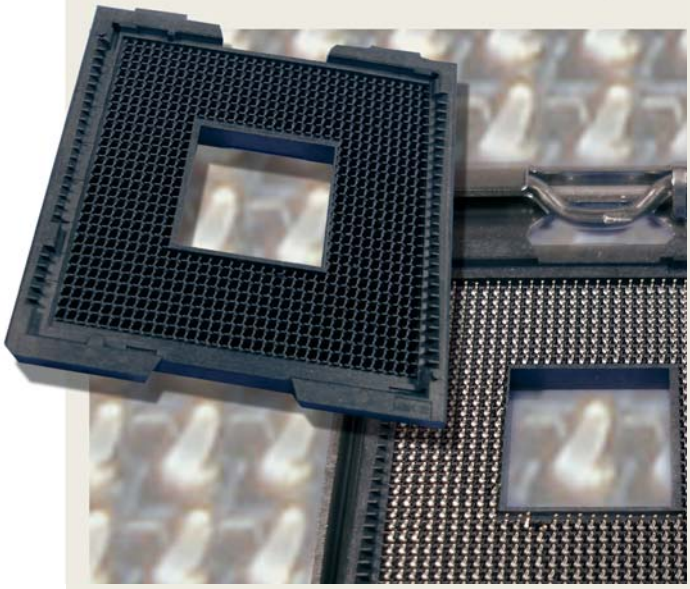
Hytrel® RS incorporates DuPont™ Cerenol™ renewably sourced polyol made with Bio-PDO™, as a replacement for petrochemical polyols. Initial grades of Hytrel® RS will have a renewable content range of 25-50 percent. Hytrel® RS will offer comparable performance to standard grades of Hytrel®. Sampling for targeted development programs is underway with broader availability expected in 2008.

The new offerings will contribute to the company's goals of doubling revenues from non-depletable resources to at least $8 billion by 2015.

http://renewable .dupont.com



New DuPont™ Zenite® LCP meets warpage challenge of thinner electronic parts



A thin-walled CPU socket benefits from the ultra-low-warp performance of DuPont™ Zenite® ZE55201BK010

New DuPont™ Zenite® ZE55201 liquid crystal polymer meets needs for ultra-low warpage in the thinner part designs used in ever smaller electronic devices, such as electronic connectors, chip sockets and interposers. Whereas standard resins, which perform perfectly well in thicker parts, can produce unacceptable warpage in the emerging generation of low-profile designs, new Zenite® ZE55201 has shown that it can meet this challenge. The new resin's ultra-low-warp performance is achieved by reducing anisotropic shrinkage. Its flow direction shrinkage is similar to that of a typical 30 percent glass-reinforced LCP, but its cross-flow shrinkage is more than 50 percent lower.

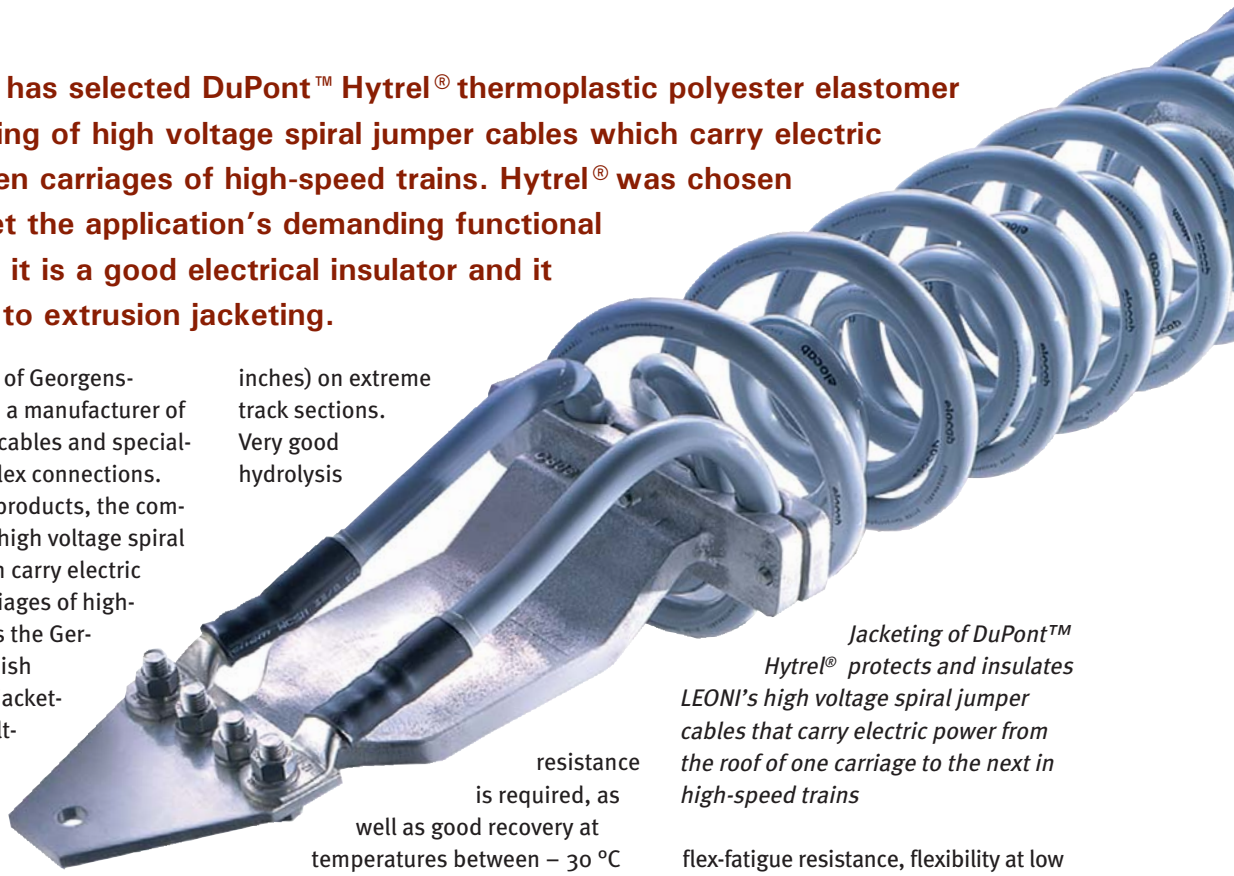
The new grade, Zenite® ZE55201 BK010, is reinforced with 50 percent glass and mineral and is available only in black. Mechanical properties and flow are in the same range as other highly filled LCP grades. A properties data sheet is available at

http://plastics.dupont.com

DuPont™ Hytrel® insulates at high speed

By Ramón Brugada, Wire and Cable Application Leader, DuPont Engineering Polymers

LEONI elocab has selected DuPont™ Hytrel® thermoplastic polyester elastomer for the jacketing of high voltage spiral jumper cables which carry electric power between carriages of high-speed trains. Hytrel® was chosen because it met the application's demanding functional requirements, it is a good electrical insulator and it is well-suited to extrusion jacketing.



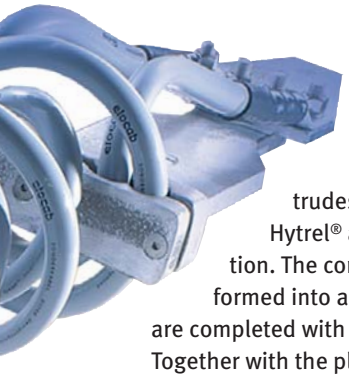
Jacketing of DuPont™ Hytrel® protects and insulates LEONI's high voltage spiral jumper cables that carry electric power from the roof of one carriage to the next in high-speed trains

LEONI elocab GmbH of Georgensgmünd, Germany, is a manufacturer of tailor-made special cables and specialist for mobile high-flex connections. Among many other products, the company manufactures high voltage spiral jumper cables which carry electric power between carriages of high-speed trains such as the German ICE or the Spanish VELARO. The cable jacketing for such high voltage cables, which reach from the roof of one carriage to the next, must withstand a demanding combination of extreme stresses. Operating voltage at contact points is 25 kV. While a train is moving, the cables are exposed to permanent vibration and have to dynamically compensate distance differences between carriages, which can be as much as 1000 mm (approximately 39 inches) on extreme track sections. Very good hydrolysis resistance is required, as well as good recovery at temperatures between – 30 °C (– 22 °F) and + 80 °C (+ 176 °F). The cables must stand up to ice, snow and hail as well as exposure to UV radiation, ozone and cleaning agents.

LEONI elocab chose Hytrel® for the jacketing of the high voltage spiral jumper cables because it meets all of the material requirements for such a demanding application. These include flex-fatigue resistance, flexibility at low temperatures, resistance to chemicals, to UV exposure and to impact. The material also had to be a good electrical insulator, and to have good processing characteristics that would permit cost-effective manufacturing.

"Our extensive tests showed that we meet all these requirements with Hytrel®, and that the required properties are maintained during years of use," says Jörg Ruder, who works in Research and Development at LEONI elocab. "A decisive criterion for our choice of material was the fact that Hytrel® offers almost identical processing characteristics from batch to batch. This means that we can extrude the jacketing over the electrical conductor, which is a highly bunched copper stranding of about 15 mm (0.59 inches) diameter, with uniform productivity and with a constant high quality."

LEONI elocab manufactures the stranded copper conductor at its



factory at Georgensgmünd, near Nuremberg, Germany, and extrudes the jacketing of Hytrel® at the same location. The complete cable is then formed into a spiral and sections are completed with terminal plates. Together with the plates, one carriage-to-carriage system for the ICE weighs about 16 kg (approximately 35 lbs).

"High-speed train manufacturers the world over are interested in our jumper cables, which are known for their tried-and-tested reliability," Ruder adds. "At present LEONI elocab is making further tests on cable constructions to be used at even lower temperatures and under more extreme mechanical stresses. In these future-oriented projects, too, we are planning to use Hytrel® as the insulating jacketing on high-tension jumper cables, because we know that in combination with this material it possesses the necessary reserves."

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DuPont consolidates DuPont™ Hytrel® production in Luxembourg

The new unit for the compounding of DuPont™ Hytrel® thermoplastic polyester elastomer was officially opened by (left to right) Marie-Thérèse Gantenbein, mayor of Hesperange (Luxembourg), Keith J. Smith, vice president & general manager at DuPont Engineering Polymers, and Jim Schmitz, mayor of Contern (Luxembourg)

DuPont has completed the consolidation of its DuPont™ Hytrel® thermoplastic polyester elastomer production in Europe with the inauguration of a new compounding unit in Luxembourg at the end of September 2007. The new line is part of a large investment project by the company to integrate the entire Hytrel® production chain – from polymerization to compounding and delivery of the finished product to customers – at its Luxembourg site for greater production efficiencies, reduced environmental impact and improved customer service. The plant expansion has also resulted in the creation of eleven new jobs at DuPont Luxembourg.

The compounding of Hytrel® had previously been carried out in Mechelen, Belgium – requiring the annual scheduling of 300 truck journeys, over a distance of 200 kilometers, to transport the polymerized material from Luxembourg to Mechelen for final processing. Direct environmental benefits of DuPont's new consolidated approach are the elimination of most handling and transportation requirements as well as a considerable reduction in packaging material consumption and disposal. The company also hopes to achieve production synergies through the integration of all processes at a single site. Further targeted benefits include increased operational flexibility and enhanced customer service.

DuPont's consolidation of its Hytrel® thermoplastic polyester elastomer production in Luxembourg will generate greater production efficiencies, reduce environmental impact and improve customer service

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