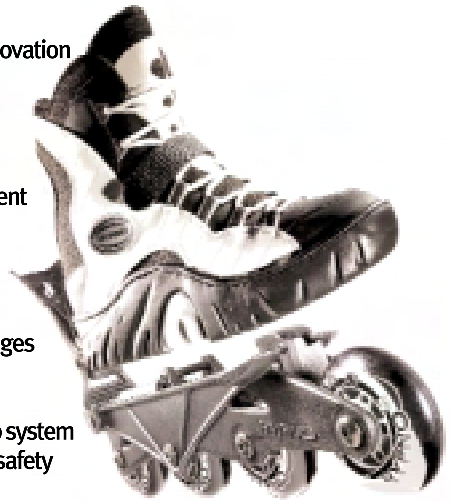
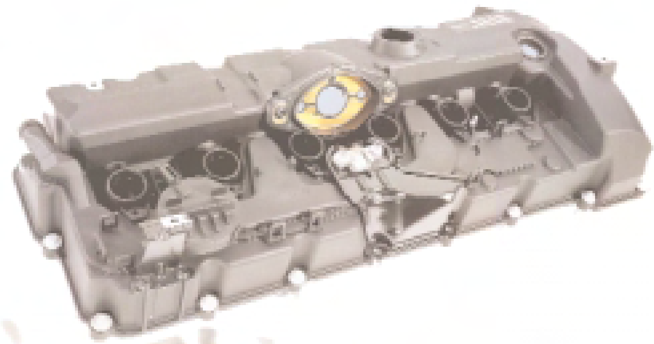
2007/3

DuPont Engineering Design

The Review of DuPont Engineering Polymers in Action





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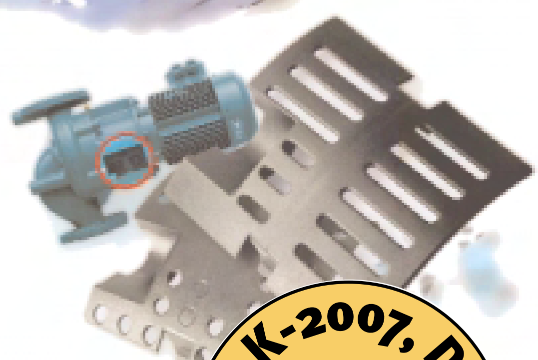


Visit us at K-2007, Düsseldorf -
October 24-31 2007
Stand D27
Hall 6

The miracles of science™

In the pursuit of innovation

Björn Hedlund, Vice President Sales & Marketing, DuPont Engineering Polymers

Welcome to the K-2007 issue of Engineering Design. The K show (K stands for Kunststoffe – the German for plastics) is widely considered to be the world's number one international trade fair for plastics and rubber, with over 2,900 exhibitors and 230,000 visitors expected to attend in Düsseldorf, from October 24-31, 2007. At the show, and in these pages, we will be focussing on our vision for 2010 – that of "Giving Shape to Smarter Ideas". In other words, how our materials and global expertise can combine to promote innovation and help customers get to market faster, with better products, more cost effectively.

While customers benefit through significantly reduced costs, consumers benefit through improved design features. There are a number of trends driving innovative, new ideas that turn into successful new materials, and new development opportunities for our customers.

A sustainable agenda

Consumers in many markets are showing their support for sustainable products at the checkout. At the same time dozens of retailers – increasing every day – are differentiating themselves beyond price and convenience with sustainable products and practices. While young, the leading indicators say sustainability is a means of differentiating. At DuPont, we believe what's good for business must also be good for the environment and for people everywhere in the world. Hence, we recently announced our intent to expand business offerings addressing safety, environment, energy and climate challenges in the global marketplace. This will be achieved through a series of programs.

Renewably-sourced materials

In our business, we have focused on the need to develop polymers from renewable resources. In the biorefinery model, Bio-PDO™ (propanediol, an intermediate for DuPont™ Sorona®) is derived from corn sugar using a patented and proprietary fermentation process. Produced in such a way, Bio-PDO™ takes 40% less energy than its petrochemical-based counterpart saving the equivalent of 13.5 million gallons (over 51 million liters) of gasoline for 100 million pounds (over 45,000 metric tons) per year of production. The processing facility we constructed with Tate & Lyle to make Bio-PDO™ is already operational and had its grand opening ceremony in June. Bio is thus a reality!

Fuel economy, reduced automotive emissions, lightweighting

While there is some debate on the number, vehicle use emissions are often blamed for up to 75% of CO_2 releases globally. At DuPont there are dozens of programs in place to greatly reduce CO_2 emissions – including developing advanced biofuels. In terms of engineering polymers, we are working in focused areas to improve barrier technology that significantly reduces permeation and on material enhancements that meet the challenges of aggressive alternative fuels. Reducing weight improves gas mileage, which also reduces emissions – 25 kilograms (55 pounds) means a one percent increase in fuel economy – critical to automotive engineers challenged to provide additional content without adding to vehicle weight.

DuPont is focussing on the need to develop polymers from renewable resources: Bio-PDO™ is derived from corn sugar using a patented and proprietary fermentation process.

The dawn of industrial biotechnology: the DuPont Tate & Lyle Bio Products Bio-PDO™ facility in Loudon, Tennessee.

Weight reduction is obviously great news for plastics; and we actively work with our automotive customers to reduce weight and improve performance. On page 4 of this issue, Nandan Rao, Technology Director for DuPont Performance Materials, covers nanocomposites and how they are poised to offer a step change in structural performance to replace heavy, structural metal components and systems.

Automotive safety - pedestrian safety requirements

Delivering safety-systems solutions in the automotive industry requires precision engineering – reliability is paramount – and this demanding environment has long been an area of expertise for DuPont. Our material solutions in this area already range from developing DuPont™ Butacite® for laminated automotive windshields and DuPont™ SentryGlas® for sunroofs and side windows, to optimizing the flexibility characteristics of DuPont™ Hytrel® thermoplastic polyester for airbag doors, and tapping the mechanical reliability of DuPont™ Delrin® acetal for automotive safety belts. What you will read about later in this issue is how new developments in polymers can help our customers improve pedestrian safety.

Improved product performance

Improving product performance is critical for many of our customers fighting to stand out in a crowded marketplace. This trend exhibits itself in automotive through extended warranties, improved customer satisfaction ratings. In the consumer products markets it reveals itself by differentiating higher-end items. In industrial products, we see this trend emerge as the desire for equipment that doesn't require continual maintenance and inspection. Since 2004 we've launched more than 115 new products to improve overall product performance, some of which are reflected in this issue.

Human connectivity

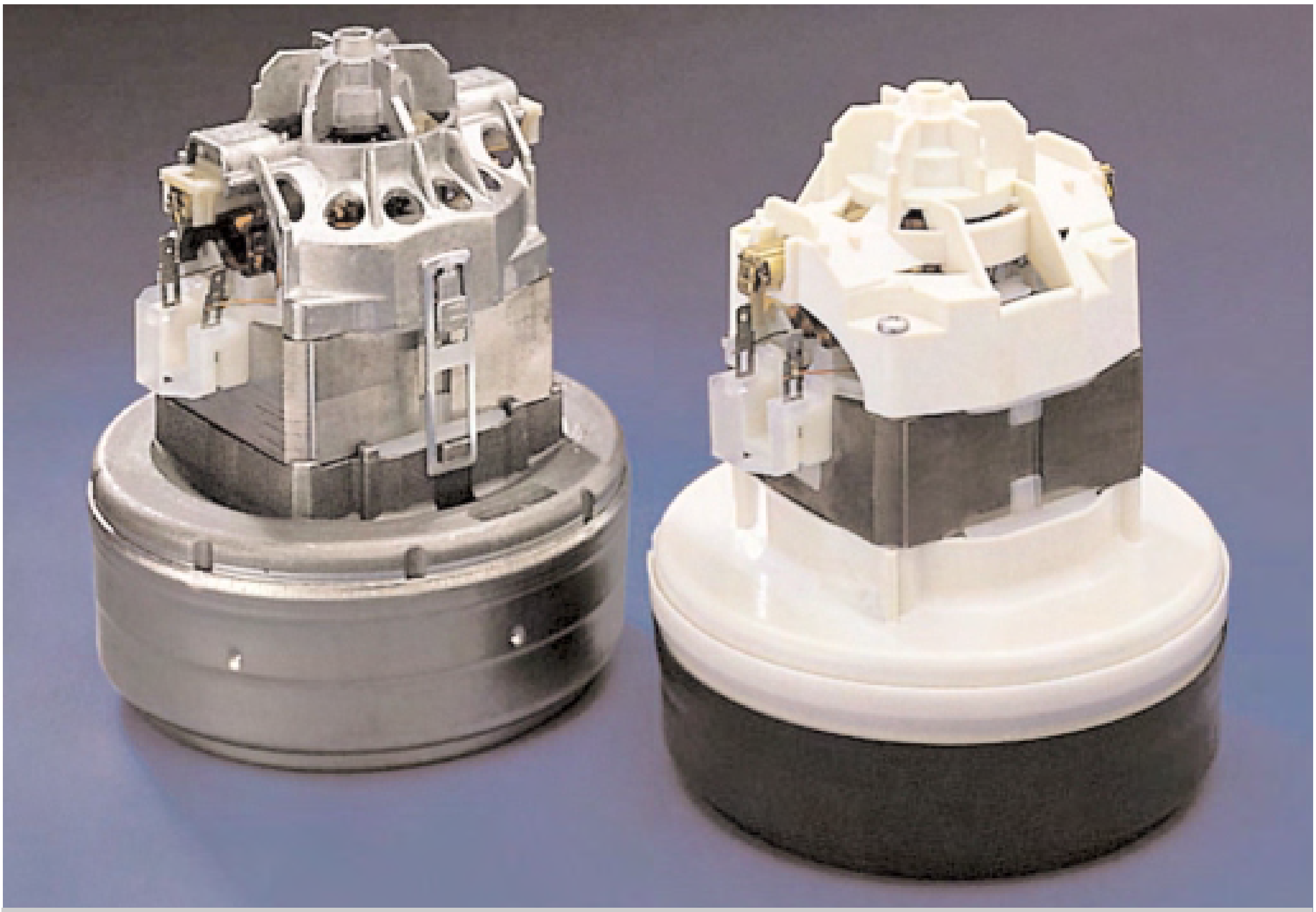
Some studies show that consumers in developed countries have reached saturation point in terms of accessability products, but people in emerging countries are driving demand for devices that continue to flatten and connect our world. That translates into billions of mobile phones, laptops, handhelds – and it translates into billions of connectors, housings, displays, etc.

While we provide material solutions for cell phones, laptops and handhelds, the trends to make them smaller, lighter, more aesthetically pleasing and recyclable will drive the need for higher temperature materials, halogen free materials and multi-functional materials – those that provide strength and beauty.

These are just some of the market trends, where high-performance materials, experienced design and development experts linked globally can "Give Shape to Smarter Ideas" – today and into the years to come.

contents

New technologies for metal replacement



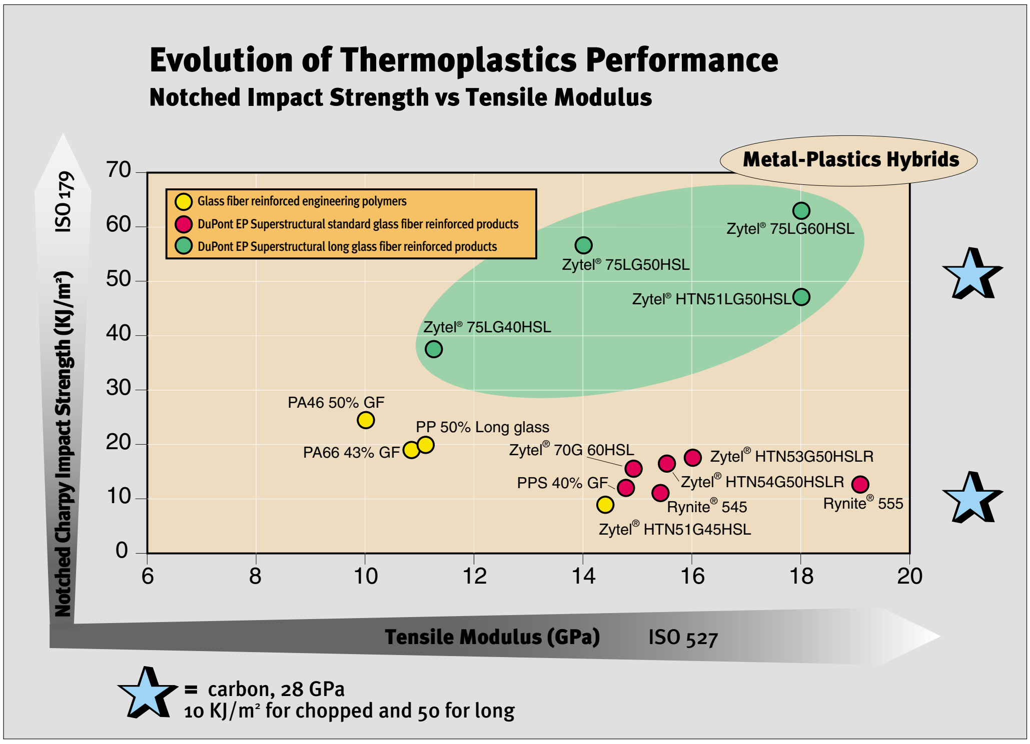
In order to deliver innovative solutions for its customers well into the future, DuPont is working on several exciting, new technology platforms. One important area of focus is the drive for metal replacement in response to escalating natural gas and energy costs. This trend relates not just to the automotive market, where improved fuel economy and weight reduction are key drivers – lighter weight, higher performance materials are desired in many high performance markets including electronics. DuPont technology solutions in development include polymers with high temperature resistance, superstructural capabilities and thermal conductivity.

By Nandan Rao, Technology Director for DuPont Performance Materials

Superstructural resins

DuPont, and others, are working to push the properties of polymer composites further in the direction of metals. The company's most recent steps involve a superstructural family using a combination of high-performance polyamides and glass or carbon-fiber reinforcement to provide levels of stiffness and strength not achieved before. High strength structural materials have been made possible with elevated concentrations of standard short-glass-fibers that required innovations in compounding technologies. High loadings of short-glass in a high modulus matrix such as DuPont™ Zytel® HTN gives outstanding performance. Such composites are used in applications where performance at high temperatures and high dimensional stability are critical, such as in tool housings, motor coil bobbins, etcetera. Thermoplastics reinforced with long-glass-fibers move them further up the metals replacement curve for applications where light weight and high strength are critical.

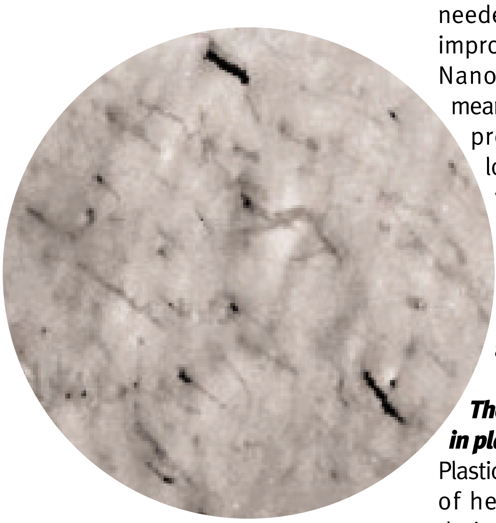
DuPont works with customers to evaluate their needs for polymer composites with structural properties closer to metal, while retaining the design flexibility and economic advantages of thermoplastics. In making progress towards the properties of metal, DuPont is concentrating its efforts on changing the polymer matrix to high performance polyamides, which yield a step change in both thermal stability and strength. Further improvements will come from metal/plastic hybrids, fabric-reinforced thermoplastic composites and long carbon fiber reinforcement. There is considerable R&D underway in the latter fields, with the promise of new product and process innovations over the next three years suitable for metal replacement in structural parts such as car seats and reinforcing beams. Such innovations will result in significant weight reduction opportunities.



As thermoplastics make progress toward the properties of metal, DuPont efforts have been aimed at improving performance in both tensile modulus and impact strength, resulting in significant weight reduction opportunities.

Progress in thermoplastic nanocomposites

Since its announcement during 2006, DuPont's proprietary nanocomposite technology has made significant progress, as the company increases its understanding of the properties attainable as it reduces the particle size of reinforcing materials to increase the interfacial area by an order of magnitude. Significant improvements in crystallization, rheological, mechanical and permeability properties can be achieved for improved processing, better structural performance, higher heat deflection temperatures, better electrical insulation and improved barrier to gas permeation. DuPont research is focused on a range of polymer matrices including polyester and polyamides.



A TEM microscopy of PET with 3 wt% nanomaterial shows the well-defined nano-fiber morphology of the DuPont nanomaterial in the PET.

Nano-reinforced PET provides a significantly higher glass transition temperature of over 80 °C (176 °F) as compared to standard PBT and PET (at around 50 °C or 176 °F). The implication of this is that one can reduce the amount of glass reinforcement that is needed, while also obtaining improved surface properties. Nanocomposites provide a means of achieving equivalent properties at lower glass loadings which opens the way for reducing the weight of parts with comparable properties while providing other attributes, such as improvements in surface appearance.

Thermal conductivity in plastics

Plastics are of course insulators of heat. The trend towards devices operating at higher voltages and the miniaturization of components require more efficient heat removal than plastics have been capable of in the past, if they are to replace metals.

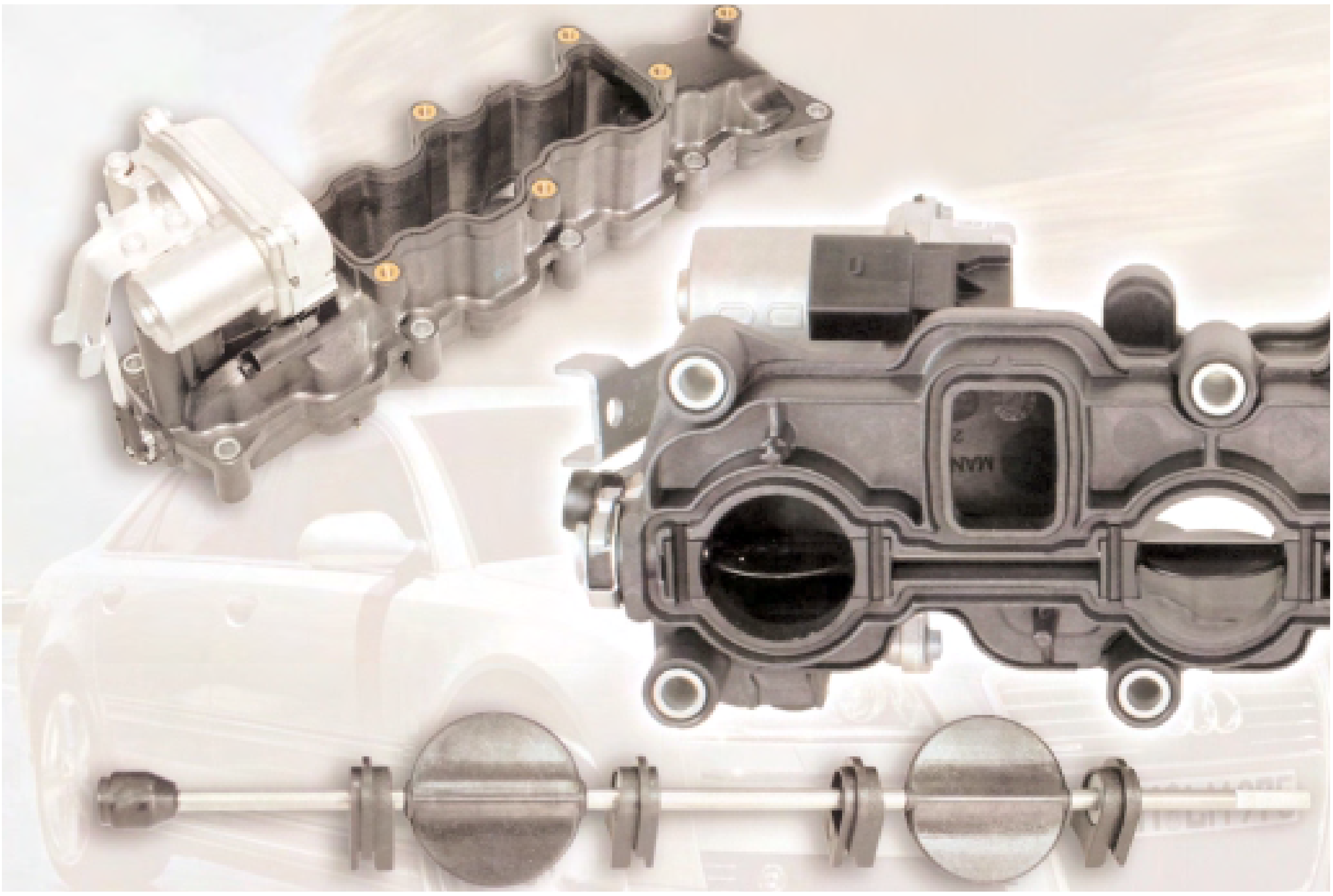
An example is that conventional automotive headlamps are moving to LED arrays to reduce energy demand. This design change will require improved heat removal. The challenges occur when balancing improved thermal conductivity with the need to retain moldability and low cost.

In the last three years, within and outside DuPont, thermal conductivity of thermoplastics has improved from 3 W/mK (watts per meter per degrees Kelvin) to approaching 50 W/mK. This was achieved via specific mixing of high filler content, addition of molding aid agents and use of carbon fiber with other fillers. These formulations provide high stiffness at an acceptable cost level, but have poor moldability. Hence, current R&D is focused on improving moldability and balancing the trade-off versus electrical properties.

High performance in electrical insulation has been achieved by adding boron-nitride (BN) coated graphite, copper (Cu) particles coated with glass and BN powder and coupling agents. On the plus side these technologies achieve electrical insulation with high thermal conductivity. However, they are expensive technologies to employ to attain such performance, and again moldability is impaired.

An alternative route to electrically insulative performance is the use of filler concentrations in block copolymer or ceramic particle technologies. While both electrical insulation and thermal conductivity are achieved, the overall level of thermal conductivity is not sufficient to meet emerging needs. Hence the overall conclusion remains, that, in terms of thermal conductivity, the challenge of obtaining all the desired properties in a single approach is still to be mastered.

Turning automotive visions into reality



Zytel® HTN PPA is used for the air-intake manifolds of the V-8 turbo-diesel engine in the Audi A8 due to its ability to withstand extremely high operating temperatures of up to 250°C.

The overall drivers for development in the automotive industry have changed little in the last decade. Cars should be made safer and more comfortable, and they should get lighter, or at least not heavier, and their environmental impact should be reduced. The real changes are to be found in the detail. DuPont Engineering Polymers with its strongly application-oriented palette of products is helping the industry to attain across-the-board objectives as well as highly specific ones.

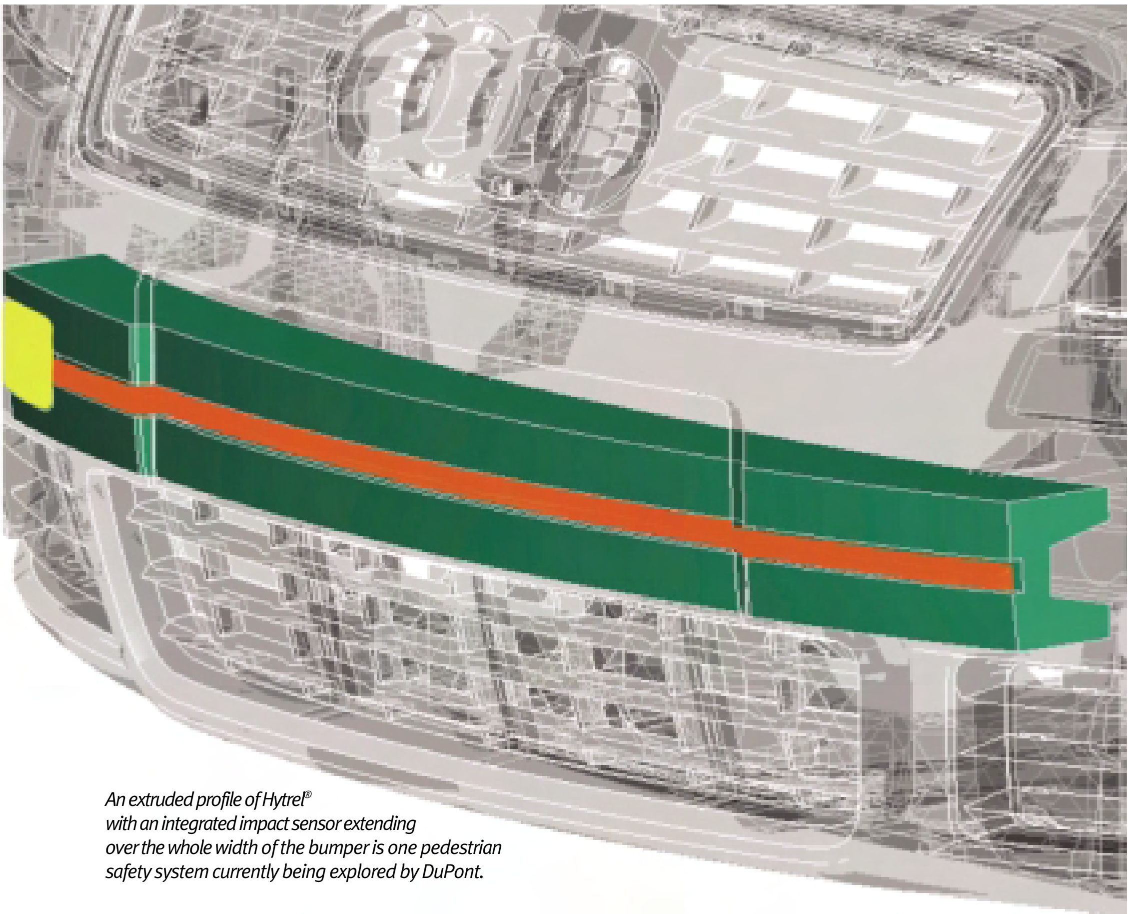
By Patrick Ferronato, Global Automotive Marketing Director, and Klaus Bender, Market Development Manager, Automotive Industry, DuPont Engineering Polymers

Minimised emissions from engines...

The automotive industry is advancing towards the ideal 'zero emissions' car. The rate of progress is determined partly by its own environmental awareness, partly by ever-stricter global mandatory requirements, and partly by customer expectations. The EURO 5 exhaust-gas standards will come into force in 2008/09, substantially reducing the already low limits for NOx, particles, CO and hydrocarbons still further. Improvements in mixture preparation and combustion through better design have made great progress, but seem to have reached a certain saturation point. More radical steps, such as hybrid drives, the use of biofuels or the selective post-treatment of exhaust gases are assuming greater importance. There is a trend to substantially smaller cubic-capacity motors, which have lower fuel consumption but need to be supercharged to achieve the required performance.

All these steps mean more severe demands on the plastic materials used. Alternative fuels, concentrated blow-by gases in mechanical separators, as well as the ammonia solution used for treating exhaust gases, have a highly aggressive effect on seals and molded parts.

The extremely limited space under the bonnet and the use of exhaust gas recirculation systems, turbo- and mechanical charging systems and self-cleaning particle filters increase the operating temperatures around the motor to levels where conventional engineering polymers often fail.



An extruded profile of Hytrel® with an integrated impact sensor extending over the whole width of the bumper is one pedestrian safety system currently being explored by DuPont.

DuPont™ Zytel® HTN polyphthalamide (PPA) meets the majority of these challenges. This polymer, which has a continuous operating temperature of up to 220 °C (428 °F), bridges the gap between the high thermal and chemical resistance of conventional high-performance plastics such as polyether sulphone (PES) or polysulphone (PSU) and the more economical nylon 6 and 66 types. Zytel® HTN types optimised for specific applications as well as new extrudable 66 nylon types with improved thermal resistance are in development. They will allow air-conduit parts exposed to high temperatures to be produced by blow-molding; they may even be candidates for metal and rubber replacement in the hot regions between the supercharger and the super-charged-air cooler.

... from fuel systems ...

The alcohols, ethers or methyl-ester-based components of bio-fuels (bio-diesel and ethanol) attack sealing materials and plastics parts, leading to their degradation and ultimately to their failure. DuPont has developed Delrin® 560HD, a special acetal for such applications. It can also be used in contact with hot diesel fuel and has been successfully incorporated in fuel supply units.

DuPont has tackled the challenges in sealing applications with new Viton® fluoroelastomers, which withstand aggressive media and respect or even exceed mandatory volatile emission limits.

These di- and terpolymers with significantly improved processing characteristics are designed for highly economical production of sealing elements.

Recently developed types such as Viton® GBLT-S combine very good resistance to fuels and liquid media with low permeability and excellent low-temperature characteristics and very good processability. Viton® GF-S combines high chemical resistance with low compression set and should be considered for use as high-performance fuel hose lining.

... and from interiors

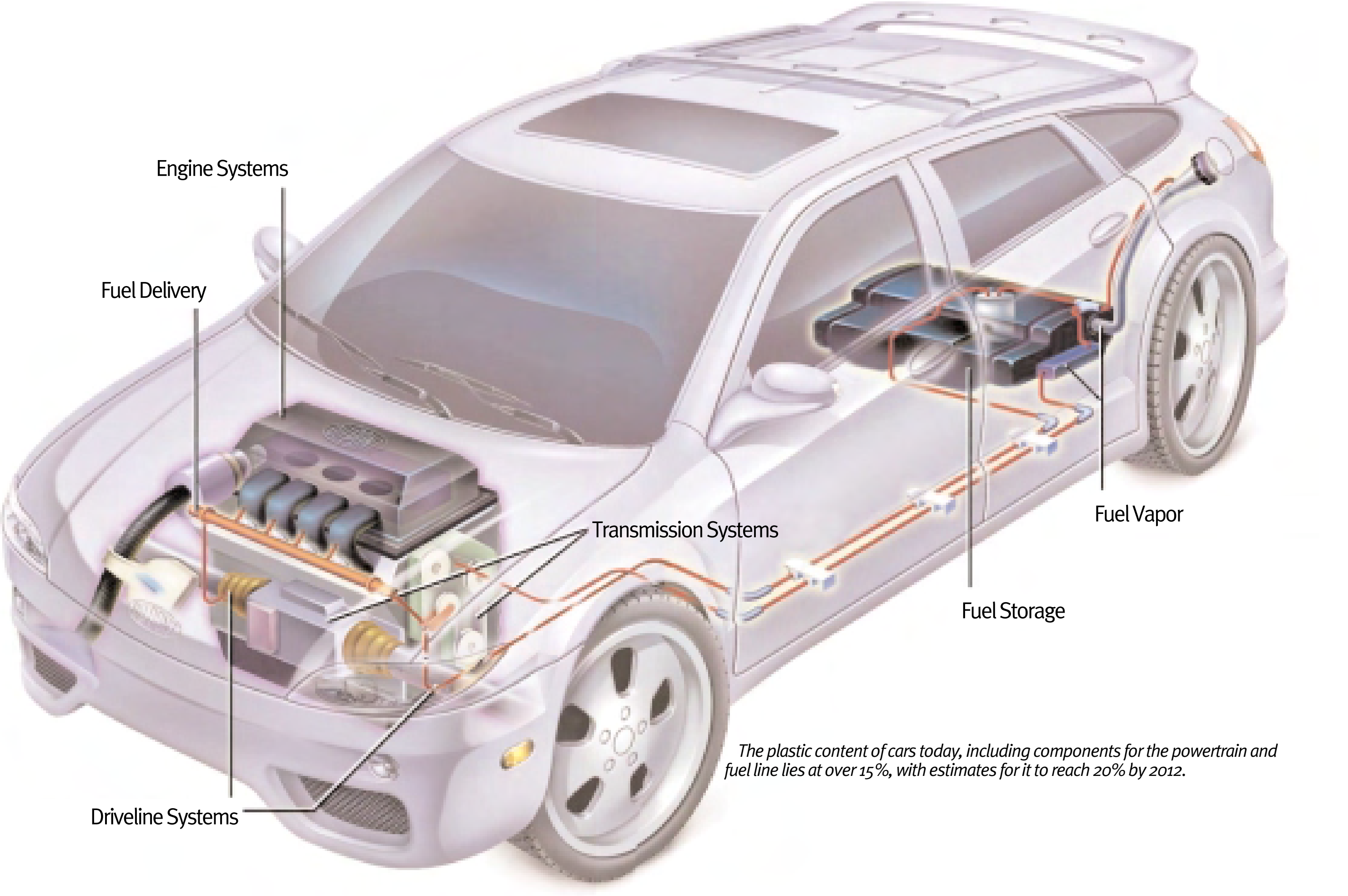
When the smell of newness has gone from a car's interior, passenger compartment materials must not generate other unpleasant smells.

Conventional acetals (POM) may in certain unfavorable circumstances become disagreeably noticeable by releasing formaldehyde. DuPont™ Delrin® 100PE, 300PE and 500PE are new POM types in which such emissions have been reduced substantially (by about 90 %). Typical applications for this new generation of POM types are gears for drives and actuators, window-lift systems, door-lock housings, safety-belt guides and pre-load devices, as well as knobs and push-buttons.

Weight-saving

The number of components in a car which serve to reduce environmental impact and improve safety and comfort continues to grow. But the space to hold them is not increasing, and adding weight is not an option. Hence designers and engineers are compelled to integrate more functionalities into individual components and/or reduce their size and weight without compromising reliability. While maximising functionalities is a speciality of thermoplastics, weight reduction calls either for plastics with substantially improved mechanical properties, or for hybrid construction methods combining thermoplastics and metals into a single unity which can then be used for structural parts.

DuPont's 'superstructural' resins offer a possible way to reduce wall thickness while maintaining load-carrying capacity. With these resins, the combination of PA and PPA types with good flow characteristics and 40 % or 60 % long-glass-fibers (LGF) reinforcement (about 12 mm or 0.47 inches) result in especially high stiffness and strength combined with good impact resistance.



The plastic content of cars today, including components for the powertrain and fuel line lies at over 15%, with estimates for it to reach 20% by 2012.

For structural parts, high-performance Zytel® HTN51LG50 based on PPA and Zytel® 75LG50 HSL based on PA-66 should be considered.

Where short fibers do not provide sufficient stability, for example in back-rests, a combination with carefully placed continuous filaments can provide a solution. In this area, as with thermoplastic/metal hybrids, DuPont is developing new materials and the appropriate technologies. Apart from seating, applications in the steering column, suspension and structural parts in the motor are mooted.

More protection, enhanced safety

Greater safety for pedestrians is a theme of current importance. Apart from changes such as a steeper angle for the bonnet, new design concepts employing soft plastics can open new perspectives.

There are many possible starting points, from front bumper and radiator grille, headlights, mudguards and bonnet, and the beauty cover immediately under the bonnet. New design ideas are under discussion for bumpers, to replace polypropylene foam, which is generally used today, with a product that stays flexible even under freezing conditions. DuPont is participating actively in the optimization of bumper systems. Promising results are coming from tests with an extruded profile of DuPont™ Hytrel® thermoplastic elastomer with an integrated impact sensor system extending over the whole width of the bumper. Co-extrudates of Hytrel® in the front part and stiffer, stronger thermoplastics in the rear part of the bumper could also offer cost-saving solutions.

Engineering plastics remain key materials

Stricter exhaust gas standards, more severe requirements in active and passive vehicle safety, limited raw materials resources, a rapidly growing number of electrical and electronic components in cars, and the demand for weight reduction—all these factors will continue to determine the future of automotive design. This in turn will require materials with specially adapted property profiles. Here, engineering plastics offer some of the broadest capabilities, and their significance will continue to grow. DuPont has anticipated these trends and is working with its specialists on a global basis on the application-oriented development of new plastics materials.

The plastics content of cars in the 1970s was about 5 %. Today it lies over 15 %; realistic estimates point to 20 % plastics content in five years' time. With innovative thinking and the market-oriented conversion of projects in close cooperation with OEMs and systems suppliers, DuPont will contribute substantially to the sustained use of plastics in automotive engineering and, in doing so, to reaching this figure.

A material with vision

The Xenon Dynamic Bending Light (DBL), from Valeo, optimizes illumination of road curves at night-time for enhanced road safety and driver comfort.

One of the areas of intense development amongst European OEMs is the Advanced (or Adaptive) Front-lighting system (AFS). The objective is to provide the driver with the best possible visibility by varying light distribution over time without dazzling oncoming traffic. In the system developed by French automotive lighting supplier Valeo, stiff and hydrolysis-resistant DuPont™ Zytel® HTN PPA is used for the housing of each headlamp unit.

By Thierry Donis, DuPont Engineering Polymers, France

Valeo, the world leading manufacturer of automotive lighting products, uses DuPont™ Zytel® HTN PolyPhtalAmide (PPA) for its Xenon Dynamic Bending Light (DBL), which is, among others, available in vehicles such as the Citroen C4 or the VW Passat. This adaptive headlamp system optimizes illumination of road curves at night-time for enhanced road safety and driver comfort. The housing for each headlamp unit is molded from a glass-reinforced and heat-stabilized grade of Zytel® HTN PPA, selected for its resistance to both high temperatures and humidity while displaying the excellent dimensional stability required for this application.

The adaptive headlamp system developed by Valeo consists of a Bi-Function-Xenon elliptic projector headlamp, together with an electronic actuator and electronic control unit. Controlled by a microcontroller linked to the vehicle's data network, the system operates the swiveling of the Bi-Function Xenon lamp by up to 15° more than the standard "straight-ahead" position. Designed for medium- to high-speed driving in both high and low beam mode, the system doubles the driver's visibility distance in road curves, and maximizes his forward visibility. Moreover, the significant increase in night-time illumination minimizes driver stress and fatigue in road curves and at intersections, improving driving comfort in all weathers and road conditions.

A cost-effective alternative to metal, a glass-reinforced and heat-stabilized grade of DuPont™ Zytel® HTN PPA was used to create the headlamp housing because it offers high stiffness even at temperatures of around 150°C, (approximatively 300° F) and hydrolysis resistance at 130-150 °C (266-300°F) for 95% RH. The material displays low outgassing, good creep and fatigue resistance, combined with relatively low moisture absorption and excellent assembly flexibility with regard to the integration of snap-fits and rivets.

Beyond comprehensive material testing, DuPont specialists in France and at the technical center in Geneva assisted in the design and processing of the injection-molded housing to help ensure trouble-free production.

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Large truck air duct blow-molded in DuPont™ Zytel® nylon

The curved air duct, which is approximately 1 meter long and with a diameter of 13 centimeters, is one of the largest blow-molded parts that DuPont is aware of.

A three-dimensional blow-molded air duct, used on Volvo trucks with a 12-liter engine, is currently being produced by TI Automotive in Norway using an unreinforced, toughened and heat-stabilized grade of DuPont™ Zytel® nylon. The duct, which weighs just over two kilograms, is one of the largest blow-molded parts that DuPont is aware of.

By Murray Smith, DuPont Engineering Polymers, Sweden

The intermediate duct deployed on the 12-liter engines of Volvo trucks in the US is used to transport clean air from the air filter to the turbo-charger. It is thus exposed to temperatures of around 140°C (284°F) and needs to contend with pressure ranges of between 1.2 and 2 bar charge pressure, as well as exhibiting resistance to oil, blow-by gases and fuel. Moreover, parts for truck engines are required to achieve extended lifetime requirements of 10,000 hours.

Looking to replace metal for the duct's manufacture, thus reducing its overall weight by approximately 50 percent, TI Automotive, a global supplier of fully integrated fuel storage and delivery systems for cars and trucks, proposed that an unreinforced, toughened and heat-stabilized grade of Zytel® nylon be used to fulfill material requirements.

Demanding processing conditions were also a factor in material selection: the complex shape of the large, curved duct, approximately 1 meter (just over 3 feet) long and with a diameter of 13 centimeters (5 inches) and varying wall thicknesses of between 4 and 2.55 millimeters (between 0.15 and 0.10 inches), requires the use of an engineering polymer with good flow characteristics and low shrinkage. The 'parison manipulation' process was used for its manufacture, a technique which is a development of conventional blow molding, whereby the extruded parison is 'manipulated' by a combination of robots and moving mold segments in order to make it conform to the 3-dimensional mold cavity. It was adopted by TI Automotive for this particular application in order to achieve the part's complex geometry and enhance mechanical performance. Parison manipulation produces scrapless parts, i.e. with no pinch weld on the finished part itself, to improve mechanical performance in critical stressed areas.

"The air duct was first supposed to be manufactured with a glass-reinforced polypropylene, but that material failed during processing," explains Kent Aurbakken, project engineer at TI Automotive in Norway. "Hence we suggested to Volvo that we use Zytel® nylon from DuPont, a material which we believed could cope with the issues associated with producing such large, curved pipes. During the entire process, DuPont has been very supportive with the provision of technical expertise both on site and from its technical center in Geneva."

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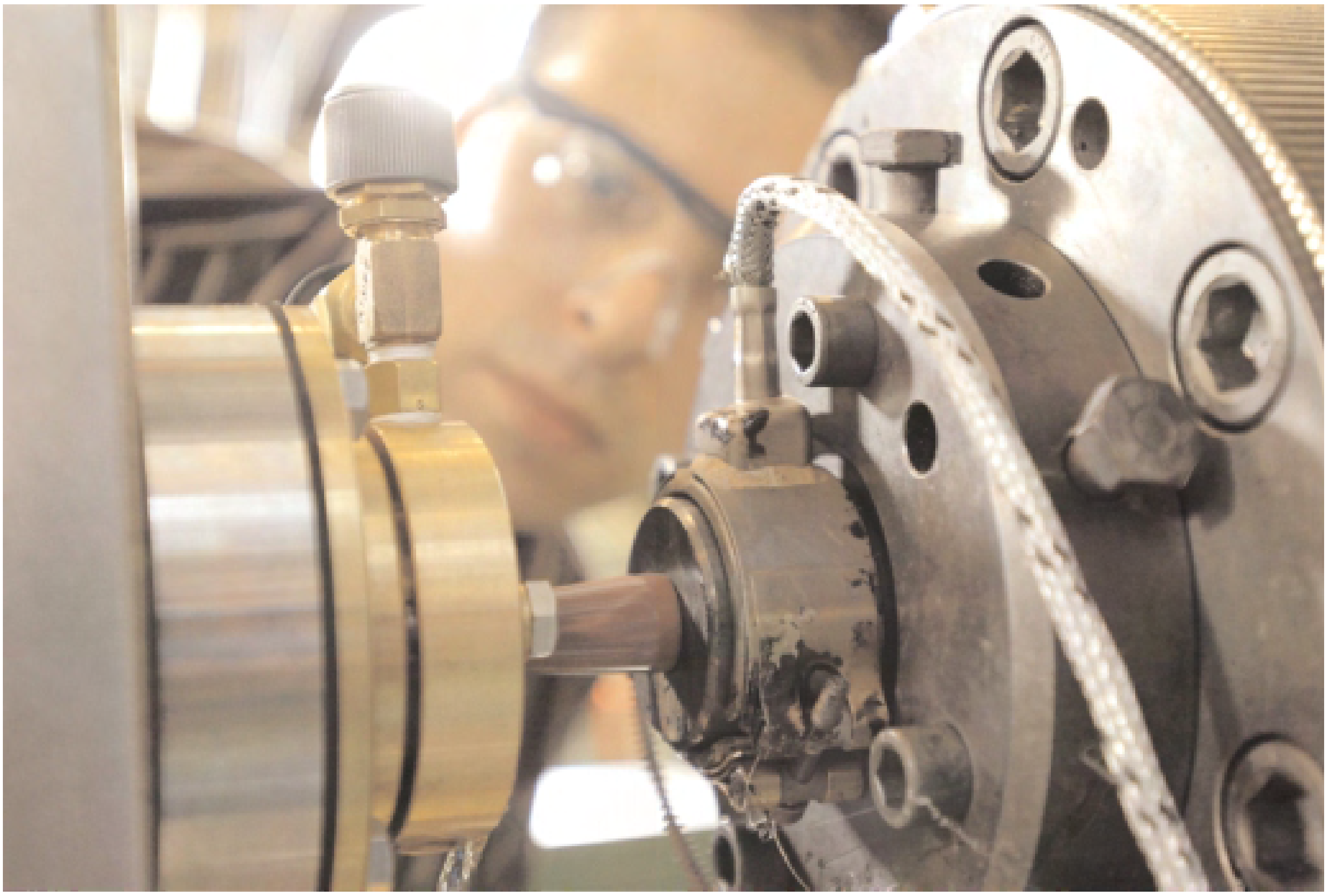
A new global center of excellence for extrusion



DuPont has extended the range of extrusion processes available to its customers.

DuPont has extended the range of extrusion processes available to its customers with the inauguration of a new multilayer and corrugation extrusion line at its European Technical Center (ETC) in Geneva, Switzerland, earlier this year. The strategic investment by DuPont marks the company's long-term commitment to broaden its material and technical expertise to the growing extrusion sector, whereby the ETC in Geneva will become DuPont's new global center of excellence for extrusion technology.

By Ramón Brugada, Extrusion Segment Leader at DuPont Engineering Polymers

Meeting extruder and end-user demands for material solutions in the area of high-performance extruded products, DuPont already offers one of the widest material portfolios for extrusion, which includes its range of semi-crystalline thermoplastics (acetals, nylons and polyesters), modified ethylene copolymers and fluoropolymers. Much of the technical support in extrusion, provided by DuPont to its customers, comes from the ETC in Meyrin, where a number of processes – including a film and sheeting line, a tubing extrusion line, a wire coating line and a blown-film line – are available for sample runs and compiling performance data. As a result, DuPont's materials are already being used in different tubing, hose, wire & cable and profile applications in the automotive and industrial sectors, where customers benefit from numerous functional and productivity benefits.

To better understand and assess new opportunities in extrusion for its materials, DuPont installed the new multilayer and corrugation extrusion line equipment at the ETC during the first quarter of 2007. Line parameters include a multilayer head for the extrusion of tubes with up to three layers and a diameter of between 4 and 32 millimeters (0.15 and 1.26 inches), while a corrugator using a vacuum forming system of up to 0.8 bar, can produce either monolayer or multilayer corrugated tubes with an outside diameter of up to 50 millimeters (1.97 inches). Typical line speed for corrugation is 5 to 10

The new multilayer and corrugation extrusion line was officially opened at DuPont's European Technical Center in Geneva during March 2007.

meters (16 to 33 feet) per minute. The extrusion of monolayer tubes with an outer diameter of 10 millimeters (0.39 inches), and at a speed of 60 meters (197 feet) per minute, is also possible on the same line.

New development opportunities for DuPont materials include multilayered extrusion, where different material combinations provide diverse properties to meet an application's specific requirements, or corrugated sections to meet flexibility requirements for simpler installation and packaging efficiencies. In some cases both multilayered and corrugated extrusions are required. Indeed one prototype application, already developed on the new line, is a part-corrugated, multilayered coolant pipe, extruded in DuPont Zytel® nylon and DuPont™ Bynel® adhesive resin as a cost-effective alternative to rubber. The integration of corrugated sections in the pipe facilitates its installation in the tight spaces of the engine compartment, while the outer layer of Zytel® ensures the pipe's mechanical stability and the inner layer of Bynel® reduces its permeability to water-glycol and increases its hot water resistance.

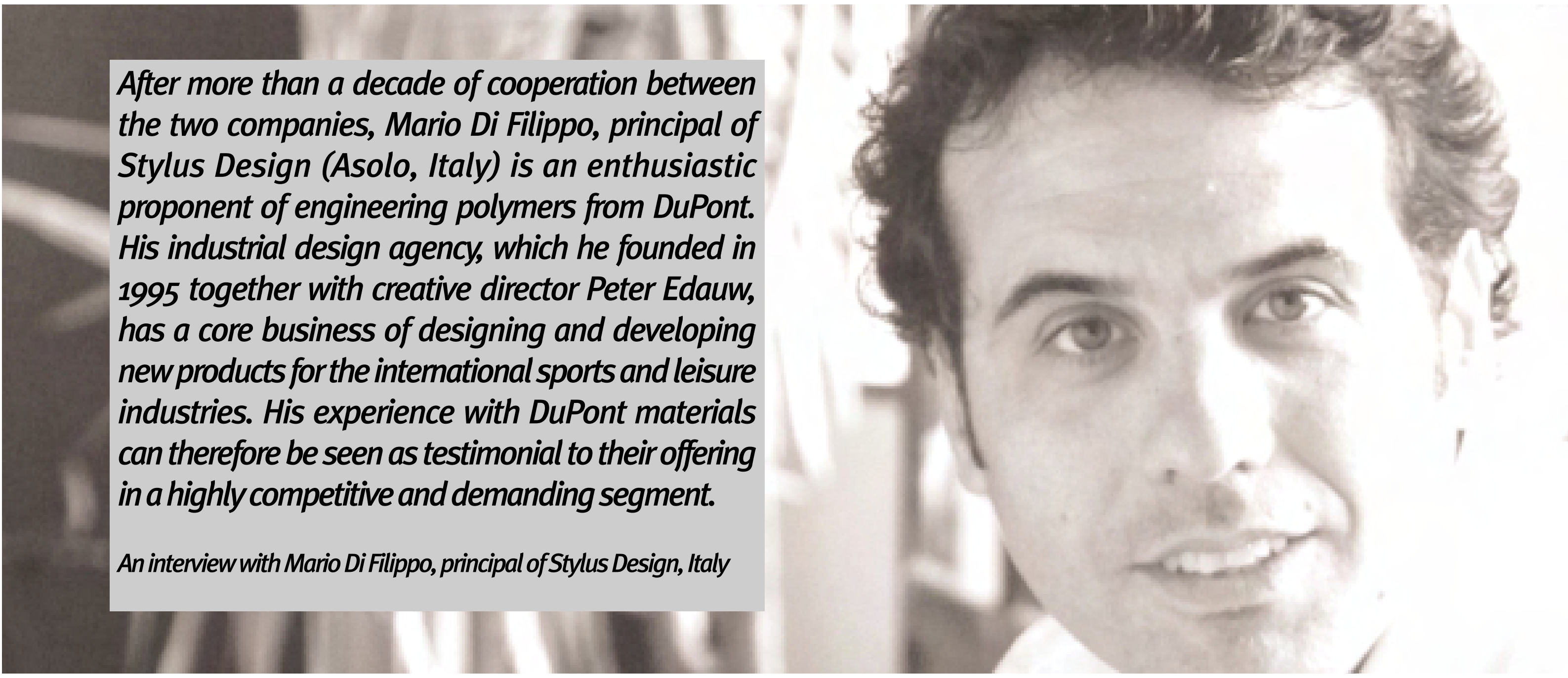
Serving as a focal point for DuPont's extended capabilities in extrusion for its range of polymer-based materials across three of its businesses - DuPont Engineering Polymers, DuPont Packaging & Industrial Polymers and DuPont Fluoropolymers – the ETC in Switzerland has been appointed the company's new center of excellence, serving the extrusion needs of customers across the globe.

According to Christophe Chervin, European extrusion technology leader at DuPont, "the new line helps us identify new opportunities in extrusion with our materials in the areas of coolant pipes and degassing tubes, blow-by tubes, servo-brake vacuum tubes, fuel vent tubes, or mandrels to name a few. The strategic investment in our capabilities in Geneva reflects our long term commitment to growth in the extrusion sector, better service for our customers and the more rapid availability of our products."

Extrusion solutions	Hoses	Tubing	Oil/Gas piping	Monofil	Profiles	Cables	Mandrels
DuPont™ ETPV	★	★			★	★	
DuPont™ Hytrel®	★	★		★	★	★	★
DuPont™ Pipelon®			★				
DuPont™ Zytel® 6 (modified)	★	★		★	★	★	
DuPont™ Zytel® 66	★	★		★	★	★	
DuPont™ Zytel® 612 & 610	★	★		★	★	★	★
DuPont™ Delrin®		★			★	★	
DuPont™ Crastin®				★	★	★	

DuPont offers one of the widest material portfolios for extrusion, which includes its range of semi-crystalline thermoplastics.

“Polymers create space for reinvention”



After more than a decade of cooperation between the two companies, Mario Di Filippo, principal of Stylus Design (Asolo, Italy) is an enthusiastic proponent of engineering polymers from DuPont. His industrial design agency, which he founded in 1995 together with creative director Peter Edauw, has a core business of designing and developing new products for the international sports and leisure industries. His experience with DuPont materials can therefore be seen as testimonial to their offering in a highly competitive and demanding segment.

An interview with Mario Di Filippo, principal of Stylus Design, Italy

Mario Di Filippo, principal of Italian company Stylus Design is an enthusiastic proponent of DuPont materials.

E.D.: When did you first "discover" engineering polymers from DuPont?

M.D.F.: I believe my very first approach to DuPont was in 1989, when we adopted the super-tough nylon DuPont™ Zytel® ST 801 for the design of ice skate frames. No other material seemed to be able to deliver similar confidence levels, given the harsh operating temperature these products must survive. We've been working for the ice skate industry since, and little has changed as regards our opinion of this material for this kind of application.

In terms of a defining moment for the cooperation between Stylus and DuPont, I would look back to 1995, when we were engaged on a truly innovative project for the inline skate industry. The development of the Hypno skate, an inline skate with a detachable wheel frame, presented us with a number of design issues:

To start with, the simple mechanical concept we had developed – I say simple because weight and user interface were of key importance – was subjected to extremely complex forces because it relied on the elasticity of its components.

Secondly, the variety of skating styles catered for by the product, and the human factor in general, presented us a set of variables which went well beyond any reasonable level of predictability at the design phase. Initial research led us to consider DuPont materials for two key parts: DuPont™ Delrin® acetal resin for a pivoting spring linkage between the wheel frame and locking lever, and Zytel® nylon for the wheel frame itself.

With DuPont's technical support we were able to reduce some of the above-mentioned variables to a point which allowed us to approach the development process with a higher degree of confidence in our decisions.

As it turned out, the product succeeded and earned an honorable mention in an international design competition, proving us right in the choice of materials, among other things.

Super-tough Zytel® ST 801 nylon was used by Peter Edauw of StylusDesign for the frame of the Easy Glider in 1989.

The Hypno skate, an inline skates with a detachable wheel frame which featured both Delrin® and Zytel® for key parts, went on to receive international acclaim.

E.D: What options do engineering polymers provide when you are approaching a design task?

M.D.F.: With a focus on mass-produced consumer goods, both integration and productivity are a priority for us. As a result we find ourselves looking to re-design objects so that they can be injection-molded using polymers. Hence we consider them to play a crucial role in our work, because they have created space for reinvention. Reinvention generates new standards in product categories, which in turn can bring freshness and new opportunities to the markets for these products.

E.D.: Which is your favorite DuPont engineering polymer to work with?

M.D.F.: A tricky question... what I can say is that in any design project we are involved with, at some point, the words Zytel®, Delrin® and Hytrel® will probably get mentioned by at least one of the parties involved. Personally, given the fields we work the most in, I like the idea of plastics working in a dynamic sense, so I often find myself bending and twisting a piece of either one or the other material between my fingers, trying to imagine what function it could perform.

E.D.: When you look to integrate engineering polymers in your work, do you consider primarily function or aesthetics, or both?

M.D.F.: Our legacy in performance products has brought us to develop what we have reason to believe is quite a unique approach to function and aesthetics, seen both individually and combined. It goes without saying that a product must perform its function flawlessly.

However, in a competitive marketplace where function alone is not a distinguishing factor, aesthetics must be given equal significance. DuPont engineering polymers help achieve this balance, as they provide solutions in terms of surface-finish and decoration, for example, which go beyond the 'static' value of the molded piece of plastic.

E.D.: What do you think the future holds for plastics – how is the design world changing its opinion?

M.D.F.: There's a lot going on in the world right now in terms of fossil fuels and raw materials which play key roles in the production of plastics. From our modest vantage point, I'm excited to see how DuPont is pursuing 'new' plastics derived from corn sugar, as I am also interested in seeing innovative applications involving recycled material or the compounding of plastics with wood or fabrics, among other fillers. I have noticed many new applications in polymers – even in construction, where 'steel and stone' are still king – even if some of these so-called 'innovative' products have been solely 'translated' from their origins, rather than being re-invented to take into account the added potential that plastics and injection molding can provide.

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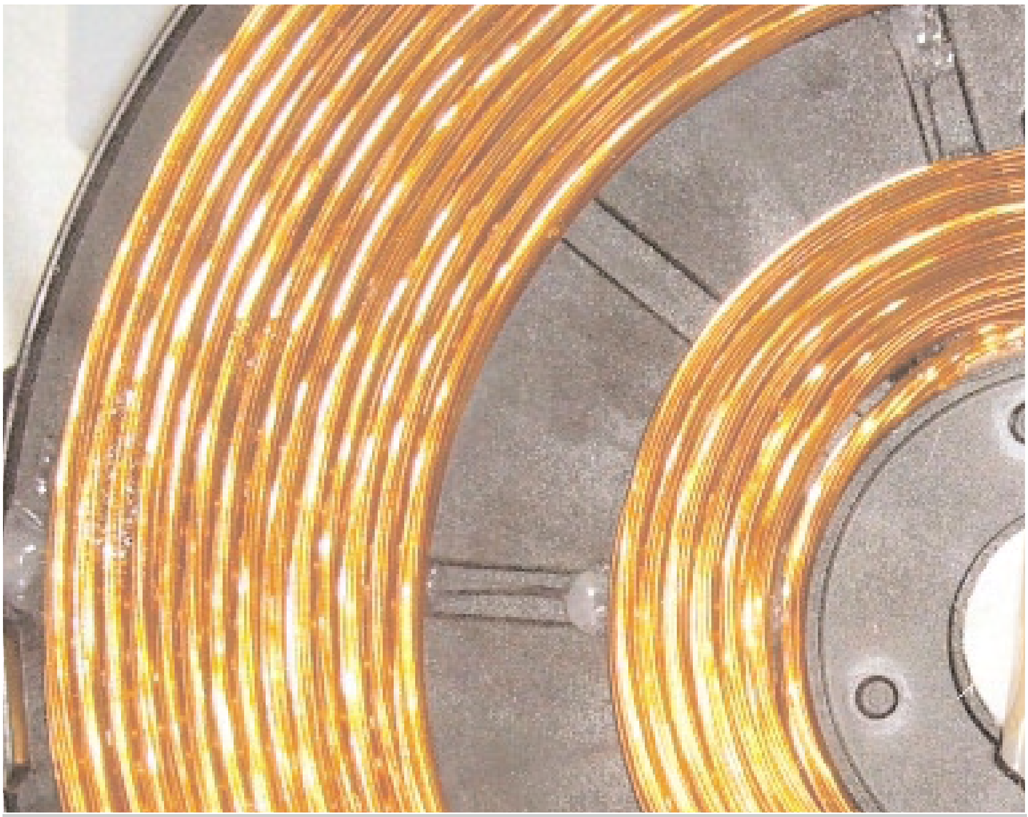
Safe and energy-efficient cooking



A black cover made of Zytel® HTN protects components of the cooking range from heat radiated by the coil rings.

For the first time, heat-resistant DuPont™ Zytel® HTN semi-aromatic polyamide has been used to cover the induction heating coils of a new IH cooking range from Hitachi Appliances, Inc. in Japan. The revolutionary range responds to most types of metal cooking vessels by producing high levels of heat for safe, reliable and energy-efficient cooking.

By Ryuta Sato, DuPont Engineering Polymers, Japan

Cooking with induction heat (IH) has caught the attention of Japanese consumers, as well as others around the world, in a big way. They are attracted to the appliances for the perceived environmental benefits of using electricity over gas, for the safety benefits of the less intensely hot cooking surfaces and for the substantial increase in heating efficiency versus gas stoves.

The primary element of an induction range is a powerful, high-frequency electromagnetic coil, powered by sophisticated electronics in the element under the unit's glass-ceramic surface.

When electric current passes through the coil, a magnetic field produces an eddy current in the cookware. The cookware's internal resistance against these eddy currents produces heat, which is generated in the cookware and not on the range itself. A previous limitation of earlier induction ranges, however, was that the low electrical resistance of aluminum and copper cookware had prevented their use.

Hence Hitachi Appliances in Japan focused its technical expertise on manufacturing IH cooking ranges that could handle pots and pans made from alternative metal substrates. It was discovered that resistance increases when an electric current is focused on the surface of the cookware and the current's path is narrowed. The solution, therefore, was to increase the power of the coils. The new series of IH cooking heaters has three newly-designed elements, capable of producing 2.6 kW of thermal energy – higher than the rating of many gas-cooker burners. In order to increase power output, the number of coil rings has been increased by 30 percent versus previous models, despite a more compact design.

The coils are covered with DuPont™ Zytel® HTN semi-aromatic polyamide, chosen for its high heat deflection temperature (up to 283°C or 541°F) and retention of dielectric strength over a wide temperature range. "The higher the thermal energy generated, the greater the high temperature performance required of the material used to protect components from the radiated heat," explains Mr. Otomo, senior engineer at Hitachi Appliances Inc.. "In contrast to the thermoset materials previously used, Zytel® HTN is exceptionally easy to injection-mold to our requirements, and thus it received an excellent rating from us for this application." A further benefit to be gained from the switch to thermoplastics from DuPont is the elimination of burr-removal – an operation required after pressing with thermosets – from the manufacturing process, and thus a reduction in production costs.

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