Are You Sitting Comfortably?

Sustainable Comfort Seat from Faurecia: thin-walled seat design contributes to lightweight vehicle construction and a greater sense of space

Lightweight Seats. The development of automotive seats in the medium term will continue to steer a course between the competing requirements of enhanced comfort and safety on the one hand and low costs and light weight on the other. This article examines how, by using polyamides, it is possible to produce lightweight seats that can be installed in more confined spaces. It also describes material solutions, such as superabsorbers and polyurethane coatings, which improve the performance of seating systems in an economic way.

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Present discussions in the automotive industry are being shaped by the economic crisis and resulting sales crisis. Consequently, even the CO_2 debate has been pushed somewhat into the background. Yet despite this, there continue to be megatrends that have a strong influence on medium- and long-term automobile development. Automotive interiors and, particularly vehicle seats, will play an important role.

The conflicting goals of increased comfort and safety requirements versus lower costs and lighter weight will become even harder to reconcile in future. This has already proved the undoing of many promising concepts. To resolve this conflict in future, it will be necessary to treat the seat as a whole system – taking into account all the different value-added segments in production and the different materials. This is where the "take-a-seat" concept developed by BASF, Ludwigshafen, Germany, comes in. In 2007, the company set up a cross-disciplinary car seat competence team, which pools together the innovative skills of various divisions. The team's expertise ranges from plastics and foams to coatings and innovative, functional material solutions (**Fig. 1**).

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Materials for Ventilation, Breathability and Conductivity

As water-absorbing, acrylic polymer systems, superabsorbers are already used in many applications such as baby diapers. Firmly attached to the fibers of a polyester nonwoven, the superabsorbing polymer particles fulfill their moisture-absorbing function in the Luquafleece system without losing any of their high absorption capacity. In a reversible process, these nonwovens can absorb ambient moisture and release it again (**Fig. 2**).

This opens up new opportunities for improving comfort in car seats. By incorporating a superabsorbing nonwoven underneath the textile or leather seat covering, weight and costs can be significantly reduced as compared with the mechanical ventilation system currently used for air-conditioned seats. The stable, long-term air-conditioning effect of these nonwovens has been demonstrated in trials and they are easy to process as roll goods, like textiles.

To create attractive and yet breathable surfaces, a technology based on polyurethane coatings known as Steron can be employed in parallel with superaborbing nonwovens. These versatile coatings can be applied onto flexible materials such as leather and textiles but also onto wood, plastic or metal, leading to highly durable surfaces providing various soft-touch and design effects. By using these coatings in combination with superabsorbers, passive air-conditioned seats can be produced. →

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Steron technology is characterized by high flexibility. Individual shapes can be economically produced, even in small lots, so allowing designers wide design scope **(Fig. 3)**.

Another new technology in this field is that of so-called e-textiles. These are textiles onto which specially tailored conductive coatings are directly applied in a novel coating process. With this technology, many different functions can be integrated into textiles. Examples that come to mind include seat heating, door and roof textiles with integrated lighting or also textile-based aerials. E-textiles make it possible to dispense with separate components, which means simpler processes, lighter weight and, of course, lower costs.

Fig. 1. Driver's seat for the Opel Insignia OPC: plastics and foams complement each other here to provide optimum crash resistance

Seat Structures Produced from Engineering Plastics

To construct lightweight, low-cost car seats offering comfort, variability and adequate crash safety, new seat concepts and structures are needed. Engineering plastics can play a key role here. Current design studies are already taking up this trend and showing how several functions or components of a seating system can be integrated into single plastic parts that increase comfort, while also allowing thin-walled structures to be used. An important design aspect here is seen in high-quality, scratch-resistant surfaces created with modern engineering plastics. These surfaces require no additional painting. Plastics have long had their justification in car seats and have made it possible to produce many components for the first time, such as head restraints and lumbar supports. Now, the development trend in lightweight construction is towards more sophisticated, highly stressed parts, which were inconceivable a few years ago, especially seat shells and seat back structures. Metal is still the dominant technology here. But steel sheets reach their limits when it comes to integrating complex functions, implementing new design trends or improving seat comfort. This is where plastics can play on their strengths and make a contribution to weight and cost optimization of the complete seat system.

First Serial Applications

The first example of a serial application for a plastic seat structure of this type is the driver's seat of the Opel Insignia OPC, a joint development between Opel, Recaro and BASF. The seat back and shell are produced from Ultramid, the BASF polyamide **(Fig. 4)**. The main focus of development was on creating a comfortable sporty seat, which meant high, stiff side cushions. The design freedom offered by plastics allowed the designer to create the entire seat shell as one part, which also possesses very good ergonomic properties that would not normally be expected from this type of seat shell. For the Insignia OPC seat shell, the manufacturer uses Ultramid B3ZG8, a glass-fiber-filled, high impact-modified polyamide characterized by high energy absorption. The free-standing seat back with integrated head restraint requires very high stiffness coupled with sufficient elongation at break. For this reason, the seat back shell is produced from Ultramid B3G10 SI. This material is required to provide a top-quality surface finish in addition to high mechanical performance, since a large part of the reverse side of the seat back is visible in the vehicle. The extreme mechanical stresses to which seat structures are exposed demand high-quality plastics offering very good flowability on the one hand and high energy-absorbing capacity on the other. But

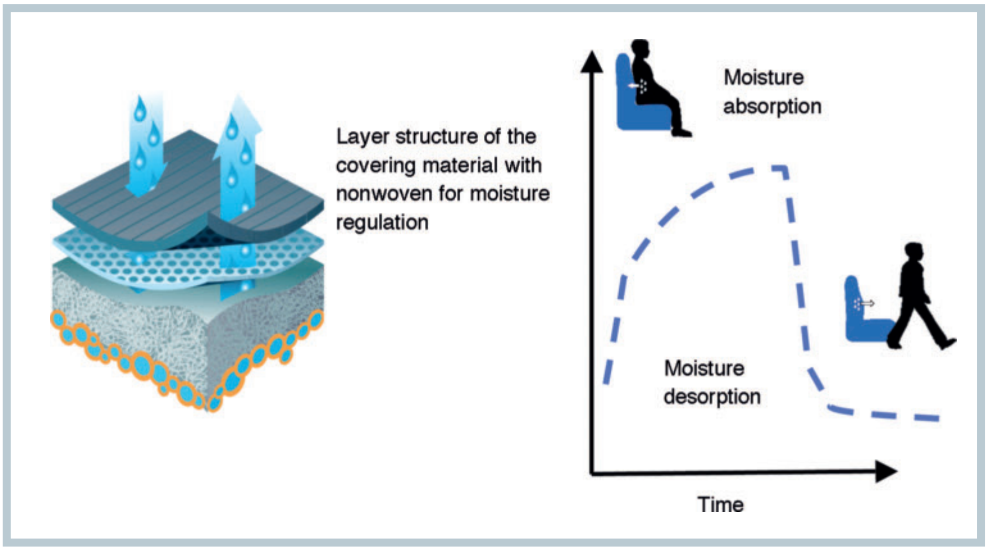

Fig. 2. A superabsorbing nonwoven for moisture regulation increases the comfort of car seats

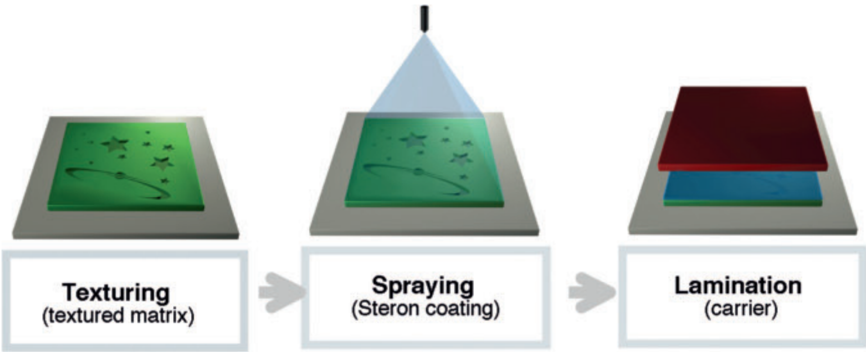

Fig. 3. A special technology with polyurethane coatings achieves breathable surfaces with different soft-touch and design effects

product development has not come to an end yet. Other fillers, high filler loading and optimized modifiers will be features of the next material generation used in this application.

One of the joint component development stages involves consultation with the polymer producer on part and mold design suitable for the injection molding process and on crash simulation. The simulation showed that the structure not only complies with legal requirements and ECE guidelines but also meets the OEM-specific crash requirements and impulse specifications. Above all, the necessary protection from shifting loads in the event of a crash requires the perfect balance of stiffness and energy-absorbing capacity, which is achieved through skillful design of the geometry and appropriate material selection. An insert adhesive-bonded to the seat back shell plays an important role here. It is produced from BASF's energy-absorbing EPP foam, Neopolen P, which integrates different functions and serves as a carrier for modules.

One key to the success of plastics in automotive applications, including car seat development, lies in the advances made in crash simulation. Precise virtual design at an early stage of the development process is essential in order to meet high crash requirements without losing sight of weight and costs. There are many different factors that influence the performance of the plastics used, ranging from processing and the anisotropy of the reinforcing materials to strain-rate-dependent viscoelasticity. All these parameters must be exactly characterized over a broad range of temperature and humidity. BASF has developed its own suitable method for this with a computer simulation tool known as Ultrasim, which has already been validated with many serial components, including the Insignia OPC seat **(Fig. 5)**.

Thermoplastic structural parts are already well established today in sports seats because, for the shorter runs involved, the low mold costs for thermoplastic injection molding are an important advantage. Expansion to industrial-scale production is the logical next step.

Economic Production Processes

Injection molding is the optimum process for producing simple and, above all, low-cost components. Only this process makes it possible to combine increasingly diverse seat functions through intelligent integration, operate at suitably fast cycle times for industrial production and deliver high-quality surfaces. Special modern methods such as gas- and water-assist molding or physical foaming are enabling the application scope of engineering plastics to be continually widened into structural applications. The critical zone of a seat back structure in terms of strength is the connection to the seat back mounting, since it is here that the greatest moments act. To ensure a uniform force flow, hybrid technologies are used. Depending on the installation space and basic mounting concept, the use of overmolded or adhesive-bonded metal parts is possible.

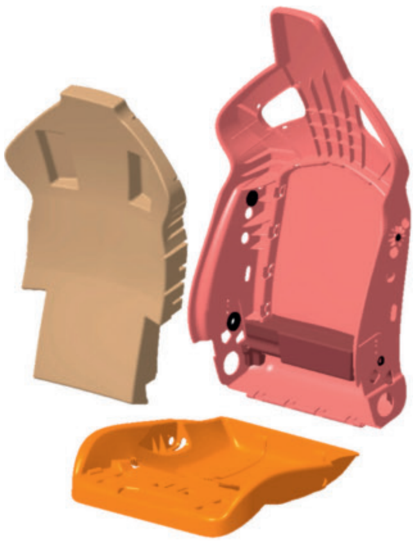

Fig. 4. Materials in the driver's seat of the Opel Insignia OPC: the insert is produced from expandable polypropylene, while specially developed polyamides are used for the seat back shell, cross bar and seat shell

Hybrids Produced from Continuous Filaments

An interesting further development in hybrid technology in this connection is the use of continuous-filament reinforcements with extremely high stiffness. The technologies used here are already state of the art for thermosets but, in the case of thermoplastics, have not previously managed to become established in industrial automotive production because of the long cycle times required. The breakthrough came with thermoplastic continuous-filament tapes, which are processed into semi-finished products using automated tape-laying processes. Through the individual laying process, it is possible to obtain not just "organosheets" but continuous-filament blanks specially constructed to cope with the specific application stresses. The geometries required in the seat structure are then created by thermoforming. These parts are overmolded with a polyamide in the injection molding process and so processed into hybrid components **(Fig. 6)**. The achievable cycle times even permit integration of semi-finished product preparation into the cycle of the injection molding process.

Initial trials persuaded automotive component supplier, Faurecia, to invest in a joint project with BASF and use continuous-filament reinforcements in the development of a new generation of car seats. In this project, material and technology expertise are pooled with seat design and production know-how in an ideal way. As with unreinforced injection molded parts, so too with continuous-filament reinforcements, simulating crash behavior is the first step in the development process. On the basis of component tests, CAE material models of the overmolded continuous-filament structures were developed. The structures are overmolded with Ultramid CompoSIT, a polyamide developed for this application by BASF. This material has very high elongation and therefore, when combined with the stiff continuous-filament structures, offers ideal mechanical properties. In addition, the material provides a high-quality surface that can be read- →

ily colored, so that painting costs can also be saved.

The jointly developed seat back concept has been virtually validated and meets existing OEM crash requirements. The resulting seats fully exploit the design possibilities offered by the plastic, combining comfort with a modern, thin-walled seat design to a high quality standard **(Title picture).** The thin-walled seat concept not only offers increased design freedom but also makes a contribution to lightweight vehicle construction that should not be underestimated, while at the same time creating a greater sense of space.

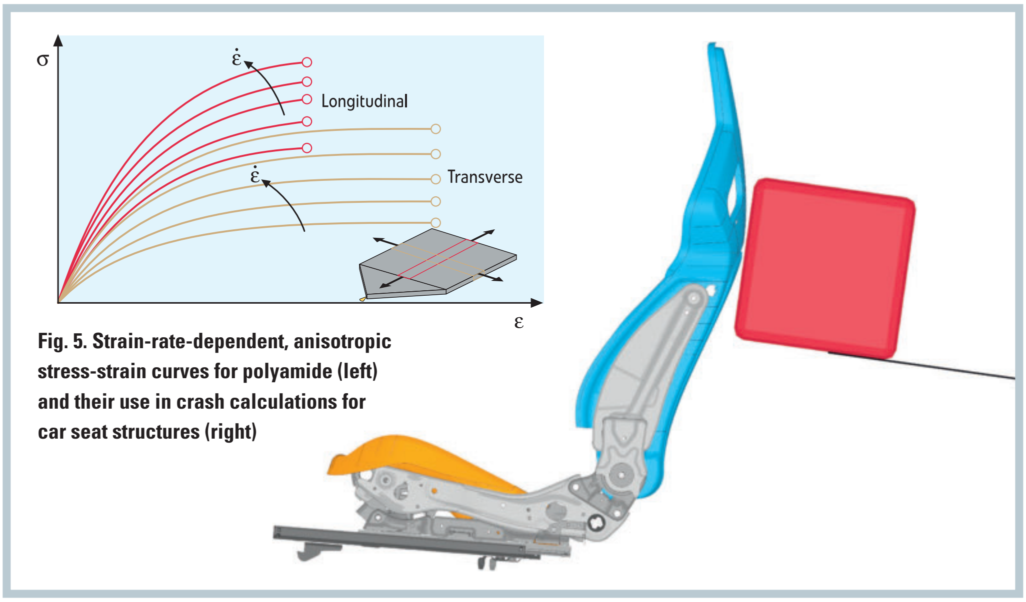

Fig. 5. Strain-rate-dependent, anisotropic stress-strain curves for polyamide (left) and their use in crash calculations for car seat structures (right)

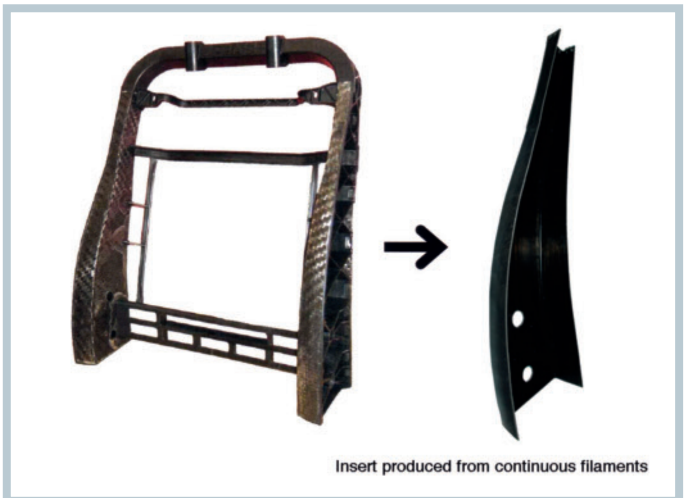

Fig. 6. Design of a seat back reinforced with inserts produced from laid continuous filaments

The future will bring integrated automotive seat structures based on new materials that will have to meet high requirements in terms of design, comfort and lightweight construction. In particular, new electric and hybrid vehicle concepts will require different seats and even more systematic implementation of lightweight construction. For such developments, tailormade structural materials from widely diverse material classes and comprehensive system know-how will be needed. ■

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