



Versatile plastic for complex molds

# Amazing diversity

Despite the rapid pace of progress in plastics technology, many molded parts are still produced from glass fiber-reinforced plastics using time-consuming processes which involve a great deal of manual input. Now, plastics experts from Bayer MaterialScience have developed a particularly cost-effective and also very environmentally friendly new process that can be automated.

Plastic from a nozzle: A mixing head for automated production of molded parts made of glass fiber-reinforced plastics (left: cut glass fibers, right: polyurethane).



Polyurethane experts: (from left) Wolfgang Brennecke, Petra Sion and Dr. Marc Schütze.

While most people associate bathtubs with relaxation, the mere thought of them is sometimes enough to cause materials engineers severe headaches! On the face of it, these “oases of relaxation” don’t look at all high-tech. However, beneath the surface lie some real innovations in materials. These days, all kinds of technical and aesthetic demands are placed on the modern bathtub or whirlpool. The material used for the bath must not soften, even at high water temperatures, and needs to be able to withstand considerable changes in temperature ranging from 15 to 70 degrees Celsius without showing any noticeable or lasting deformation.

Traditionally, plastic bathtubs are made by heating large sheets of acrylic plastic and using a vacuum to draw them into a mold. This process is known as thermoforming. Bathtubs made of glass fiber-reinforced plastic (GRP) then have a mixture of unsaturated polyester resins (UP), styrene and cut glass fibers sprayed onto the back. The styrene reduces the viscosity of the polyester and also serves as a reactant in the cross-linking of the long-chain polyester molecules. The problem with these products is that styrene is considered hazardous to health, and its maximum permissible concentration in the workplace has recently been lowered.

The reaction between polyester and styrene creates a plastic matrix in which the glass fibers are embedded. However, this manufacturing process still requires a great deal of manual input, since each part requires time-consuming hand finishing – laminating – to ensure that the molded part has optimum strength and an acceptable surface. After spray application, the glass fibers only form a loose compound and therefore need to be rolled flat and compressed fiber by fiber. “It takes two to three hours to produce a bathtub using this method,” explains Dr. Marc Schütze, a plastics expert at Bayer MaterialScience.

#### Innovative spraying process removes the need for manual input

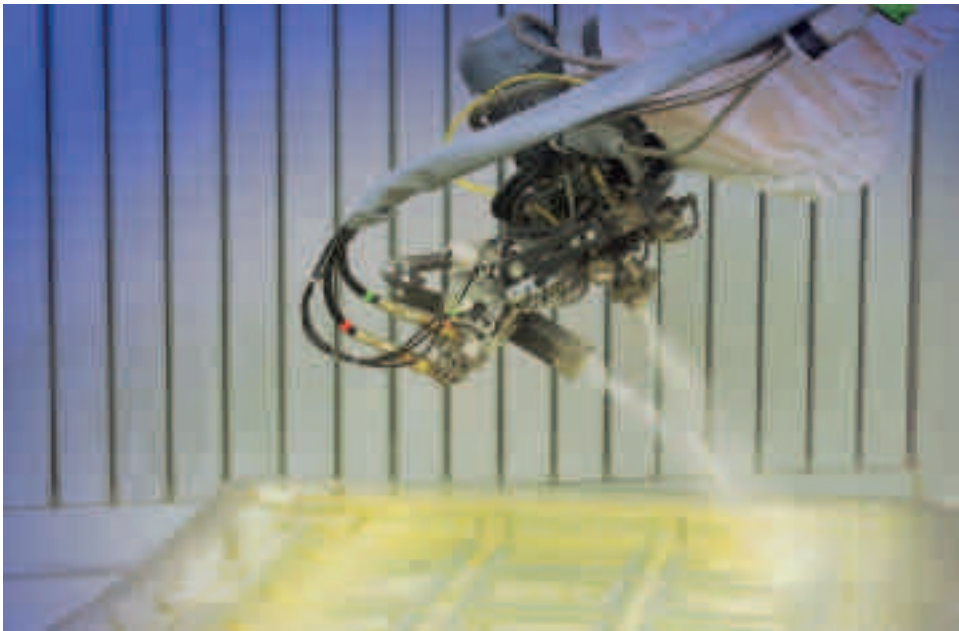
Now, a new product that Dr. Schütze and his team have developed in just eighteen months is set to make this laborious manual labor a thing of the past. Multitec® Short Fiber Spraying is a multi-component polyurethane system formulated for spray application. It employs isocyanate, polyols and a foaming additive and allows molded parts to be produced with varying structures by combining solid and foamed layers. The liquid components are processed using a spraying machine which handles the metering as well as the mixing. At the heart of the

#### Versatile polyurethane

Polyurethane is a versatile plastic produced from liquid components – polyols and diisocyanates – by polyaddition at room temperature. It can be foamed or solid, rigid, brittle and even soft and elastic. It is used to produce mattresses, instrument panels, bumpers, seals, floorings, coatings, adhesives, insulating foams and packaging.



Speedy hot rods: Many of the add-on parts on motor racing vehicles, such as spoilers and side skirts, can be made of glass fiber-reinforced polyurethane.



Automatic production: A robotic arm guides the mixing head over the mold during the spraying process.

### The secret of strength

The stability of a molded part made of fiber-reinforced plastics primarily depends on the plastic matrix and the length and type of fibers. The optimum combination of the properties of the matrix and the fibers creates immense stability.

machine is the spraying head, which dispenses the polyurethane mixture using compressed air. A special cutter slices the roving, a continuous bundle of glass fibers, into pieces measuring six to 15 millimeters, and these are then fed into the polyurethane spray

stream. The limits in the size of the fibers are dictated by the mechanics of the process. If the fibers are too short, the stiffness of the part will be reduced. If they are too long, they cannot be properly embedded in the matrix. Just as steel mats provide concrete with immense stability in construction applications, the glass fibers considerably enhance the stability of the polyurethane matrix material.

### Water – an environmentally friendly blowing agent

However, the stability of the product does not just depend on the fiber length, but also on the structure of the different reinforcing layers. For a bath-

tub, a combination of foamed and solid layers with and without glass fibers is used to create a particularly stable product. The plastics experts at Bayer use water as an environmentally friendly blowing agent to foam the plastic. Isocyanate, one of the basic ingredients in polyurethane, reacts with water to produce carbon dioxide. Whether you're making a whirlpool bath, truck bumpers or components for boat-building, the products all need to be stable and light. "Multitec® Short Fiber Spraying provides the means of producing these molded parts without having to cope with the disadvantages of traditional GRP technology," explains Schütze. Multitec® not only eliminates the manual input involved in laminating, but also does away with annealing. This is a production step which usually involves heat-treatment of the molded part in an oven at 60 to 80 degrees Celsius for around two hours, and serves to harden the plastic. With the new Bayer technology, hardening takes just three to five minutes at room temperature. With the traditional GRP method, it takes around three hours to produce a bathtub. The Multitec® system cuts this to just 20 minutes.

Multitec® Short Fiber Spraying can also be operated by robot. "That not only enhances productivity, it also greatly improves reproducibility and



Molded part production: an engine cover for a bus is removed from the mold.



**Polyurethane – layer by layer**  
Producing GRP bath tubs and shower trays used to involve laborious manual work, but these days the materials used to make sanitary ware are much more complex in structure.

Acrylic sheet  
Solid PU with glass fibers (GRP)  
PU foam  
Solid PU with glass fibers (GRP)

therefore the quality of the molded parts,” says Schütze. “With Multitec® Short Fiber Spraying, almost anything is possible,” he says. “You can even use it to produce large parts such as garage doors or challenging shapes such as truck bumpers.”

### Elimination of styrene cuts production time considerably

The Bayer materials experts are currently working together with engineers from the automotive industry on the development of a new generation of electric vehicles – including electric taxis and postal vehicles – for the City of London. “Since these vehicles obviously need to be light, they require large bodywork components made of plastic rather than steel,” explains Schütze, who sees opportunities for the new Bayer system in this project. “Even the motor-sport community is showing an interest, because auto-tuning calls for fast, low-cost, short-series production of parts such as front and rear spoilers and side moldings.” In these applications, Bayer works with the customer to develop a tailor-made solution. The same applies to the production of rotor blades for wind turbines and hull sections for boats. Bayer MaterialScience has also developed a new coating specifically for the new polyurethane system. Rather than

being applied to the molded part after production, as is the normal approach, this coating is sprayed directly into the mold. This method, which is also known as in-mold coating, is also entirely styrene-free. In comparison with conventional in-mold coatings based on polyester, the waiting time between production stages can be cut, since the lack of styrene means that there are no lengthy reaction and flash-off times. Using Multitec® Short Fiber Spraying means that GRP processing can now be made entirely styrene-free. “This is particularly important, since we can safely assume that at some point in time a complete ban on styrene may be impending,” says Schütze. However, the Bayer research team isn’t terribly concerned by all this at the moment. The success of Multitec® has meant that even Dr. Marc Schütze now associates bathtubs with relaxation.

[www.bayermaterialscience.com](http://www.bayermaterialscience.com)  
Enter the search term “polyurethane” to gain access to comprehensive information about polyurethane production at Bayer.



A plastic sample is subjected to a bending test.