A champion featherweight

A car that is supposed to use a minimum of fuel must not weigh too much. Consequently, replacing heavy sheet steel parts with lightweights made of plastic is a guiding principle in the automotive industry. Researchers at Bayer Polymers have now developed a plastic blend for body parts that retains its shape at all times and even effortlessly withstands the toughest conditions.

At only one-and-a-half kilograms, a fender made of Triax® is a real featherweight that helps save gas.

Plastics expert Dr. Marc Vathauer with an unpainted Triax® fender.

Gone are the days of the legendary Tin Lizzy, the world's first mass-produced car, when even the bumpers were made of iron. Today, a variety of plastics averaging 170 kilograms is packed into every car. The percentage of this lightweight material relative to the total vehicle weight has increased more than ten-fold in the last 50 years. And for good reason: plastics are light, versatile and don't rust. They have become an integral part of a car's interior, tires and bumpers.

Plastic body components also offer numerous advantages. They can be manufactured with much cheaper tools than their sheet-steel counterparts and molded into any conceivable shape. If a resilient plastic is selected, parts dented in relatively minor collisions flex back into shape all on their own. And not least, plastics incorporated into cars in the right place can also lessen the consequences of accidents involving pedestrians.

All the same, plastics have been unable to take over the body area on a large scale, because most mass-production systems are geared to sheet steel. Converting plants and retraining staff would cost billions. In order to still benefit from the great advantages of plastics, carmakers are increasingly using mixed designs that combine steel and plastic parts.

But there is a problem with this method: if the sheet metal hood and plastic fenders are to give the appearance of having been cast from the same mold, their surfaces must look absolutely identical after painting. This in turn means that all materials have to be painted together "online". A true challenge, because the path through a painting line is certainly not a walk in the park for plastics. At temperatures of over 200 degrees Celsius, a lot of plastics soften, while others simply shrink. Previously, there was only one plastic blend capable of withstanding these conditions.

Good paint adhesion thanks to low water absorption

A team headed by Dr. Marc Vathauer, project manager in the Polymer Alloys unit of the Bayer Polymers Innovation department, has impressively demonstrated how effectively competition can spark inventiveness. The Bayer scientists spent only a few years poring over measurement curves and turning new findings into ever-better formulations before receiving official certification from a well-known automotive manufacturer that the result of their work – Triax® DP3155 – displays outstanding properties. A fender made of the material is currently being tested as part of a major car series scheduled to be launched on the market in the next few years.

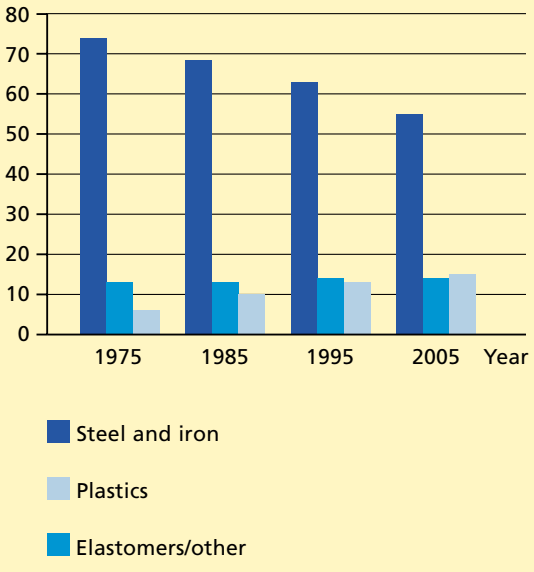
The new blend retains its shape even at high temperatures, while a mineral filler provides the required stability. And the new Triax® absorbs very little water – a major plus, because water stored in a plastic can migrate to the paint layer during the drying process and form unwanted bubbles. The Bayer team found an additive that resolves this problem.

Another important requirement of future materials is their recyclability, and Triax® fulfills it. Says Vathauer: "We melted down several batches and found that 80 to 90 percent of the good properties are retained." Finally, a Triax® fender on a high-end mid-

More plastic, less steel

The history of plastic in automotive applications has been a real success story since the 1980s. The proportion of plastic referred to total vehicle weight has risen continuously since then and currently stands at about 14 percent.

Percentage of material relative to total vehicle weight



Loosening electrons

In virtually all plastics, the electrons are fixed so firmly that they cannot conduct electrical charges. But for paint to adhere well to plastics, they must be capable of conducting electricity. Two methods have now become established to achieve this property: the long-chain molecules are mixed with substances that can conduct electricity, such as steel fibers, aluminum chips or suitable types of carbon black. Alternatively, plastics are used in which the electrons are fairly loose to begin with. They can then be coaxed into motion with the help of strong oxidizing or reducing agents. In the process, these doping substances either suck or press the sluggish electrons out of their bonds.

Plastic panel

range car weighs only one-and-a-half kilograms, making it lighter than the latest Notebooks. It would weigh more than twice as much if made of steel. The material developed in the Dormagen laboratories does have one shortcoming: it is not electrically conductive. To ensure better adhesion of primer and paint, a sheet metal body-in-white is electrically charged in the painting line. Therefore, Triax® fenders currently have to be provided with an additional conductive layer before passing through the painting line. Because this step is quite complicated, the researchers on Vathauer's team are already testing an additive that allows electrons to flow through the plastic.

"The results are extremely promising even at this early stage," says Vathauer of the current status. "Various automotive manufacturers have already ordered initial samples of the new material."

Proven plastics cleverly combined

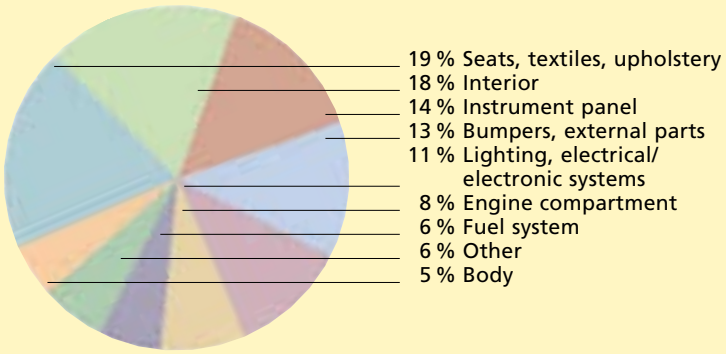
The two primary Triax® components are plastics that have long since demonstrated their worth in large-scale applications: a polyamide used to make tubes and hoses, and ABS (acrylonitrile-butadiene-styrene), which is used for example in coffee machine housings.

With a blend of this kind, plastics engineers - like distillers composing a blended whisky – hope to mix a cocktail of good properties. "The trick is to blend the components in such a way that the good characteristics of one plastic offset the poor characteristics of the other," says Vathauer, explaining the art of plastic blending. On account of the polyamide, the blend is very strong and most chemicals can't do it any harm. It also ensures that a Triax® body part retains its shape even when a car stands in the hot sun. The ABS component makes the plastic resilient: minor dents disappear like magic.

Permanently combining the plastics in a melted state was a tricky task. "You need a compatibilizer to blend the ABS and the polyamide," explains Vathauer. It connects the immiscible substances like an adapter: one side adheres to the ABS, while the other binds the polyamide. In this way, it ensures that the starting materials don't drift apart again once exposed to high temperatures and pressures during processing. Polymers and additives are melted and blended in an extruder: an enormous, stainless steel plastics mixer with bucket-size feed openings. At the end of the extruder, the finished plastic blend – which has since cooled almost completely – is churned out in long, thin spaghetti-like threads right into a pelletizer. Re-melted and injected into a mold, the plastic becomes a fender. It would also be possible to make other body parts from Triax®: "Basically, all

Car parts made of plastic

The automotive industry is an important engine of innovation in plastics, which are used in all parts of a car. With the exception of the front windshield, even the glazing will soon be made of plastic.



Horst Dieter Botzet inspects the precipitation process used to make plastics electrically conductive.

vertical parts could be made of Triax," says Vathauer, describing the application options of the new material.
In contrast, it is not suitable for the roof of a car. "It's just not rigid enough yet. Sooner or later, the roof would sag," he adds. As a fender installed in a test car, the plastic blend is currently on the road all over the world and successfully defying even the severest climatic conditions.

www.plastics-car.com/applications/index.html
This web site offers comprehensive background information and forecasts on the use of plastics in automotive engineering.

Ralf Hönow fills an extruder for blending the two plastic components.

Interview with Dr. Ludwig Vollrath, Düsseldorf

"Plastic will increasingly replace glass in cars"

***research* spoke with Dr. Ludwig Vollrath, head of the Plastics section of the German Association of Engineers (VDI), about the importance of plastics for future car generations.**

When will the first all-plastic, mass-produced car roll off the production line?
A car in which literally all components are made of plastic is not an issue at present. Nevertheless, plastic is of course an extraordinarily versatile material. The proportion of plastic relative to the total weight of a car is currently hovering around 14 percent.

Will the percentage continue to rise?
Yes, definitely. Mostly because the quality of plastics continues to improve. They will perform more sophisticated tasks and help fulfill the requirements imposed on the car of the future. The glazing will also be increasingly replaced by plastics. This is already standard for lamps and headlamps. The goal is "organic glazing", meaning to manufacture both the glazing and the car roof from plastic.

Of course, a key advantage is the low weight of plastics. Customer demands for more comfort and safety can be fulfilled without substantially increasing the overall weight of the vehicles. The next step is up to the plastics manufacturers, design engineers and processors. Take the body of a car, for example. On account of customers' increasing demand for personalized cars, body parts have to be produced in frequently changing shapes. I think this area offers key growth potential for plastics applications, also from an economic standpoint.

Isn't 14 percent plastic in cars rather low?
The figure 14 percent refers to the total weight of the car. But plastics are considerably lighter than steel. If we instead compare the number of parts made of plastic to the total number of parts in a car, we get a very different picture.

In the past, several models with primarily plastic bodies came out on the market, the most recent example being the Smart. Can't this concept be transferred to mass-production?
That concept is perfect for the Smart. It also shows that plastics have long since shaken off the cheap image of the former East German Trabant car, which was largely made of plastic. But for the mass-production of other cars, steel still has a distinct competitive advantage in many areas because of the already existing manufacturing plants and mature technologies.