

LIGHTWEIGHTING WORLD

THE MAGAZINE OF INNOVATION + COLLABORATION

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COMPONENT LIGHTWEIGHTING SOLUTIONS

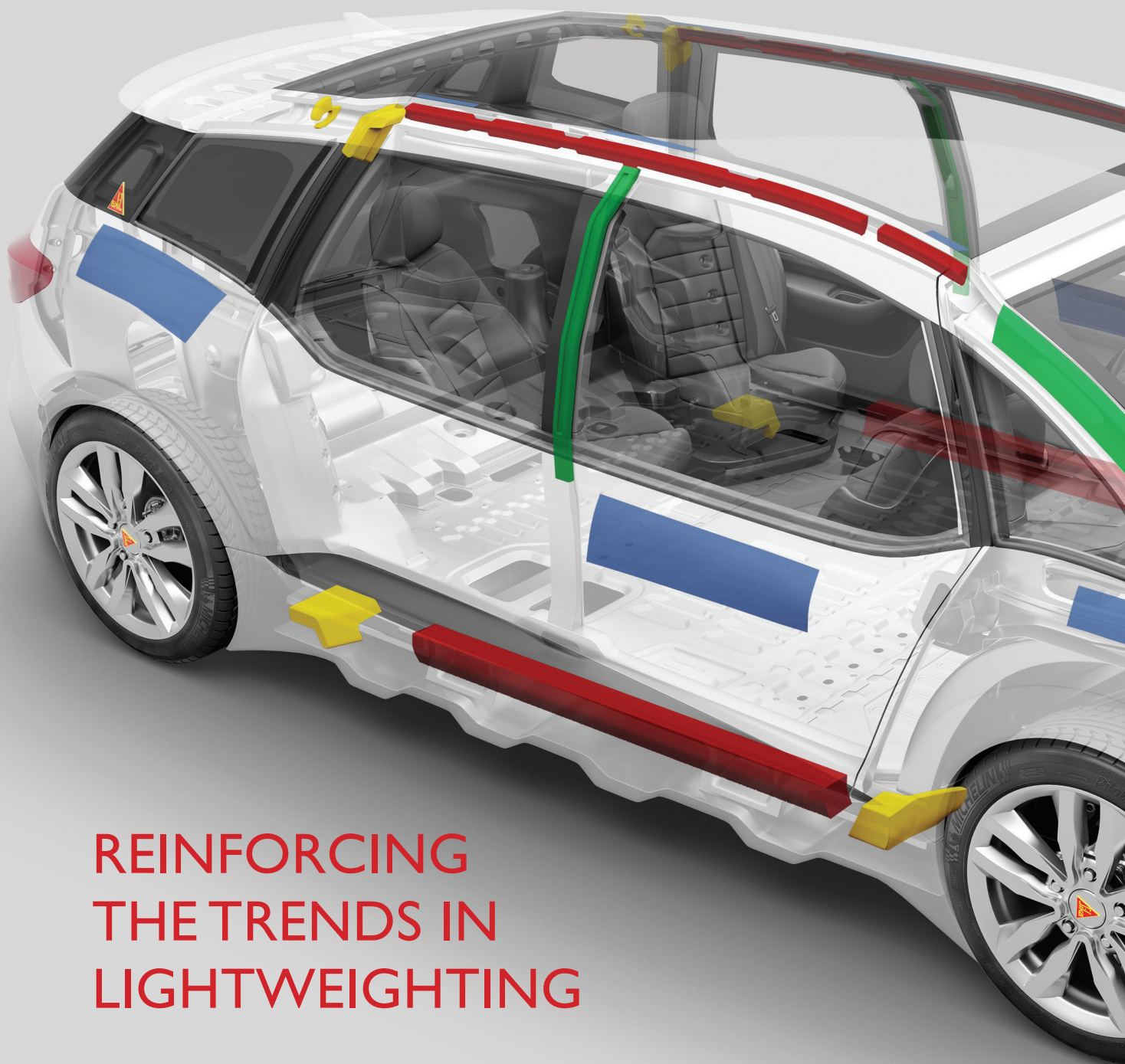
+
PREVIEW
LIGHTWEIGHTING
WORLD EXPO 2019

SPEAKER LINEUP

Aluminum
Extrusion
Alloys

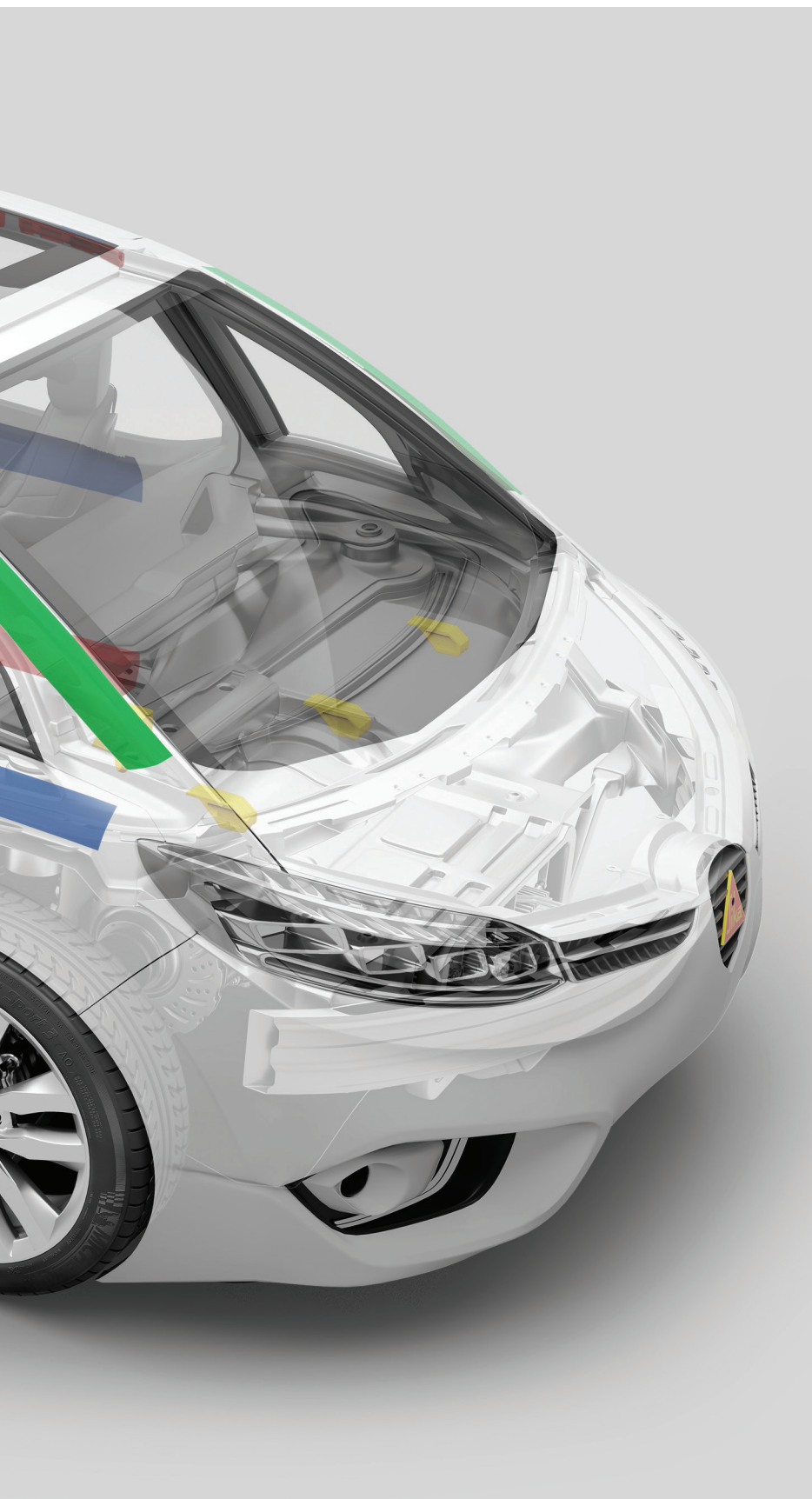
Engineered
Structural
Inserts

By Denis Souvay, global product manager structural reinforcers, Sika Automotive
+ Michael Meier, head structural systems, Sika Automotive



REINFORCING THE TRENDS IN LIGHTWEIGHTING

Adding NVH and crash performance



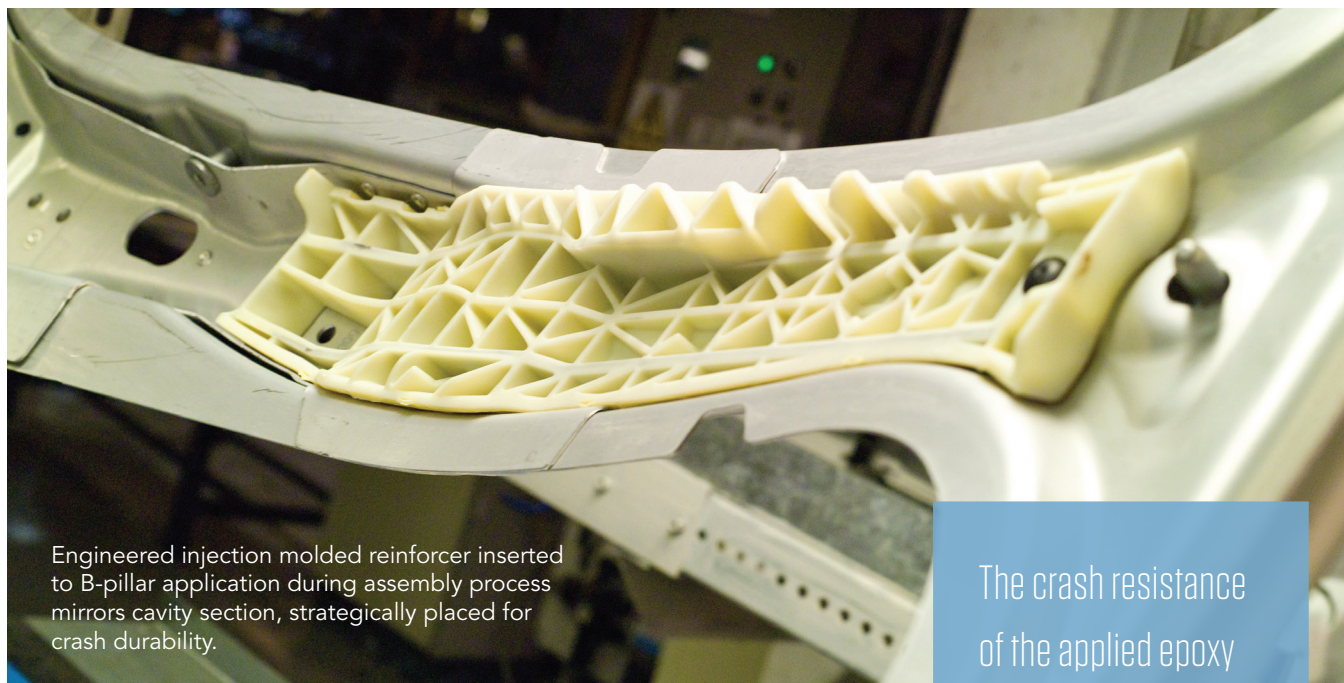
The challenges in vehicle design and assembly are getting bigger. Lightweight construction, increasing requirements for crash safety, cost pressures, design of derivative car models on the same platform, material flexibility and shortened development times are aspects that are often difficult to reconcile.

Added to the equation, efforts to reduce mass for increased fuel economy, emissions reductions or to increase range through the reduction of metals or metal thicknesses can fundamentally modify structural performance of the car body.

Within the last several years, the integration of heavy batteries of electric vehicles with additional crash-safety requirements have expanded from just the occupants to the batteries themselves, while adding a growing material mix in the car bodies. No engine noise means higher demand for acoustic and noise, vibration and harshness (NVH) performance. Put together, these challenges lead to brand-new solutions to achieve the combined targets for vehicle performance requirements.

Sika has solutions to help vehicle designers address these challenges. One of many solutions is a focus on engineered structural inserts used for reinforcement. Increasingly, plastic components with structural foams or structural adhesives are used to achieve structural performance, which have their final properties only after curing in the e-coat ovens.

The concept and real-world results are long proven—precise reinforcement placements for car-body stiffness



Engineered injection molded reinforcer inserted to B-pillar application during assembly process mirrors cavity section, strategically placed for crash durability.

The crash resistance of the applied epoxy foam or structural adhesive guarantees the transmission of high forces to tension and shear.

improvement (NVH applications) or for better crash performance (structural enhancements). SikaReinforcer technology has been used successfully for more than 15 years. Plastic reinforcement elements, called Sika-Structure, are adhesively bonded to the surrounding substrates by molded structural foam or through a growing concept, liquid epoxy adhesives.

As mentioned, the usage field for NVH applications is focused on the improvement of the dynamic stiffness of a car body. By reinforcing the body structure section at specific emplacement zones, SikaReinforcer parts will act as a block to dynamic bending or torsions of the car body, which will limit the “pumping effect” of the sections. The result is a stiffer body leading to better handling and increased cabin comfort.

Reinforcer components can be integrated into the already existing structures in late development phases,

for instance when technical requirements arise. At this late stage, changes of existing sheet-metal tools usually lead to high costs. Even greater are the advantages of early incorporation of SikaReinforcer technology into the pre-design of a vehicle. Then, lower steel grades and lower material thicknesses can be used because the reinforcement of critical zones by structural parts with Reinforcer takes place.

For Crash Applications—By using reinforcer components in crash-sensitive sections, a collapse of the subject profiles is prevented. Crash energy is absorbed through the reinforcer insert and adhesive, whereby the deformation of the subject component can be significantly reduced. The failure of a structure due to high local forces is specifically prevented.

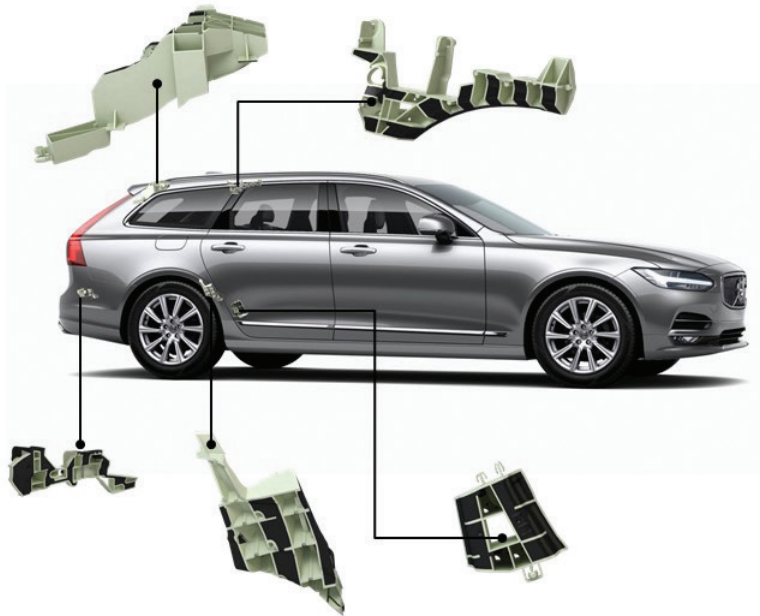
The crash resistance of the applied epoxy foam or structural adhesive guarantees the transmission of high forces to tension and shear. Plastic-

reinforcing elements open up completely new possibilities for the design of the bodyshell.

In addition to the improved deformation performance and occupant compartment penetration reduction in the event of a crash, in most cases, there is a double benefit—an increased stiffness of the body is achieved, as mentioned, for NVH applications. Further, by using crash-resistant adhesives instead of structural foams to secure the reinforcement element, the performance of the reinforcing solution can be massively increased. This technology is called HSB (High Strength Bonding).

LOCAL AND NVH APPLICATIONS

VOLVO S90 NVH PACKAGE



SIKA Automotive – Reinforcement Technologies

■ High performance

Extensive use of UHSS to increase crash performance of body structure results in loss of NVH performance.

→ Expanding reinforcers placed at structural nodes increases static torsional stiffness by 3200 KNmm/° *
(*: performance of the NVH package with 10 reinforcers/car)

■ Lightweight solution

Huge weight reduction compared to equivalent performing steel solution saving > 10 kg

■ Design freedom

Injection-molded parts show very high freedom of design to fulfill all customer requirements.

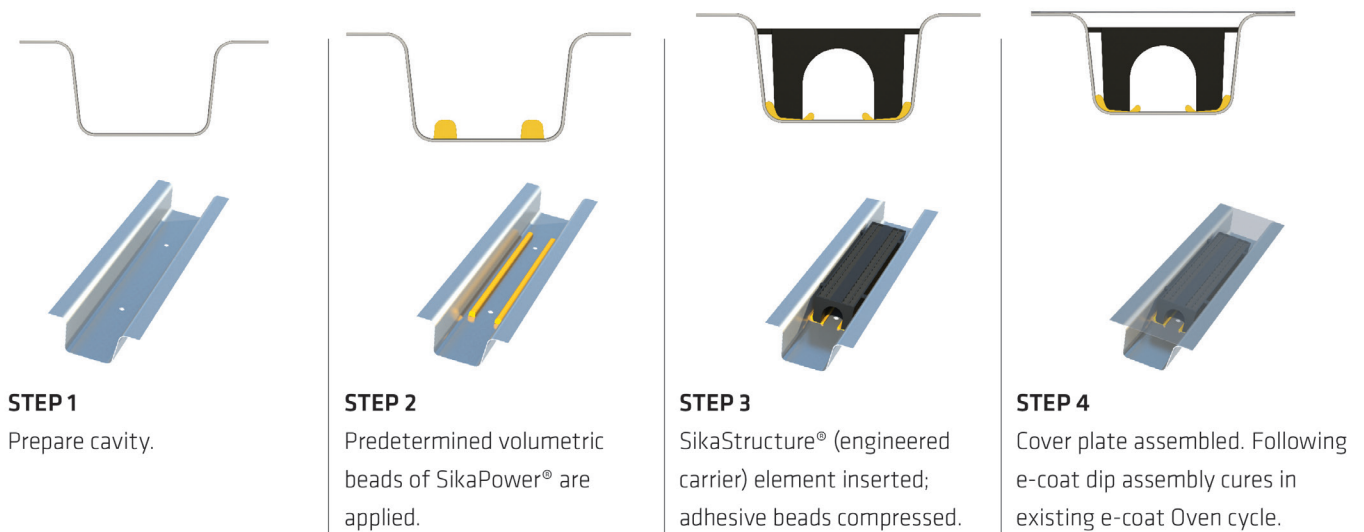
■ Joining of inaccessible areas

Possibility to join several metal sheets where welding is not possible



Applications and noted performance improvements through targeted use of reinforcers on the Volvo V90

ASSEMBLY PROCESS FOR HSB APPLICATION



Typical assembly process for Sika high-strength bonding application coupling crash-durable adhesives with SikaStructure engineered inserts



Application target

- Side crash of electric Golf derivative with 300 kg additional weight (batteries)
- Global reduction of sheet-metal thickness in roof frame

Lightweight solution

- Weight reduction (vs. steel solution) > 2.5 kg

Design freedom

- Injection molded parts show very high freedom of design to fulfill all customer requirements

Cost reduction

- Sheet metals and crossing on B-pillar head discharged (downsizing possible)
- Steel weight reduction provide savings

Application of reinforcements and benefits gained by using Sika HSB concept in VW E Golf model

First Development Phase—In this phase of the solution, feasibility, performance and weight are determined by CAE simulation. This phase can typically be realized within a couple of weeks, which gives the designer multiple choices for solving a crash or stiffness issue. In the optimization phase, the ratio of power and weight is usually significantly improved. Here, the development engineer can fall back on a variety of technical options.

A first step is the selection of the suitable material, usually a technical plastic. Due to the specific choice of

the glass-fiber content in the material, the optimal structural design and other parameters, it is possible to achieve the best balance between strength, ductility, weight and costs. Plastic components with their high degree of design flexibility offer possibilities that can't be realized with steel parts or can be realized only with greater effort.

While there are other possibilities currently available, such as intensive use of press-hardened steel (PHS) or ultra high-strength steel (UHSS) in the high-loaded crash areas of the

occupant safety cell and a switch to aluminum for external panel or doors, or complete aluminum car bodies for lightweighting, the material makeup and design are much more expensive and complex particularly for high-volume car models.

Additionally, while trials have been made and continue to intensify the use of carbon fiber reinforced polymer (CFRP), the material currently faces difficulties in penetrating the market in high volume due to challenges in recycling capability and a very high cost level. In comparison, SikaRein-

Plastic components with their high degree of design flexibility offer possibilities that can't be realized with steel parts or can be realized only with greater effort.

forcer engineered plastics technology is ready to use, easy to integrate with vast user experience and many applications in production.

Why don't advanced reinforcement technologies gain more attraction?

Simply put, a lack of awareness of the possible performance enhancements such technology approaches can offer. At present, we rarely observe the introduction of this technology in the strategic development of new car models. We mainly see that designers are tending to use alternative materials to standard steel, like PHS, UHSS, aluminum and sometimes CFRP. We do see heavy activity introduced when traditional design factors fail after the initial design. It is time to reverse this trend.

Many reasons are at the source of this current situation, as many designers are entrenched in selecting traditional solutions.

- For decades, the use of steel has been a proven technology, using existing and proven production equipment, with strong voluminous experience and knowledge sets to design car bodies.
- The suppliers of raw material are mainly focused on their own material and are competing against the raw material of their competitor (e.g., steel against aluminum).
- More and more, automotive engineers are deploying efforts to build up a symbiosis of all available materials, with the main target

to use “the right material at the right place” in the body structure, balancing the costs, the material performances and the technical state of art of each technology.

Plastic components are still seen as “low value” components—assumed as correct by considering the raw material alone—without knowing its interaction and performance potential with other known raw materials, particularly when combined with specific engineering advantages and knowledge of material integrations.

- Finally, there is a lack of awareness and knowledge of non-traditional reinforcement techniques. One reason they are featured in this article is to inform. There also may be a trust factor. Designers don't like to depend on plastic components for traditional metal applications.

In any case, when such technology could be necessary to solve crash or stiffness issues, we can assume OEM engineers are migrating to the most convenient solution (in terms of technology accessibility and confidence) because they are challenged by a development timeline. Sika has an experienced team and can support finding the best location, CAE methods, process integration and support with a high level of flexibility for any customer request.

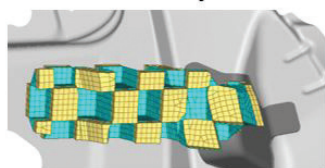
Development and Industrialization of Reinforcers

Our development engineers construct the specific lightweight structural ele-

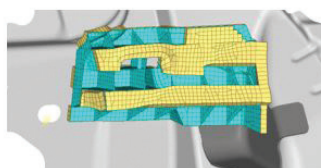
Automotive engineers
are deploying efforts to
build up a symbiosis of
all available materials,
with the main target to
use “the right material
at the right place.”

ments in close cooperation with the car manufacturer. This includes the definition of concepts for the respective application, the iterative optimization of design and connection, and the release of the overall solution by means of experiments. This verification includes the implementation of crash tests for the validation of the mechanical properties and on the other hand, the verification of the process capability under series conditions.

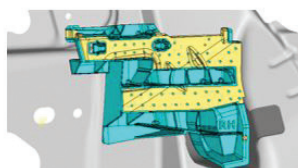
The full benefit of engaging reinforcer solutions as outlined can be realized in the most relevant manner by engagement at the start of the design process, which allows for optimization/iteration of the part design, production and assembly methods. When engaged early in the process, our reinforcer high-performance solu-



Ribbed design for potential estimation



First design considering all constraints



Production design

Applications and noted performance improvements through targeted use of reinforcers on the Volvo V90

With the freedom of design of injection-molded support elements, stiffness jumps can be avoided, as they are almost always present at the ends of steel inserts.

tions normally result in favorable cost parameters over traditional material solutions.

With the freedom of design of injection-molded support elements, stiffness jumps can be avoided, as they are almost always present at the ends of steel inserts. These stiffness jumps often lead to undesired stress localization under load.

By using these measures, the vehicle body can be designed specifically for the needs of different model variants and targeted segment markets. Through the combination of crash-resistant adhesives or structural foam and lightweight structures, the efficiency of the reinforcing elements can be raised to an unprecedented level.

Application Areas and Possibilities

The implementation of SikaReinforcer often lets the OEM meet additional requirements without changing the basic design of steel components and tools. Such reinforcement increases performance compared to pure steel structures, enhances the dimensional stability of the body in the event of a crash and yields a lower weight than a steel reinforcement.

Not least in variant design, the use of reinforcers is interesting. Advantages arise where a basic construction can cover a large part of the applications and only individual vehicle derivatives can be upgraded with structural elements as necessary. With SikaReinforcer, the vehicles needing increased requirements are selectively reinforced, while the rest of the vehicles will not be burdened by extra weight and additional costs.

Examples of this are hybrid and electric vehicles, which due to their higher mass load, the vehicle structure plays more heavily in the crash event than those with an internal combustion engine. Selective reinforcement can also be used for protection in vehicle component structures including metal extrusions, vehicle rocker panels and battery enclosures.

Conclusion

The molded reinforcer elements, coupled with structural foams, or performance-enhancing special crash-resistant adhesives enable a new level of performance of structural elements. It results in new design and assembly options in body construction, which

contributes to stiffer, crash-optimized, weight-reduced and cost-efficient vehicles. **LW**

ABOUT THE AUTHORS

Denis Souvay is the global product manager, reinforcement technologies at Sika Automotive AG. He is a general mechanical engineer with more than 30 years' experience in the automotive industry, including 15 years in program management. Since 1999, he has focused on the introduction of lightweighting plastic solutions for car bodies, driven by growing customer needs of lightweighting solutions. Since 2010, Mr. Souvay has led global product management for automotive reinforcing solutions at Sika Automotive.

He graduated from École Nationale d'Ingénieurs in France and completed his technical studies with a specialization in industrial marketing management.



Michael Meier, head structural systems, Sika Automotive, is leading an international team of engineers and is responsible for the virtual development of structural inserts, mechanical characterization of the products and onsite support of customers. He has been with Sika Automotive for more than 11 years, during which time he has successfully brought more than 200 applications onto the market.

