



# KRAIBON®

Rubber improves composites

## KRAIBON® – elastomers as the perfect supplement for fiber reinforced plastics

### Lighter, quieter, more economical!

Gummiwerk KRAIBURG always endeavors to open up new business areas and extend the use of elastomers as a high-tech material. Thus it has been shown that Gummiwerk KRAIBURG's elastomer compounds are an outstanding supplement for fiber reinforced plastics (FRP) and they can compensate for the disadvantages of this material class.

With this “material of the future” the forces acting on the material are absorbed primarily by the fibers. These fibers can withstand particularly high loads longitudinally, although they are relatively intolerant to lateral strains, such as impact from a stone.

Another characteristic of fiber reinforced plastics is the relatively high component stiffness, which in turn results in low damping behavior and poor acoustic properties as compared to conventional materials.

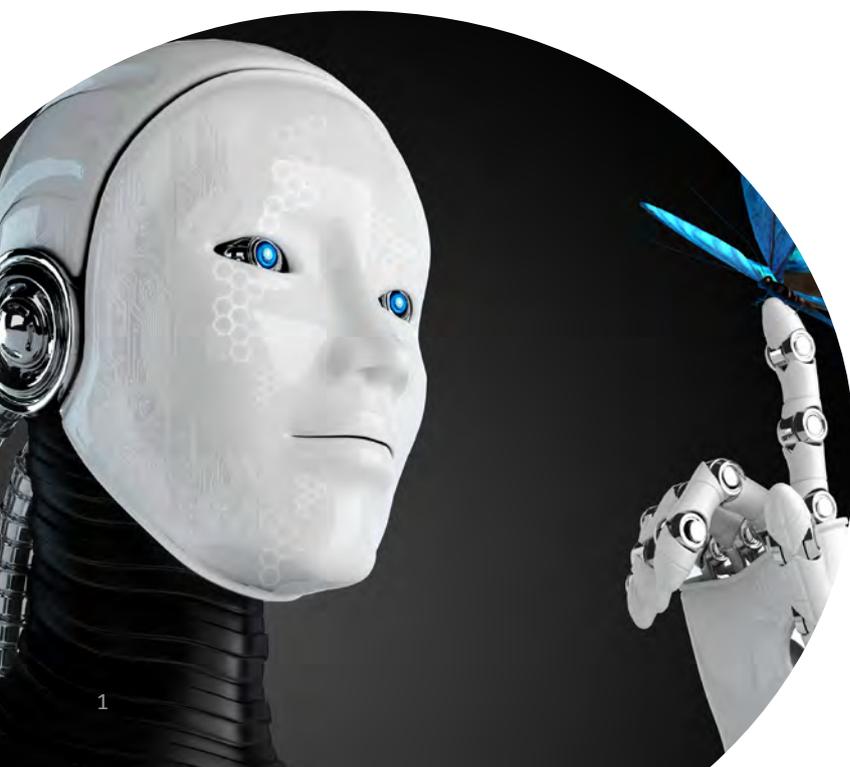
This is precisely where the elastomer compounds from Gummiwerk KRAIBURG come in:

KRAIBON® is a thin film made of non-cross-linked rubber that hardens within the component laminate in the same production process. A hybrid material occurs that combines the best of both worlds.

By integrating KRAIBON® in the composition of FRP it is possible to achieve an alternating structure of hard and soft material that combines the good mechanical properties of the FRP with the good “elastic” properties of the elastomer. The main areas of application are improved acoustics and impact and splintering behavior.

The decisive advantages are direct integration of the elastomers in the normal manufacturing process for FRP components and a direct connection between elastomer and FRP without additional bonding agents. This innovative technology is used selectively in industries such as automotive construction, wind power, aeronautics, rail vehicles and medical technology.

Industries and applications  
e.g.: automotive industry,  
wind power, aerospace,  
railway, medical  
technology, sports.



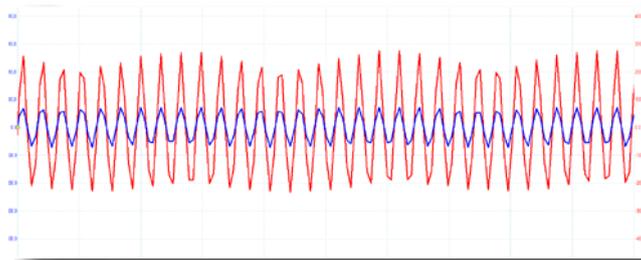


## Acoustics – featherlight damping for composites

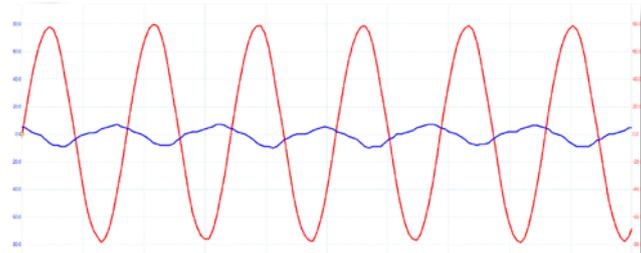
Lightweight construction is a central element in modern vehicle manufacturing. However, at the same time, lightweight construction must also take the comfort requirements of customers into account.

Loud and uncomfortable vehicles are hard to sell. There are various solutions to address Noise, Vibration, Harshness (NVH), however, as basis, heavyweight mats are used. It is clear, that 'heavyweight' clashes with the concept of 'lightweight construction'.

In the graphics below, the outstanding performance of KRAIBON® as compared to pure CFRP components and alubutyl-damped components is obvious. KRAIBON® exceeds the performance of the heavyweight mats, with a weight reduction of approx. 2.5 kg/m<sup>2</sup> as compared to the conventional solution.



Vibration behavior at 120 Hz



Vibration behavior at 620 Hz

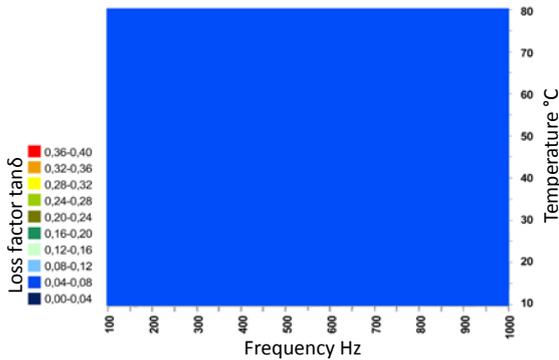
- CFRP panel **without** KRAIBON®
- CFK panel **with** KRAIBON®

**KRAIBON®**  
combines  
lightweight  
construction and  
comfort.

The acoustic behavior of composite components can be significantly improved through the use of KRAIBON®. Studies show that KRAIBON® exceeds the structure-borne sound damping of alubutyl and that it does so at a fraction of the weight.

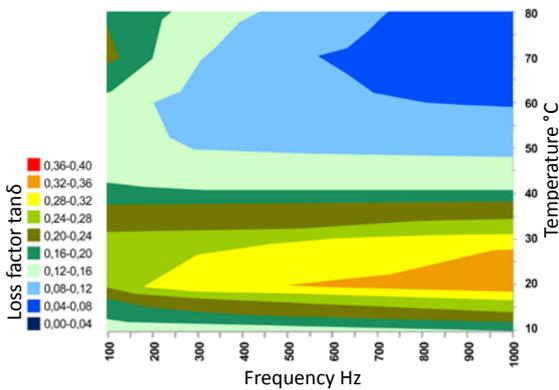
# ACOUSTICS

## Acoustics – featherlight damping for composites



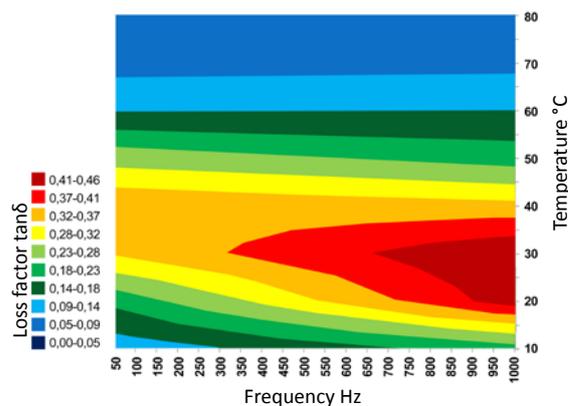
### CFRP

The damping (loss factor  $\tan\delta$ ) of a pure CFRP panel is under 4 %. In practice this is expressed in a very tinny sound.



### Aluminumbutyl

The attenuation of a pure CFRP panel via retroactively applied alubutyl (additional area weight approx 2.8 kg/m<sup>2</sup>), shows a maximum damping of approximately 30 % at room temperature.



### KRAIBON®

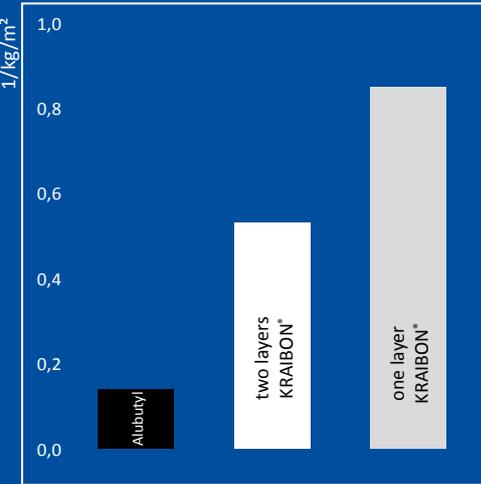
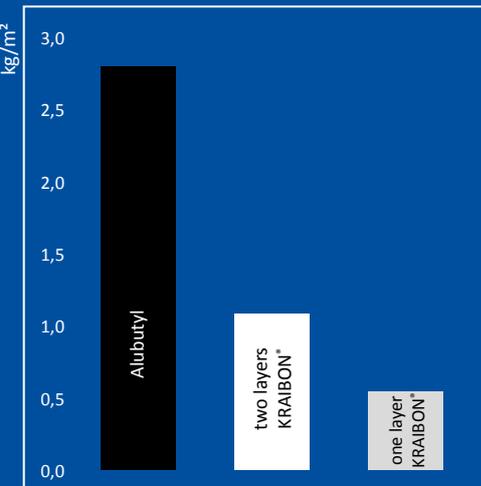
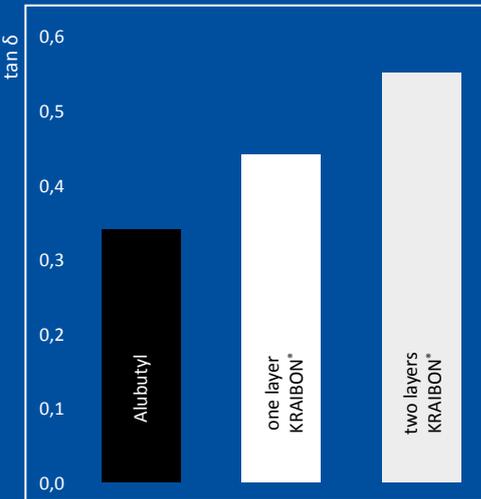
The attenuation of a CFRP panel with integrated KRAIBON® shows maximum damping at room temperature of 40 %. The area weight in addition to the CFRP panel is only approximately 0.6 kg/m<sup>2</sup>.

Thus this structure delivers better performance and saves 2.0–2.5 kg of weight per square meter!

Weight reduction of 2.5 kg/m<sup>2</sup> in comparison with conventional solutions!



### Damping / weight / performance:



## Damping comparison

Even at low layer thicknesses, and thus a low additional weight, KRAIBON® shows a higher damping capacity than aluminum-butyl. Consequently, KRAIBURG can also develop customized solutions that take damping, temperature range and rigidity into account.

## Weight comparison

Through constrained layer damping, a significantly more efficient damping is possible. In this regard one layer of KRAIBON® weighs only 20 % of a customary alubutyl coating.

## Performance comparison

Comparing the ratio of the loss factor achieved to the additional weight used, the great advantage of KRAIBON® becomes clear. The performance (loss factor to weight) increases by approx. 600 %.

## Advantages:

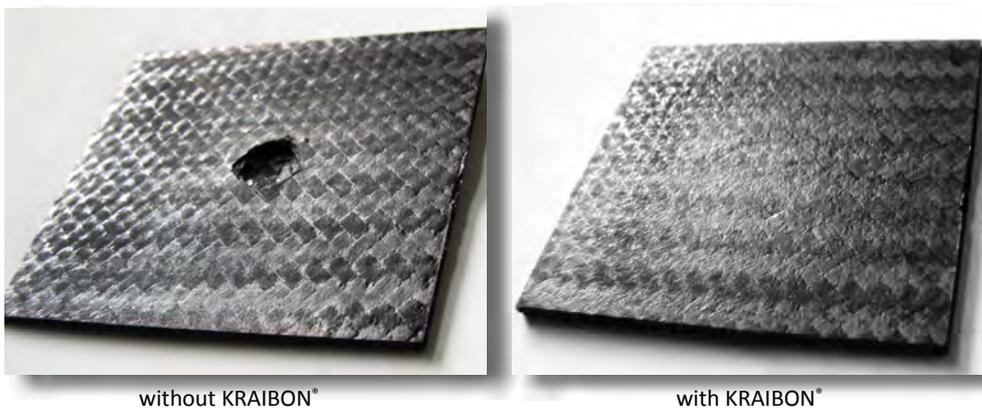
- Through inlaying modified elastomers, the CFRP loss can be significantly increased.
- The damping achieved through KRAIBON® layers in CFRP is greater than the damping of CFRP with alubutyl.
- The area weight of KRAIBON® layers is significantly lower than of alubutyl.
- With KRAIBON®, the performance, i.e. the ratio of max. loss factor and area weight, can be increased by approx. 600 % in comparison with alubutyl.

# IMPACT

## Impact- and splintering protection for composites

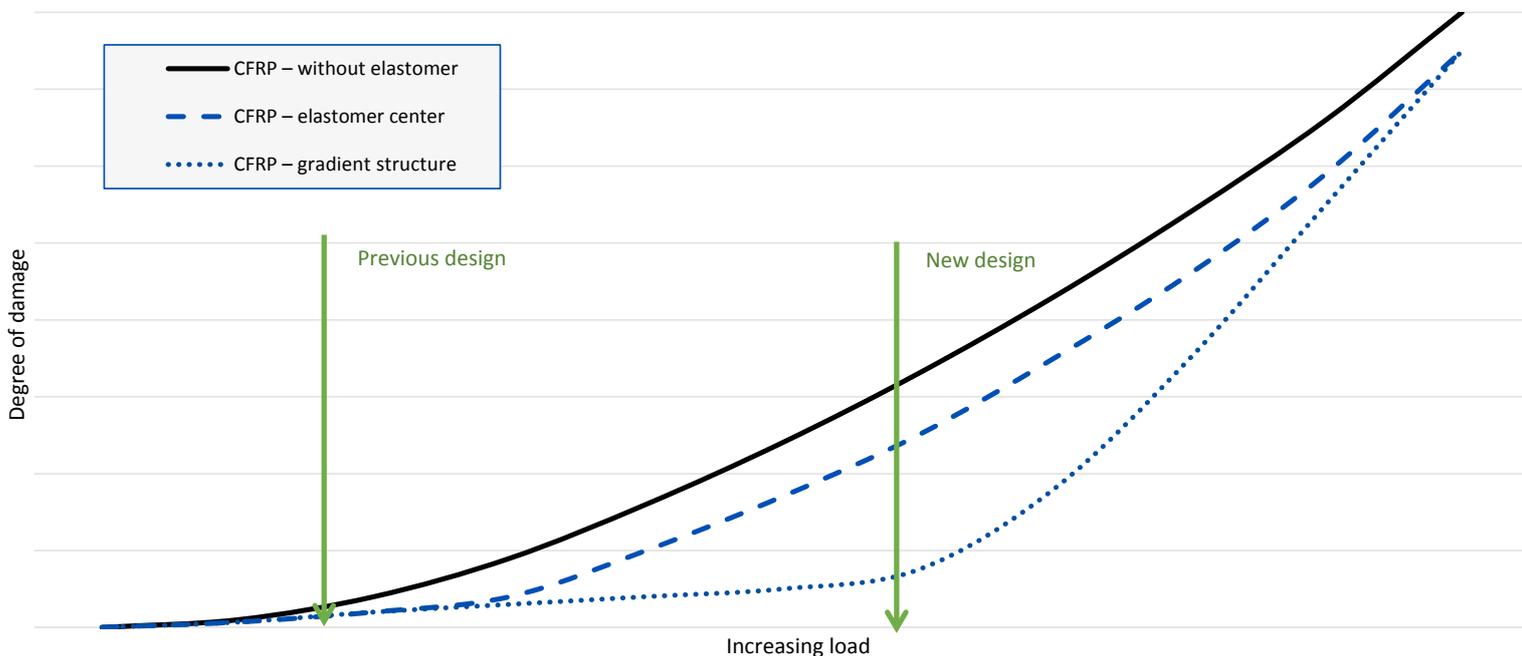
Fiber reinforced plastics are light, but easy to destroy.

One way around this problem is the design of structures that exceed the primary requirement. Another approach is protection with additionally applied films or the integration of expensive high-performance fabric. All approaches either drive up the weight and / or the price.



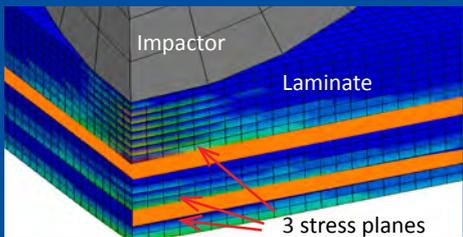
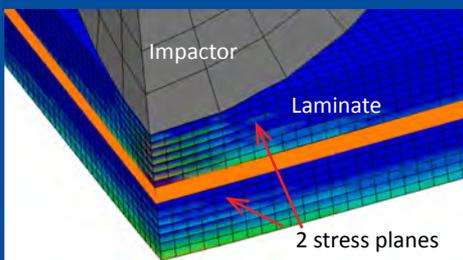
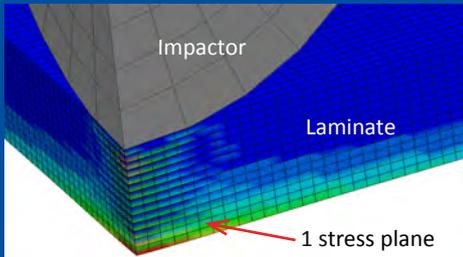
With the integration of KRAIBON®, a clear enhancement of damage tolerance can be achieved without necessitating an increase in weight or cost.

In the graphic below, the component with KRAIBON® can either be designed for higher loads **or** for constant impact tolerance. The end result is a lighter and more cost-effective product.





## Drop tower test: FEM model



KRAIBON®

## CFRP

The layer of CFRP opposite from the impactor absorbs the majority of the impact load and is consequently destroyed.

## One layer KRAIBON®

KRAIBON® makes it possible for individual layers in a laminate to accommodate the occurring loads with relative independence. Thus, multiple load-bearing layers exist, which in the event of impact simultaneously absorb the maximum occurring load.

## Multiple layers KRAIBON®

Depending on whether one or multiple KRAIBON® layers are integrated in the layer structure, the impact tolerance increases by 100 % per layer. With the aid of this layer structure, the resistance capacity of the components, and simultaneously the service life of the components, is significantly increased, or the component becomes lighter and more favorably priced, depending on the requirement.

Crash test: Conventional structure



Crash test: Structure with KRAIBON®



If, in addition to damage tolerance, shattering behavior should also be improved, KRAIBON® offers possibilities that were previously inconceivable with conventional materials.

- Easy integration of KRAIBON® significantly improves the shattering behavior.
- Energy dissipation can be significantly optimized.
- Elastomers enter into an outstanding bond with the fiber composite material and prevents the shattered fragments from detaching.

# HYBRID

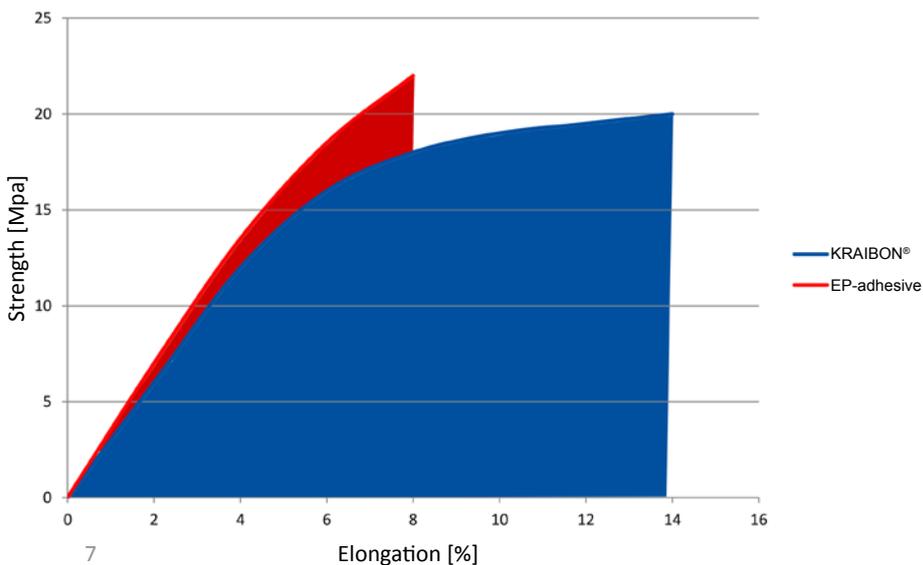
## Hybrid composites – CFRP - KRAIBON® - Metal



Hybrid material combinations of metal and carbon open up a highly attractive field in the area of composite material construction. Through the combination of these two materials, components that are lighter than pure metal, and significantly more affordable than CFRP components are possible.

A clear weakness of these composites is the bonding agents that are conventionally used. They are moderately effective in compensating for differences in the materials, and can cause a weakening of the component. KRAIBON® offers an innovative, high-performance alternative to conventional bonding agents.

- When metal is combined directly with carbon using a bonding agent, contact corrosion can occur. Through use of KRAIBON®, an insulating layer is inserted between the two materials, which prevents corrosion and considerably extends the service life of the component.
- A large variance in thermal expansion of the two materials occurs through the variable temperatures during production, painting processes and in the end application. This results in stresses in the material composite. KRAIBON® compensates for these stresses significantly better than conventional bonding agents and retains an excellent adhesion to both materials.
- Example: A hybrid component of aluminum and CFRP, 1000 mm in length, is manufactured at 150 °C. At -30 °C the length of the aluminum component is approx. 996 mm, the length of the CFRP proportion is 1000 mm. On the edge an adhesive layer of 0.3 mm must compensate a length difference of 2 mm. Thus it is elongated by approx. 566 %.

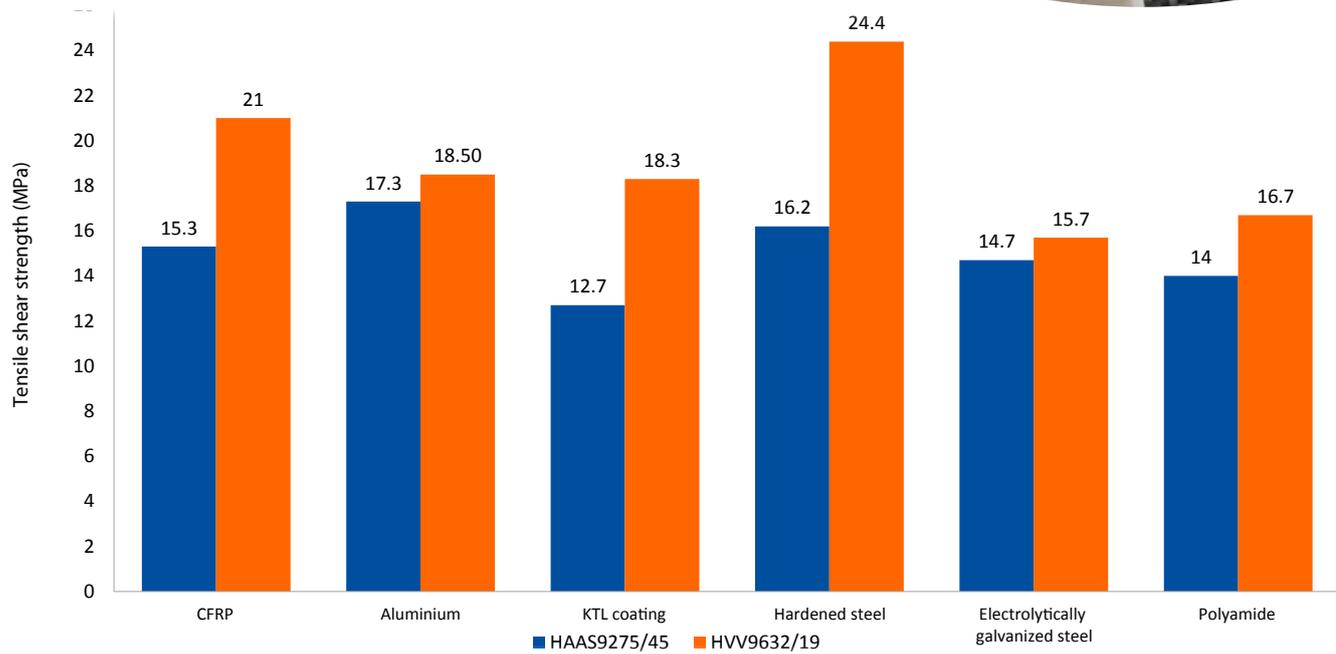


- KRAIBON® in hybrid material combinations provides very good adhesion, greater flexibility, and – particularly for crashrelevant applications – significantly better energy absorption and thus safety reserves.

New possibilities in  
the field of CFRP-  
metal-hybrid  
compounds!



### Comparison of the adhesion between HVV9632/19 and HAAS9275/45



### CARBON

- High strength
- High rigidity
- Low density
- High energy absorption

### KRAIBON®

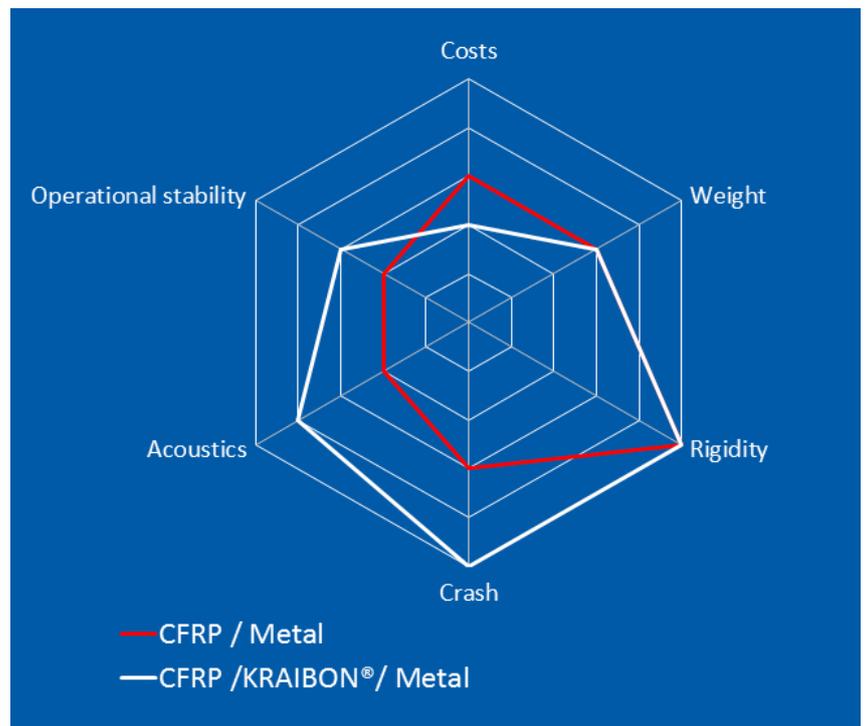
- Low density
- Permanent viscoelasticity
- Good damping effect

### METAL

- High rigidity
- High strength
- Ductile failure

### EFFECT MECHANISM

- Constrained layer damping
- Thermal decoupling
- Electrochemical decoupling





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The logo consists of the word "KRAIBON" in a bold, sans-serif font, followed by a registered trademark symbol (®). The letters are white with a thin blue outline. The background is a dark grey geometric shape that overlaps with a blue horizontal bar above it.

# KRAIBON®

a product of:

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