


PERLUCOR®

Transparent ceramics for ballistic and optronic protection applications

CeramTec
CeramTec-ETEC GmbH

High Performing Multi-Hit Solutions for Every Mission

Not many companies are able to offer a product that creates a new trend or an entirely new approach to a given problem. Ceramics' manufacturer CeramTec is the first European company to develop series-ready transparent ceramics. High weights and thicknesses as well as low resistance against scratches and rockfalls have always been a major problem for existing transparent armour systems.

CeramTec-ETEC's material, called Perlucor®, was officially presented to the military market at the IDEX exhibition 2013 two years ago and is now used in a variety of applications. Having similar properties as sapphire, Perlucor® has been proven to be an excellent and very cost-effective new material for transparent ballistic and environmental composite protection systems for vehicles and optical/optronic equipment.

CeramTec-ETEC is a well-known producer of Alumina and Silicon Carbide based opaque armour ceramics for more than 20 years, which can be found in most of the German military vehicles with composite armour, as well as many of those built by other European or worldwide countries.

Intensive research and development work enabled CeramTec specialists to successfully transfer the advantages of ceramics to the world of transparent materials. The result is a material offering an affordable alternative to sapphire glass on the one hand and being easier and more cost-effective in processing on the other.

(Photo: CeramTec)

Perlucor® multi tile-glass composite panel

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Transparent Armour Materials

If you look at different hard materials that can be used for transparent armour applications, you can find single crystals, glass and ceramics. Sapphire as a single crystal has a strictly oriented lattice structure with high atomic and ionic binding forces leading to high hardness, strength and melting temperature. One of its disadvantages, though, is its optical and mechanical anisotropic behaviour. On the microscopic scale, glass is the complete opposite to a single crystal, with a more randomly oriented structure and weaker binding forces between its elements. This leads to lower melting temperatures and hardness. Simplified it is a frozen liquid.

CeramTec's Perlucor® – a polycrystalline ceramic material – can combine the positive aspects of both materials.

Not only does it show a high bonding force comparable to sapphire between its atomic elements, with similarly high hardness, strength and melting temperature, but it is also optically and mechanically isotropic like glass. This has certain ballistic and processing advantages. Combined with a highly automated and fully optimised process, Perlucor® therefore has a cost to performance ratio much lower than other potential single crystal and ceramic solutions.

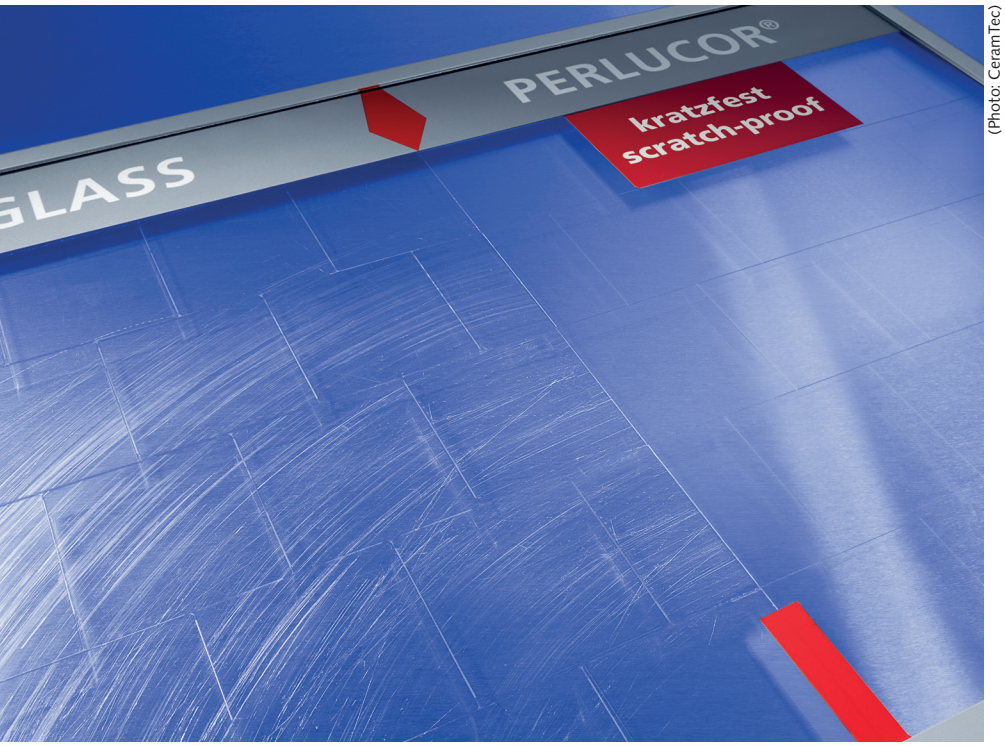
The history of transparent ceramics suggests it hadn't been that much of a success story, which CeramTec believed to be down to the high costs associated with it. With that in mind, the company started to develop a completely new process route to minimise costs significantly. In this way CeramTec has been able to reduce costs compared to sapphire by 50 to 70 per cent for ballistic panels.

(Photo: ISAF/Bundeswehr)

Windscreen scratched through sand

Main advantages of using Perlucor® in armour systems

If you think about building up a multilayer, ballistic window with a layer of transparent ceramics in the front, Perlucor® enables you to save up to 50 per cent or more in weight and thickness. Considering current systems with an average area weight of 190 to 210 kg m² for STANAG 4569 Level 3 you could achieve for instance a weight saving of 70 to 100 kg/m². Taking the high weight saving at the much reduced costs compared to sapphire into account, a Perlucor® based transparent armour system will come up with a very compatible €/kg weight saving ratio which is difficult to achieve within any other areas of the vehicle. Furthermore, the increased life time cycle by two to five times because of Perlucor®s scratch resistance, gives an additional overall cost benefit when such a new transparent armour system is used within a vehicle.



(Photo: CeramTec)

Perlucor® is less scratched compared to glass

Main Advantages compared to conventional glass systems:

- 40 to 60 per cent weight and thickness reduction
- Multi-Hit capability and visibility
- Extremely scratch resistant
- compared to sapphire 60 per cent cost savings
- Two to five times increased lifetime cycle
- Reduced €/kg weight saving ratio compared to other weight reduction possibilities within a vehicle

Also, the multi-tile panel design offers an efficient transparent multi-hit solution. In the opaque field the general trend for ceramics moves to smaller and smaller elements to adapt to the small distances between the shots as required, for instance within the STANAG 4569 or ATPD specifications. Within the transparent armour field, one has been very limited to ful-

fil these requirements until today. The only way to go for an efficient multi-hit solution, comparable to the opaque field, has been to increase the thickness and consequently the weight of the armour system significantly. Now, by having the possibility to transfer the proven technology of the opaque to the transparent field, you can use smaller Perlucor® tiles and arrange them in a window to gain a multi-hit efficiency comparable to opaque armour systems.

(Photo: Zwilling)

Scratch protection applications for optical soldier equipment

Further protection of windows, optical and optronic equipment

Another application within the military field has shown up during the past year. Especially in sandy and rocky areas such as Afghanistan, vehicle windows had to suffer because of stone hits as well as scratches caused by the wiper blades moving across the sand and dust covered front window. Equally, ballistic windows pre-damaged by stone hits are examined whether they lose some of their ballistic performance. This could create an unforeseeable and unknown risk, while the vehicle is used in combat.

CeramTec-ETEC has developed a really innovative and seminal solution to protect windows against such type of wear. By laminating a thin layer (<1.0 mm) of Perlucor® on top of the front glass layer, the window can be protected successfully against such damages. This can increase the lifetime cycle three to ten times. Similar protection will be applicable for optical equipment such as telescopes, camera lenses, infrared imaging equipment and other sensors used by modern soldier and vehicle warfare. Flat as well as curved protection lenses made out of Perlucor® transparent ceramic can help to increase the lifetime of such highly valuable as well as sensitive optical equipment.

Especially for these optical applications CeramTec-ETEC has developed together with a partner company a new extremely hard anti-reflective coating working exceptionally well with Perlucor® as a base material. It increases the transparency to above 92 per cent if used as a one-sided coating or even above 96 per cent if applied on both sides of the Perlucor® lens. Wear test results have shown that the AR coating on top of Perlucor® performs much better even than chemical strengthened and special "scratch resistant" glass alone, which are available on the international market. In the end this provides a combination of the most transparent and scratch-resistant solution on the market. Because CeramTec is able to provide layers done to 500 µm and less, costs can be reduced to a minimum in comparison to sapphire or other solutions.

(Photo: Bundeswehr)

Scratch protection applications for periscopes and optical/optronic vehicle equipment

Summarised, Perlucor® has proven to be an excellent material used within transparent ballistic and optical/optronic applications, giving the customer a high performing multi-hit solution with a much lower weight and thickness, an increased lifetime with a very reasonable cost/performance ratio compared to compatible materials.

CeramTec-ETEC will exhibit both, a ballistic door window panel and a scratch and stone-hit protected panel, at their stand at the DSEi in London taking place from September 15th to 18th (Stand no. S6-311).