BLACK CERAMICS FOR BALLISTIC PROTECTION

LIGHTWEIGHT - PERFORMANCE - FLEXIBILITY

Modern military equipment must be highly flexible, available for rapid response and provide maximum safety. Among many factors crucial to success, innovative materials play an important role in providing the required performance profile. Ballistic protection is one such area. "Black ceramics" – technically known as non-oxide ceramics – enable highest protection levels at lowest possible weight.

Fig. 1: TETRABOR® hot pressed boron carbide body armor plate

A Comparison of Armor Materials

In the key properties essential for ballistic protection, such as hardness, Young's modulus, sonic velocity and compressive strength, ESK's black ceramic materials, like EKasic® sintered silicon carbide and TETRABOR® boron carbide, are superior to all of the alternative materials (Fig. 2).

And as this all comes at lower weight compared to alumina and armor steel, the goal is clear: provide the required ballistic protection at the lowest possible weight.

Body Armor

In this application ESK's boron carbide ceramic plates are typically combined with a high-end composite backing structure. Polyethylene-based fibers such as Dyneema® or Spectra Shield®, and aramid fibers such as Twaron® and Kevlar®, are used in combination with a variety of resins, chosen specifically to meet the application requirements.

ESK offers hot pressed boron carbide plates in different designs and sizes.

Areal densities of boron carbide composite systems designed for protection according to German SK4 (7.62 x 51 AP) start at 30 kg/m^2. This is lower in weight than silicon carbide based systems (typically 36 kg/m^2) and significantly lower than alumina based systems (typically 42 kg/m^2). It allows weight savings of up to 1 kg for a typical torso plate. Significant weight savings can also be achieved for plates offering protection levels of NIJ 0101.06 Level IV+ (7.62 x 51 AP M2).

Boron carbide based systems offer highest protection combined with unique weight savings compared to conventional systems, resulting in improved mobility, reduced fatigue and increased comfort for the soldier.

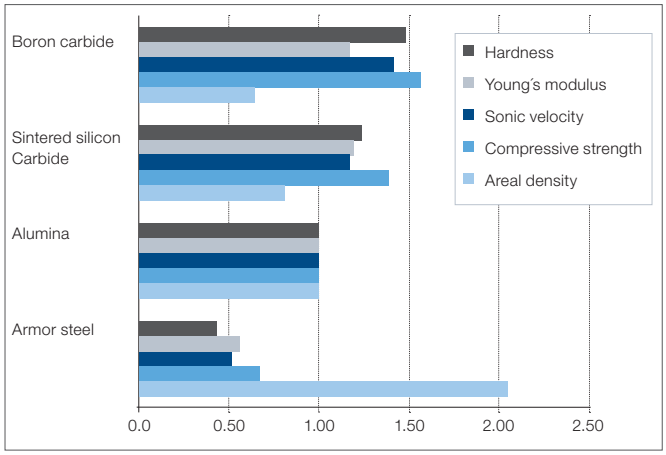

Fig. 2: Comparison of key properties of various armor materials (data normalized to alumina property = 1.0)

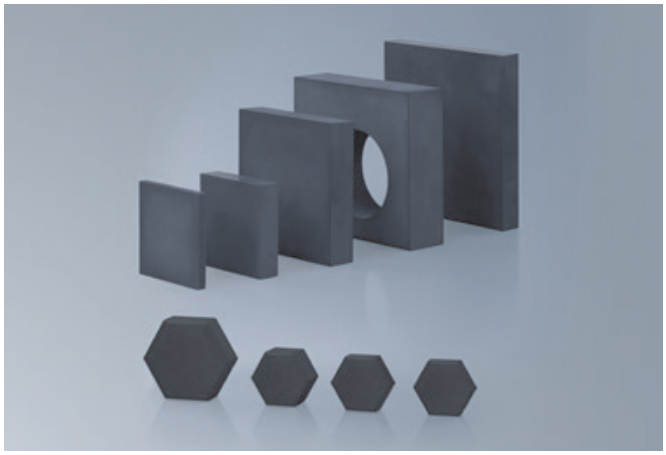

Fig. 3: Typical standard components for ballistic protection in EKasic® sintered silicon carbide

Vehicle Armor

Optimal ballistic protection of vehicles is the key to safe and successful deployment. Protection is required against a variety of threats in today's theatres, ranging from small arms fire and long range medium and large caliber rounds all the way to mines, roadside bombs, IEDs, EFPs and RPGs. In addition to established materials like metals and composites, ceramic materials play an important role in ballistic protection of vehicles. Through shape design and the use of strategic metal plates, underbelly protection against blast has been increased on many vehicles. Some of the weight introduced by these improvements can be recouped by using lightweight ceramic composite structures providing protection against ballistic rounds and fragmentation in other parts of the vehicles. With the "black" materials leading the way in offering protection at the lowest areal densities, exceptional protection can be provided within the overall weight budget. A variety of standard ceramic components such as cylinders/pellets, hexagons and plates/tiles, are used to build armor panels for vehicles. With weight becoming increasingly more important, EKasic® sintered silicon carbide components are the perfect solution for this application. The achievable reduction in weight has an immediate positive impact on airlift capability, payload, floatability, fuel consumption, cruising range, lifecycle cost and overall through-life reliability of the vehicle.

Aircraft Armor

When it comes to ballistic protection of aircrafts, it's all about weight. Since the 1960s ESK has supplied hot pressed boron carbide tiles for helicopter seats. Over time the geometries have become more complex, and as a result, precut ceramic panels in TETERABOR® boron carbide and EKasic® sintered silicon carbide are playing a more and more important role in today's designs.

Composite armor systems based on these materials offer highest protection in combination with significant reduction in weight.

ESK

ESK Ceramics GmbH & Co. KG, a wholly owned subsidiary of Ceradyne, Inc., was founded in 1922 in Kempten, Germany. ESK is a leading supplier of boron carbide powders and black ceramics components for ballistic protection. Besides armor applications, ESK offers advanced ceramic products for wide-ranging industrial applications.

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The management system has been certified according to DIN EN ISO 9001, DIN EN ISO 14001.

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