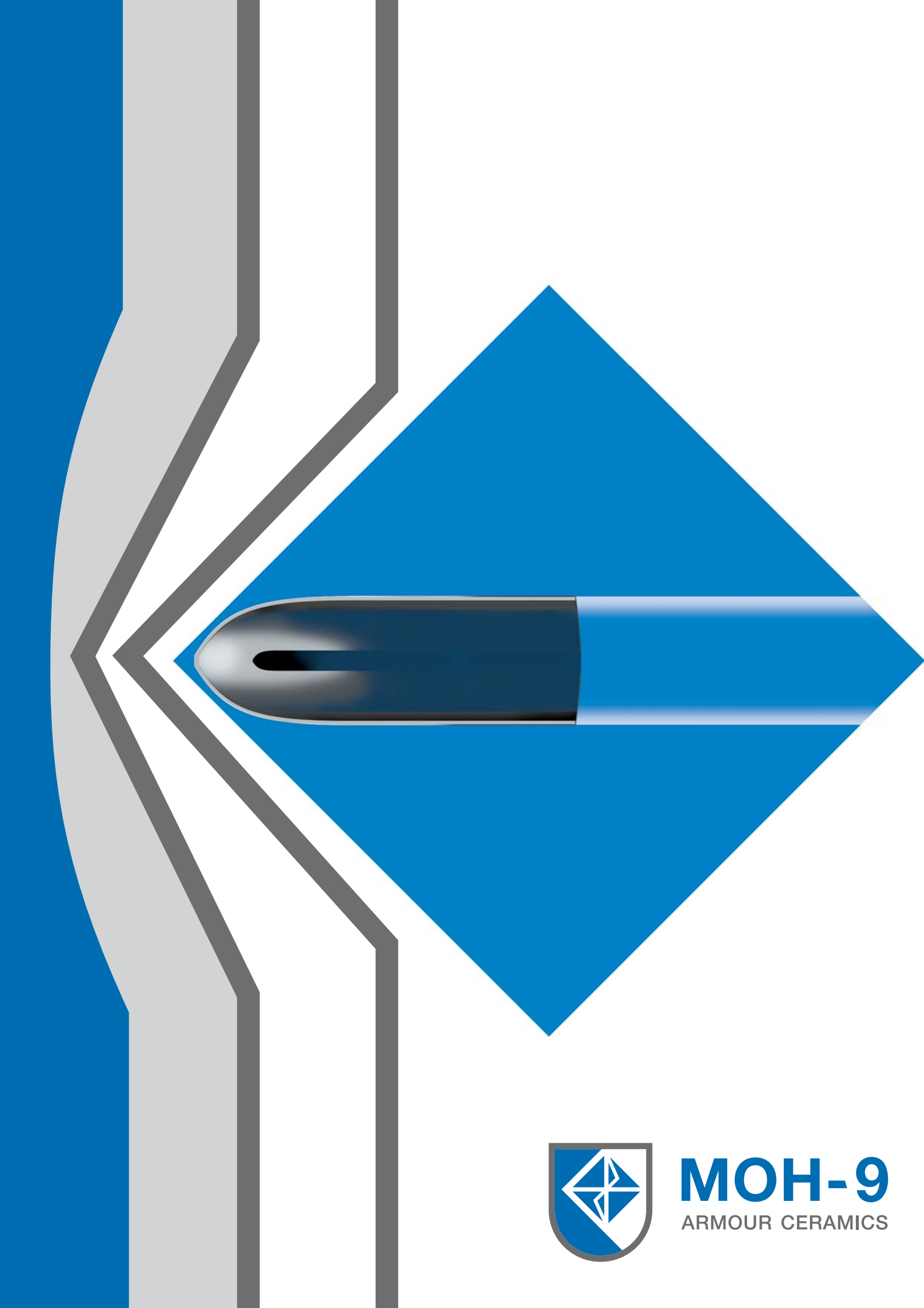




MOH-9
ARMOUR CERAMICS

MOH-9, YOUR PARTNER IN...

Although formally established in 1981, MOH-9's origins can be traced back to the middle seventies, when it developed Alumina ceramic tiles as part of the armour protection for helicopter seats. Today, the company has an established track record in the manufacturing and supply of alumina ceramics for use in body, vehicle, aircraft, ship and building armour. In its more than 25 years of existence the company has always strived to remain at the cutting edge of armour ceramic technology and is the only manufacturer of monolithic plates in the southern hemisphere. Extensive in-house research and development, together with internationally recognised institutes such as University of Pretoria and the Fraunhofer Institute in Germany, result in constantly upgraded materials and manufacturing processes to meet the new ballistic challenges.

More than 70% of MOH-9's products are used worldwide in military, police and private security forces.

The basis of its success is to satisfy customer demands for standard and special applications, specific products, continuous improvement and innovation and Total Quality Management in accordance with ISO 9001:2000 (certified by TÜV Rheinland).



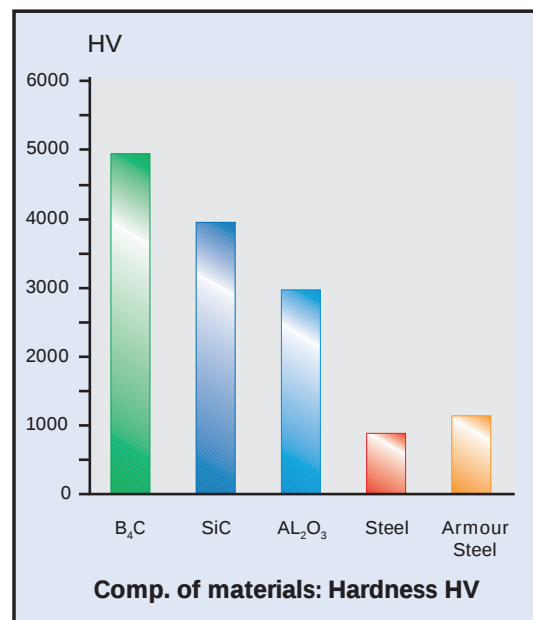
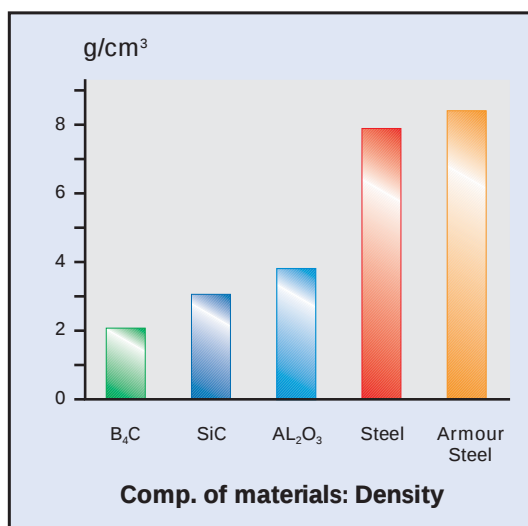
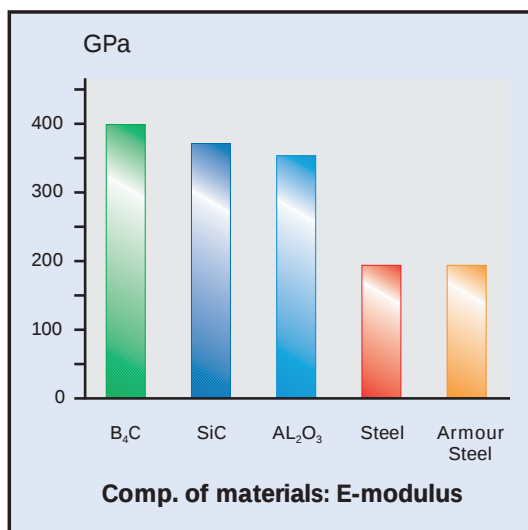
... HIGH PERFORMANCE CERAMICS...

Ceramic materials, although very brittle, are a very cost effective and powerful solution to meet the new requirements such as lower weight and more effective protection against modern ammunitions, for example armour piercing bullets.

For ballistic applications of ceramic materials the following properties are required

- High hardness
- High fracture toughness
- High Youngst Modulus
- High sonic velocity
- Low weight per area

Alumina oxide is one of the most important ceramic materials which fulfills the above-mentioned requirements, especially because of its competitive price-efficiency ratio and shaping techniques. Alumina oxide is used in most applications, while SiC and B₄C are used in weight sensitive applications to achieve further weight reductions.



... FOR CERAMIC FIBRE COMPOSITE ARMOUR SYSTEMS ...

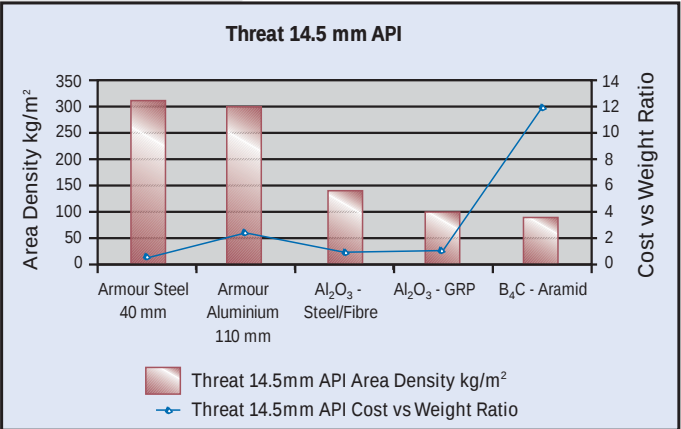
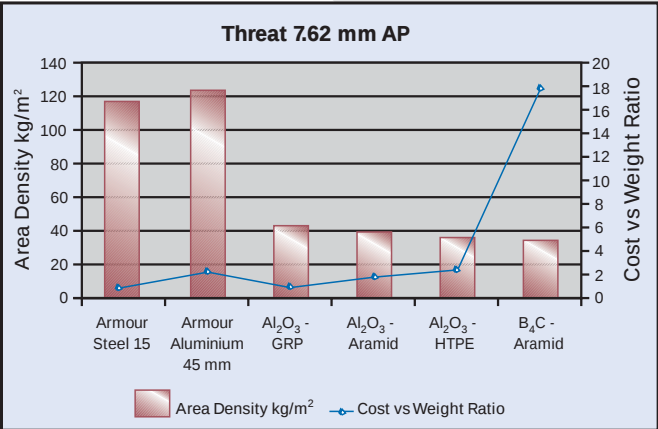
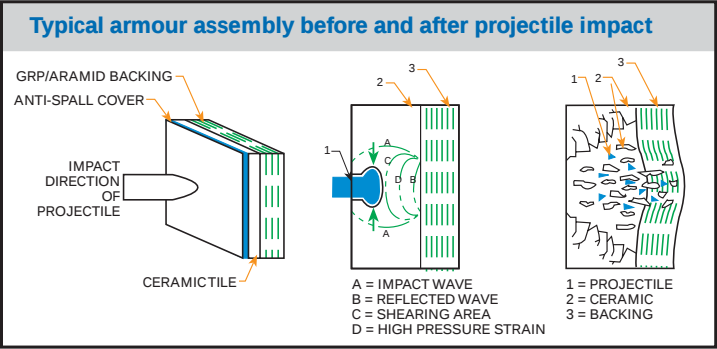
Ceramic materials are combined with other fibrous materials within a composite construction to overcome the brittleness of this material, and to take advantage of the other properties of ceramics.

A composite system normally comprises of various layers of woven high performance polyaramide (Kevlar or Twaron), polyethylene fibres or glass fibre composites as “ backing” material with the ceramic component bonded in the front. The joining technique, and especially the selection of the adhesive used between the ceramic and the backing, is of crucial importance for the ballistic performance especially for the multi shot capability of the whole system. In addition, an anti-spall liner can be fixed onto the front of the ceramic in order to facilitate collection of the shrapnel.



...TO DESTROY AND STOP THE BULLETS ...

When the bullet strikes the ceramic surface, initially a deformation of the bullet tip takes place and thus an enlargement of the cross section. Impact, friction processes and reciprocal effects between the longitudinal shockwave and the reflected wave destroy the bullet and pulverize the ceramic during penetration. The low mass of the remaining bullet fragments have a considerably lower kinetic energy and can be entrapped by elastic/plastic deformation within the backing. When this mechanism takes place, only a relatively small share of kinetic energy of the bullet is transformed into fracture energy. Selection of the correct adhesive ensures that bullets striking the ceramic will not cause any loosening of the ceramic from the backing, yet permit the shock waves to be transferred.



... USED FOR BODY PROTECTION ...

To upgrade bullet proof vests for protection against rifle ammunition, ceramic – fibre composites can be inserted into the front and back of the vest. Monolithic ceramic plates are used mostly in these ceramic composite inserts for body protection.

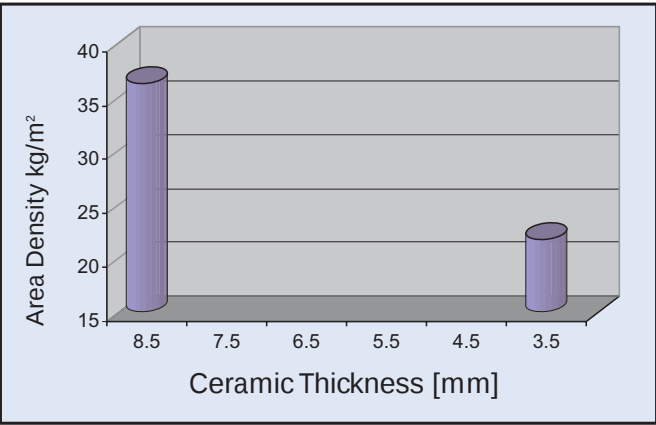
MOH-9 Armour Ceramics Monolithic Breastplates offer the following advantages:

- Selected material range
- Various single, double and multi curved shapes
- Dimensions up to 350 x 300 mm
- Thickness' from 3.0 up to 12.0 mm
- Big selection of breast, groin, side and shoulder plates
- Special shaped plates for females
- Special designed plates as per customer request

For improved multi hit protection, ceramic inserts made out of 50 x 50 mm single curved tiles can be supplied.



Level III+ Composite Weight Reduction Utilising Thin Ceramic Plates



... CERAMIC PLATES CAN BE VERY LIGHT ...

Special selection of raw materials and forming methods allow the manufacturing of breastplates with a thickness of only 3.0 - 3.5 mm with a very homogenous, translucent appearance.

Use of thin alumina breastplates, 3.0 – 4.5 mm, together with special rigid fibre composites as backing material, result in very lightweight body armour composite systems with a weight advantage of up to 30 % when compared to conventional ceramic composite systems.

Ceramic Armour Protection Materials

(Published data are typical values)

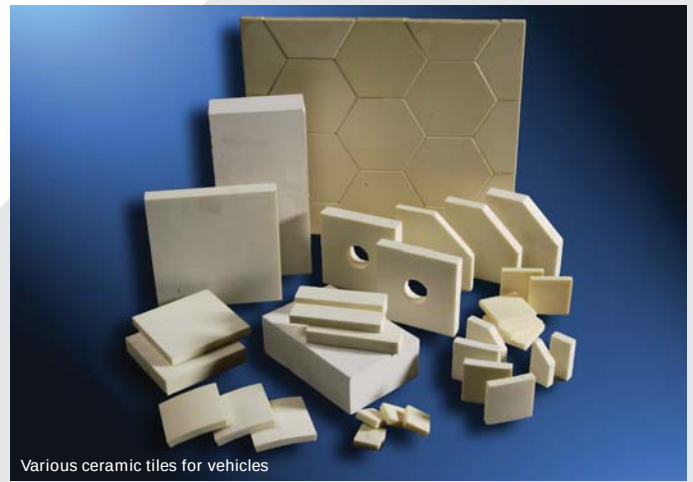
	MP92	MP96	MP99
Al ₂ O ₃ content	92	96	99,7
Density (g/cm ³)	3,62	3,78	3,90
Porosity (%)	0	0	0
Modules of Rupture (MPa)	280	320	340
Modules of Elasticity (GPa)	295	330	340
Fracture toughness (MNm ^{-3/2})	3,0	3,5	3,9
Vickers hardness (N/mm ²) HV ₅	1023	1277	1651
Sound velocity (m/s)	9900	10220	10680



... AND VEHICLE PROTECTION ...

Ceramic tiles can also be used in the form of panel assemblies for armour protection systems for vehicles, tanks, fixed-wing aircrafts, helicopters and other military or security vehicles.

- Light armour systems for calibres from 5.54 up to 7.62 mm (ball or armour piercing bullets).
- Medium armour systems for 12.7 up to 35 mm ammunition
- Heavy armour systems for large calibre anti-tank projectiles.
- Other protection systems against artillery, mortar and grenade fragments, land mines or even shaped charges.



Various ceramic tiles for vehicles



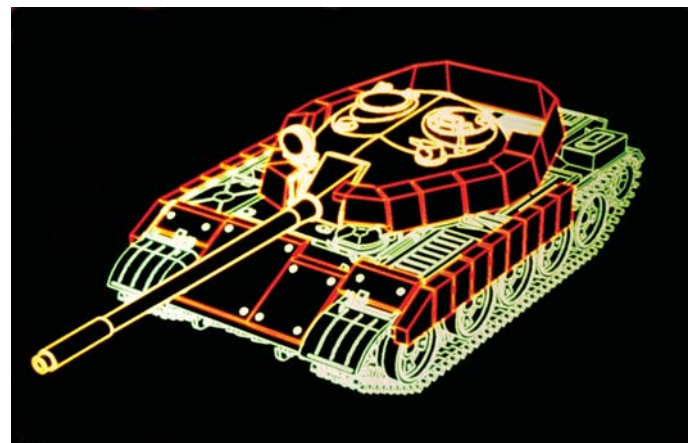
Vehicle ceramic add on panels



Helicopter chair protection with ceramic fibre composite

ADVANTAGES ARE:

- Panel design according to customer requirements
- 50 x 50 mm, 100 x 100 mm or bigger tile sizes and specially pre-cut tiles.
- Specifically placed holes in the ceramic panels
- Joint gaps of less than 0.3 mm between the tiles minimise weak points with regard to the ballistic strength of the whole composite system.

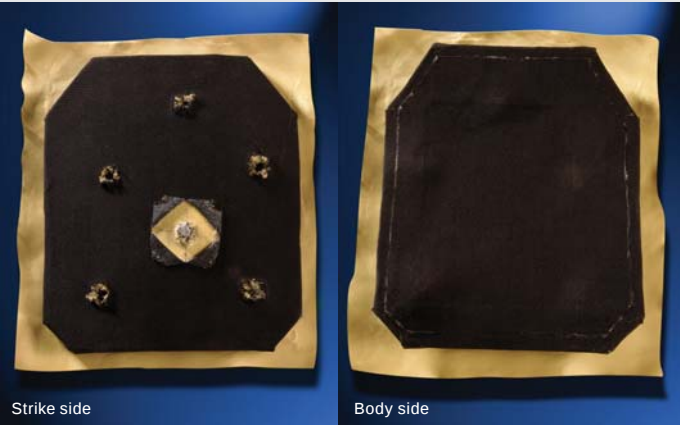


... AN ISO 9001:2000 MANUFACTURING AND DESIGN PROCESS ...

MOH-9 Armour Ceramics utilises a special selection of alumina based ceramic materials with alumina contents varying from 92 up to 99.7 %. This ensures the best solution for ballistic protection in terms of level, minimum weight and cost requirements.

To ensure its products conform to the highest quality standards, MOH-9 performs stringent quality control tests throughout the manufacturing process, final inspection and ballistic tests in accordance with local and international requirements. Only absolute control over raw material selection, production process and final quality inspection guarantee a bulk density of close to 100 % of the theoretical density, crack and pore free components with tight dimensional tolerances and flat and parallel surfaces. These are critical requirements to achieve the optimum repeatable ballistic performance of alumina oxide tiles in various applications.

Ballistic Insert Test 6 shots 7.61x51mm NATO Ball



... WITH PROVEN EXCELLENT BALLISTIC PERFORMANCE.

In conjunction with South African companies MOH-9 Armour Ceramics has access to various ballistic test facilities including a modern ballistic proof tunnel with proof calibres up to 40 mm, various blast and long distance test ranges, as well as ultra high-speed photography, flash X-ray and crater bottom velocity analysis facilities, to ensure the performance of alumina based composites up to heavy armour protection systems.

Ballistic tests are performed according to local and international standards such as the American NIJ Standard or the European CEN Standard and any other customer specific test requirements.

NIJ Standard - 0101.04 Ballistic Resistance of Personal Body Armour				
Threat Class	Test Bullet	Bullet Weight (g)	Bullet Velocity ± 9.14 (m/s)	Max Backface Deformation (mm)
I	.22 Calibre LRLRN	2.6	329	44
	.38 ACR FMJRN	6.2	322	44
IIA	9mm FMJ RN	8.0	341	44
	40 S&W FMJ	11.7	322	44
II	9mm FMJ RN	8.0	367	44
	.357 Mag JSP	10.2	436	44
IIIA	9mm FMJ RN	8.2	436	44
	44 Mag JHP	15.6	436	44
III	7.62mm NATO FMJ	9.6	838	44
	.30 Calibre M2 AP	10.8	869	44

Comments:
FMJ: Full Metal Jacketed
RN: Round Nose
JHP: Jacketed Hollow Point
JSP: Jacketed Soft Point
AP: Armour Piercing
LRLRN: Long Rifle Lead Round Nose

CEN - Bullet Resistance, prEN ISO 14876-2					
Performance Level	Ammunition	Bullet Mass (g)	Bullet Velocity (m/s)	Max Backface Deformation (mm)	Description of Level for Users
I	9x19mm, FMSJ	8.0	360 $\pm$ 10	44	Widely Used Concealed Handguns
2	9x19mm, FMSJ	8.0	415 $\pm$ 10	44	Widely used Submachine Guns
3	9x19mm, FMSJ .357 Magnum FMJ	8.0 10.2	425 $\pm$ 10 430 $\pm$ 10	44 44	Exceptional Handguns
4	5.56x45mm, M193 7.62x51mm, NATO Ball	3.6 9.4	970 $\pm$ 15 830 $\pm$ 15	44 44	Widely Used Normal Rifle Ammunition
5	7.62x51mm AP Hardened Steel Core	9.7	820 $\pm$ 15	44	Widely Used Armour Piercing Rifle Ammunition
S	12/70 gauge Brenneke Solid Lead Slug	32	425 $\pm$ 25	44	Shotguns Slugs, and Point-blank Shot Strike

Comments:
FMSJ: Full Metal Steel Jacketed
AP: Armour Piercing



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