Military technology is constantly changing, and the defense industry is consistently challenged to provide solutions that better protect our military servicemen and women. Surprising as it may be to some, transparent armor plays a significant role in a multitude of defense platforms, including high performance glass and glass-ceramic materials for applications such as vehicle and body armor.

SCHOTT Defense has been helping the U.S. military to improve the reliability and effectiveness of its equipment for over 40 years. During this time, the company has helped to transform protective solutions for today's warfighter, most recently with the DiamondView transparent armor system, a state-of-the-art glass ceramic transparent armor solution for military vehicles.

M-ATV

Recent DoD contracts for MRAP All-Terrain Vehicles (M-ATV's) highlight the challenges that companies in the defense sector face in supplying an increasingly sophisticated breed of military vehicles to meet a very complex set of specifications. These trucks are designed to function all over the world in extremely rugged terrain, while protecting vehicle occupants against IED explosions and ballistic attack.

DoD's contract called for M-ATV's designed to maneuver easily in rugged and rocky terrain. The Marine Corp needed them to be lightweight for greater transportability and to help prevent rollovers. Creating lightweight transparent armor that was strong enough to provide excellent protection yet also able to withstand extreme environmental conditions was no easy task. SCHOTT's glass-ceramic and borosilicate float offered a solution. Not only is it significantly lighter than traditional soda lime float glass windows, it offers strength that military vehicle armor requires for the utmost in security and transparency.

See-through Protection

Traditional transparent armor systems use laminated glass layers with a polymer backing to stop ballistic projectiles, often consisting of armor-piercing (AP) threats with a soft outer jacket and a hard armor-piercing core. Traditional glass-only systems can be thick and heavy due to the amount of glass needed to stop high-powered projectiles. In glass systems, where the thickness of individual glass layers ranges from 4-12 mm, the glass needs to absorb the energy from the projectile and slow down the armor-piercing core enough for subsequent glass or backing layers to catch the core. Further, when used in harsh environments (including sand and chemicals), traditional designs tend to exhibit a loss in clarity.

To combat these problems, SCHOTT developed a ceramic glass technology, called ZERODUR®, which offers a transparent armor solution in a zero expansion glass ceramic. An inorganic, non-porous glass ceramic, ZERODUR® provides a balance of glass and crystal phases with little to no thermal expansion. As the crystalline and glass

phases have chemical characteristics and hardness similar to those of optical glass, ZERODUR® glass ceramic can be processed using the same machines and tools as optical and technical glass. The composition, structure, and stability of polycrystalline materials with a low thermal expansion can be manufactured by utilizing normal production processes together with controlled crystallization. Thus glass ceramics with thermal coefficients of extremely low expansion can be obtained.

Surveying the Situation

Transparent armor is certainly not the only area where high-tech glass components play a significant role in safety. Specialized glass materials can be found in many other technologies that soldiers use to stay protected, including surveillance equipment. The key challenge for surveillance systems is to provide a wider viewing range and higher resolution without making them too heavy or causing eye strain.

SCHOTT has made significant advancements in surveillance technologies through the introduction of a fiber optics image combiner. Used in helmet-mounted display systems (HMDs), this module is not only smaller and lighter than its predecessors, but also has the capability to capture multiple images and compile them into one panoramic view, allowing users to survey their surroundings with a wider scope. By customizing the size and format of these fiber optic image combiners, the components are more flexible for a variety of HMD systems.

"Own the Night"

Also recently introduced is SCHOTT's second component to a full night vision system, which addresses filtering that allows soldiers to examine their surroundings while staying concealed in the darkness. Head-up infrared night vision systems enable drivers to see as far as 150 m ahead of them without blinding oncoming drivers. Emitted infrared beams are reflected back towards an infrared camera, which then electronically transmits the images to a head-up display available to the driver. A night vision filter is used in these systems to block the visible light that is emitted by a halogen lamp, so that only the infrared spectrum can pass.

Night vision infrared systems (NVIS) are passive systems, typically helmet-mounted binocular image intensification devices that have a very high sensitivity to radiation in the approximate region of 600nm to 930nm (orange to near infrared). NVIS work by converting photons from the outside night scene onto a micro-displayed visible image, and have the capability to amplify the nighttime scene approximately 2000 times. To protect the image intensifier assembly, these systems are equipped with an automatic gain control (AGC) which will aperture down the NVIS when exposed to bright lights. If displays or light sources in vehicle cabins are not properly filtered, the AGC will activate and NVIS will become proportionally less sensitive to nighttime objects.

Testing

SCHOTT also invests heavily in new product development, and has established relationships with national laboratories to test the capability of transparent armor and component products. One of these primary test areas is with high tech defense materials developed using advanced laser glass and packaging for highly sensitive electronics. Some of these innovative product areas include satellite systems, radar control systems, and underwater detection systems.