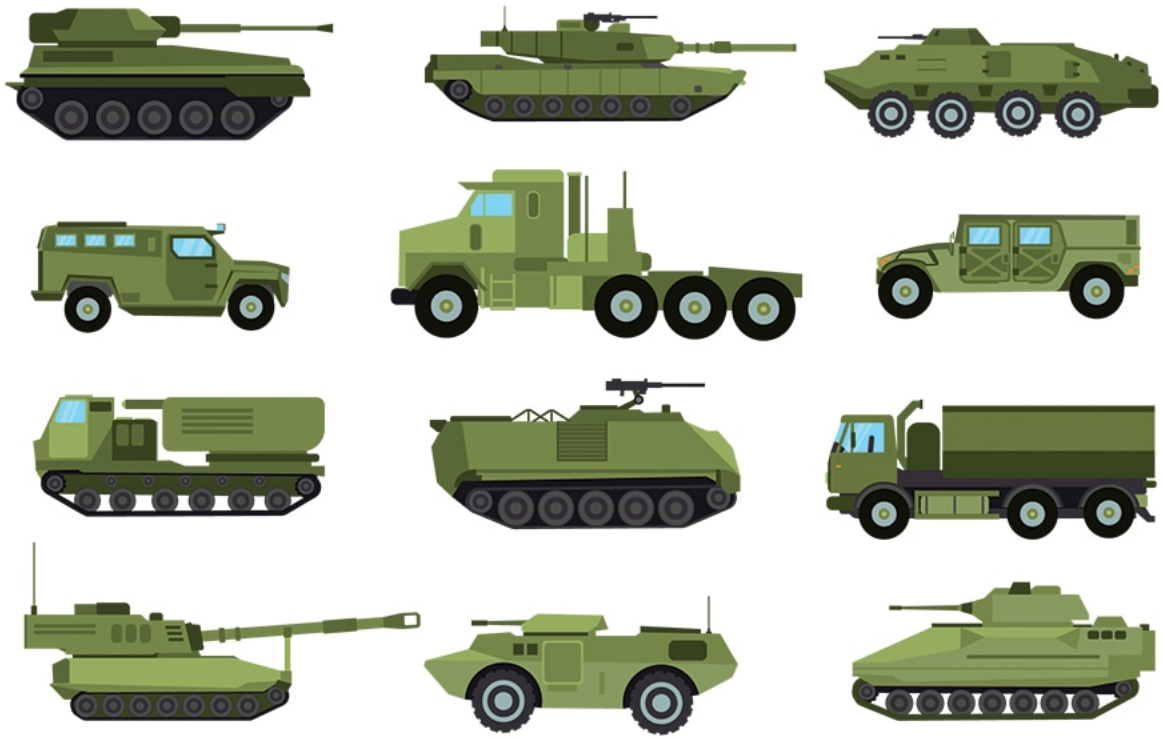
Technical Ceramics for Military Purposes

By Benedette Cuffari Feb 2 2018

Technical ceramics exhibit a number of useful properties that make them the most common application for armor systems within the military and defense industry. These properties include: having a relatively low weight, high-performance during ballistic-scale impacts, an ability to withstand extremely high temperatures, low friction and resistance to wear, corrosion and hardness.

Some of the ceramic materials that have been the most useful for military armor applications include Al_2O_3 (alumina), B_4C (boron carbide) and SiC (silicon carbide), as well as a number of ceramic matrix composites (CMCs), such as Al_2O_3/ZrO_2 systems[1]. Of these materials, alumina is the most commonly utilized technical ceramic for body armor, as it exhibits hardness, refractoriness and modulus of elasticity at a much lower cost when compared to other commercially available technical ceramics.



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Body Armor

When used as ballistic body armor, the numerous and versatile properties of ceramics allow for the speed of bullets to be reduced and ultimately transform the bullets into small fragments. Military personal protective equipment composed of technical ceramics has

already been applied to special operations forces that require body, side and shoulder armor. Advanced protective equipment for other vulnerable areas of the body such as the hips, legs and arms are currently under development.

Vehicle Armor

For vehicle purposes, ceramic armors can be incorporated into the panels for military fighting vehicles and turrets, warships, helicopters and armored vehicles. Additionally, companies like Morgan Advanced Materials offer ceramics armor for high-security garages and warehouse doors, as well as for shields that are used to protect security cameras and other communication equipment.

Ceramics in Aircrafts

In addition to utilizing engineered technical ceramics for the outer protection of aircrafts in the form of panels, the resistance of these ceramics to high temperatures, vibration and other extreme mechanical conditions are useful for aerospace-grade electronic substrates, as well as lighting, antenna and sensor components.

Specifically, within the military aircraft sector, CMCs have shown to be a clear advantage over previously used metal components used in aircraft engines. CMCs are typically lighter than other metals by 30-50% and are capable of handling much higher operating temperatures, measuring above 1100 °C, which can improve fuel economy and efficiency in larger aircraft engines.

Ballistic Transparent Ceramics

For a material to be transparent, light must be able to transmit light through it without any significant absorption or loss in reflection occurring. As the continued research and development in the field of technical ceramics has allowed transparent ceramics to become commercially available in sizes of up to 900 cm2, military personnel are interested in the incorporation of this material into windows for laser-based communications. Defense laser systems that require protection from the field and high transmittance to ensure that light does not obstruct the transmitted image could especially benefit from transparent ceramics. The ballistic and high-performance mechanical properties of ceramics are also particularly useful for application in the windows and windshields of military vehicles.

Some other defense and commercial applications of transparent ceramics within the

military sector include:

- Aircraft
- Missle domes
- Transparent armors
- IR windows
- Hyper-hemispherical domes
- Laser windows
- Military aircraft lenses
- Semiconductor processing applications
- Scanner windows[2]

References:

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