

Project Title: Development of Lightweight, Ultra-Strong Transparent Glass-Ceramic Material and Fabrication of Laminated Armor Panels Thereof for Armoured Vehicles, Combat Aircraft to Reduce the Areal Density

Task of CSIR-SERC: *Numerical simulation on ballistic performances of proposed armor panels towards development of design procedure*

Duration: April 2024-March 2026

Deliverables: To design a lightweight glass ceramic transparent target layering configuration to defeat the 7.62 projectile.

Significant Achievements:

The project successfully achieved the development of an indigenous process technology for synthesizing transparent, nanocrystalline Magnesium Aluminate Spinel (MAS) and Lithium Aluminosilicate (LAS) glass-ceramic blocks of size $200 \times 200 \times 10 \text{ mm}^3$, demonstrating superior strength and optical clarity. Using this breakthrough, multi-layered transparent armor panels were designed and fabricated with optimized configurations to reduce areal density while meeting stringent ballistic performance requirements. A total of 10 transparent armour panels of size $200 \times 200 \text{ mm}^2$ were delivered, each achieving an areal density in the range of $90 - 100 \text{ kg/m}^2$ and validated against NIJ Threat Level III (Rifle) specifications. These achievements mark a significant advancement in lightweight transparent protective systems, enabling reduced weight without compromising safety, and establishing a scalable technology platform that strengthens national self-reliance in defense materials and opens pathways for future applications in aerospace and critical infrastructure. Following may be considered as significant achievements:

- A suitable constitutive model for projectile and glass materials have been identified and considered in numerical simulations.
- Based on the inputs received from CGCRI the transparent target layering configuration is obtained to defeat the 7.62 projectile and achieving an areal density in the range of $90 - 100 \text{ kg/m}^2$
- A suitable layered target configuration for lightweight transparent armor panel was obtained to defeat NIJ level III impact. However, it needs to be validated through experiments.

Team:

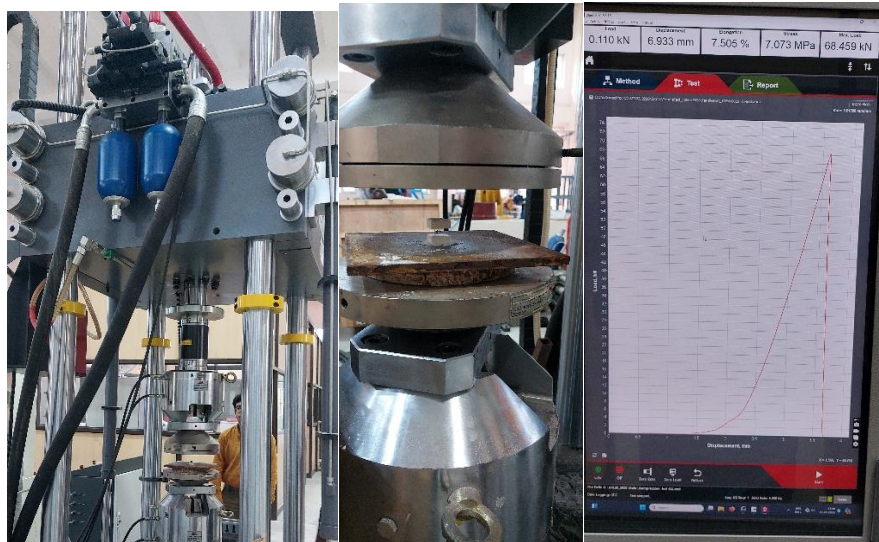
Dr. Amar Prakash (PI)

Dr. J. Venkatesan (Co-PI)

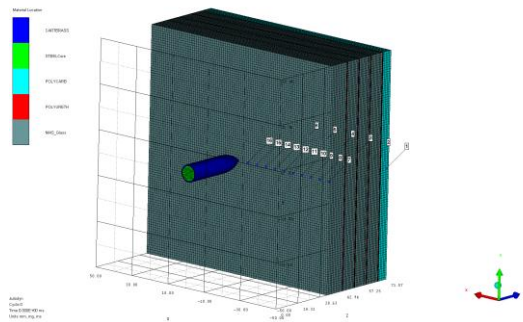
Shri. Kanishka Bhattacharya

(Collaborative Teams: CSIR-CGCRI (Nodal) and CSIR-NCL Pune)

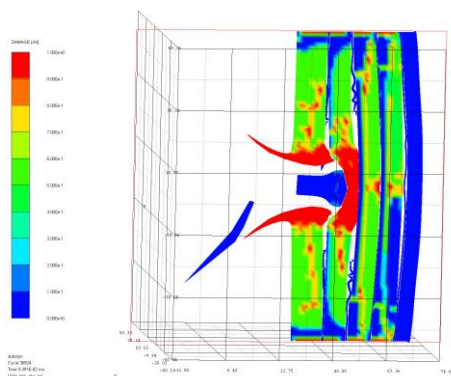
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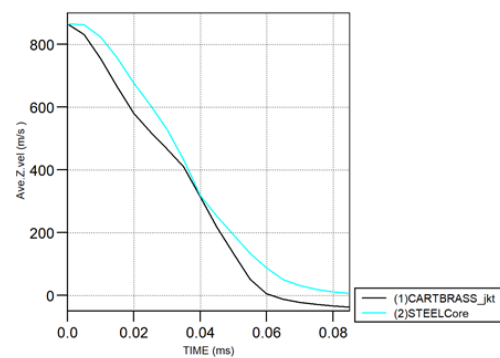
Uniaxial Compression test on ceramic specimens with UTM



Multilayer layered MAS target with Polyurethane (bond) layer and Polycarbonate (backing) layer-Geometry model



Target Damage Contours



Projectile Velocity History

Numerical responses of ballistic impact on transparent armour Panels