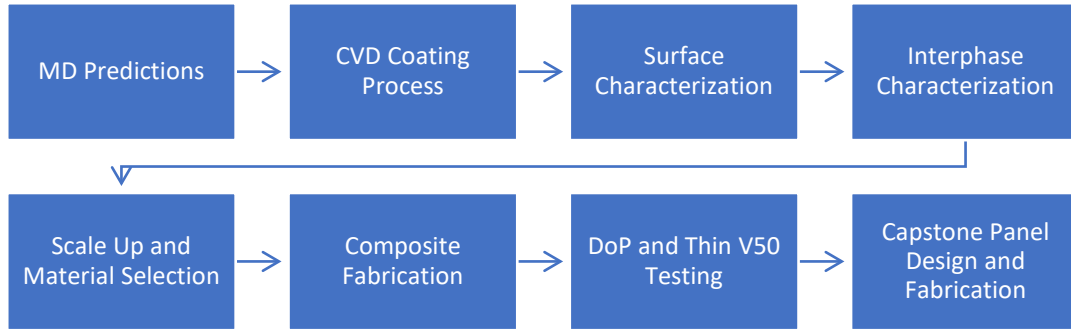
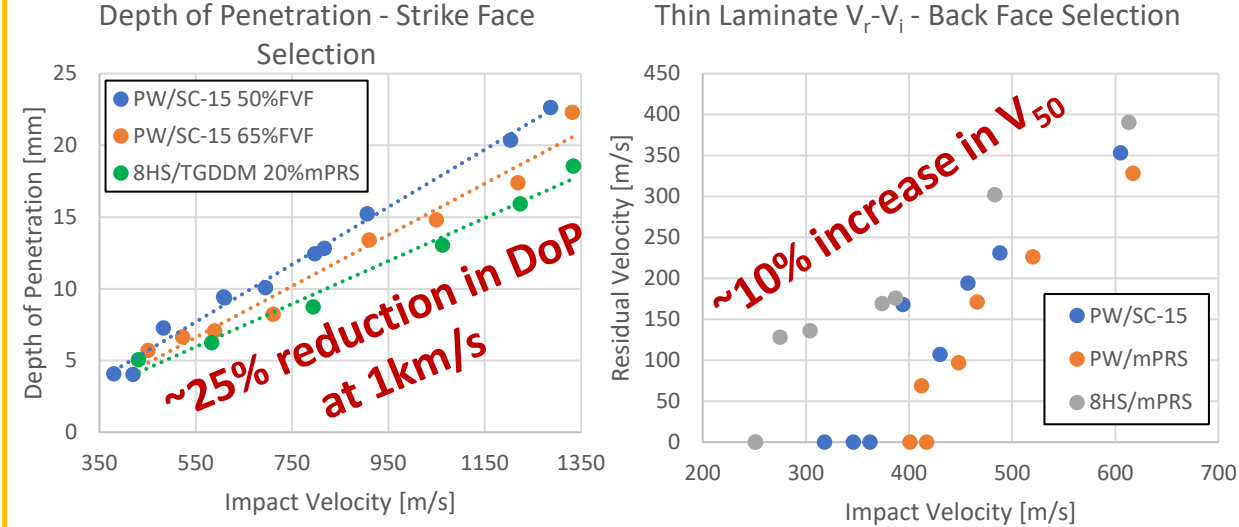


Key Goals and Technical Approach

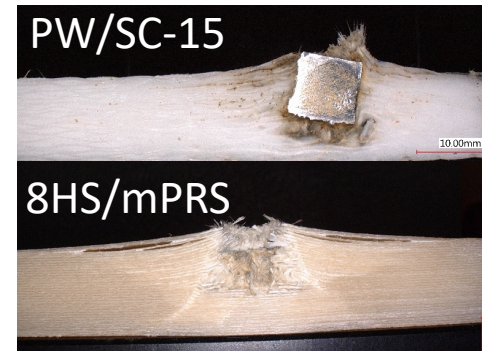
- Large database of new resin/interface combinations has been developed for material design and optimization with IFSS varying by 50-115 MPa, resin yield from 61-164 MPa, and resin energy absorption 70-120 J/cc
- Design a functionally graded composite from the materials properties to improve ballistic performance



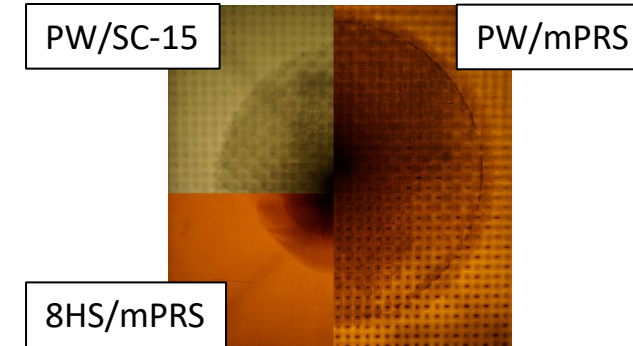
Major Results, Key Accomplishments



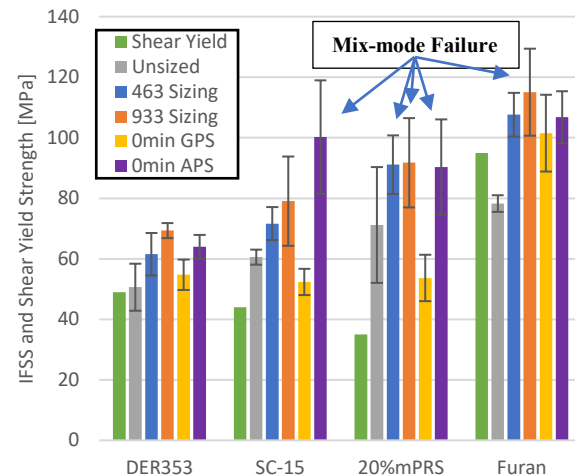
Materials by design by selecting IFSS/Resin/Architecture can vary the V50 from 250-400 m/s and extend delamination from 3" to over 6" in thin laminates

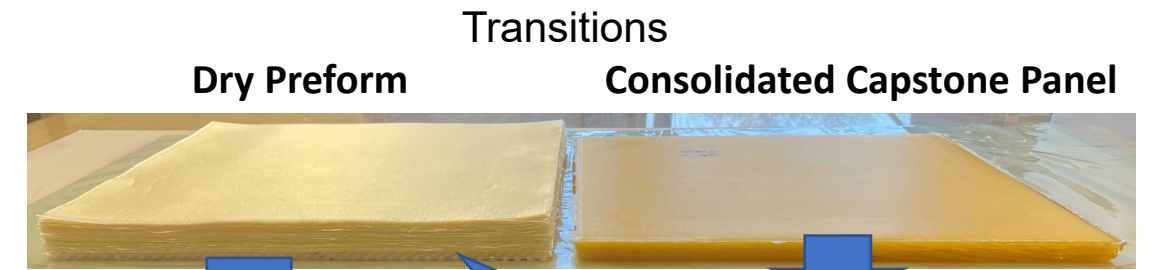


Sectioned DoP Samples



1/4" V₅₀ Sample Delamination



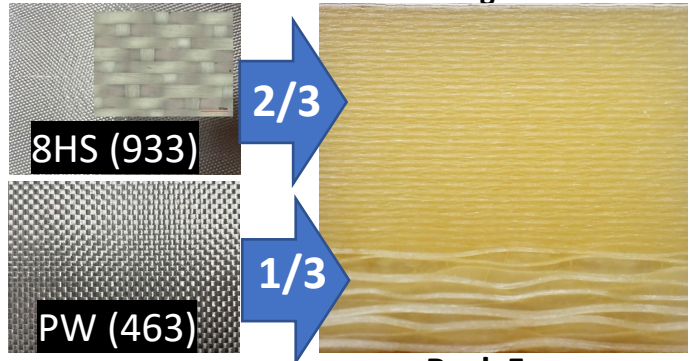


Capstone Panel Fabrication



Areal Density	Thickness
36 kg/m ² (7.4 lb/ft ²)	18 mm (0.7 in)

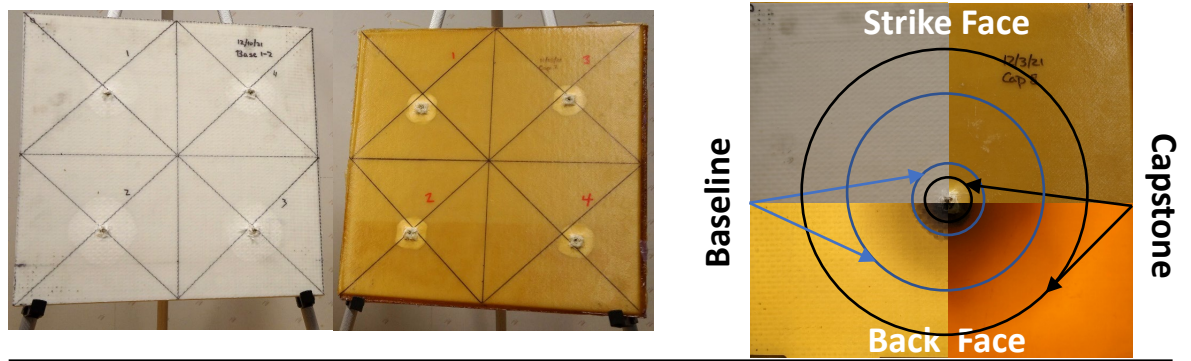
FGM Capstone Microstructure
Strike Face
 High FVF, IFSS, & Resin Toughness



Back Face
 High FVF & Resin Toughness, Low IFSS

- Fiber/matrix Interface Database
- Test methodology for IFSS
- CVD Silane Deposition Process and process to scale
- Capstone Panel Design and Fabrication Methodology
- Conference Proceedings
 - Kubota, M., Deitzel, J. M., & Gillespie Jr, J. W. Role of Surface Functionality and Polyamic Acid in Carbon Fiber/PEI Interface.
 - Kubota, M., Chowdhury, S., Deitzel, J. M., Gillespie Jr, J. W., Palmese, G. R. (2020). Tailoring the S-2 Glass/Epoxy Interface Properties Through Chemical Vapor Deposition of Silane Adhesion Promoters. In *Proceedings of the American Society for Composites—Thirty-fifth Technical Conference*.

Functionally Graded Capstone Design Shows Superior Ballistic Performance



Capstone panel has smaller strike face delamination; higher penetration resistance on the front while increased energy absorption/inplane tension properties on the back

- **Equivalent Areal Density:**
 - **Capstone V₅₀: 1108 m/s** vs PW/SC-15 Baseline V₅₀: 957 m/s
 - **Capstone design absorbs 34% more energy** than baseline
- **Equivalent level of protection as baseline**
 - **Capstone design can be made 23% thinner/14% lighter**

