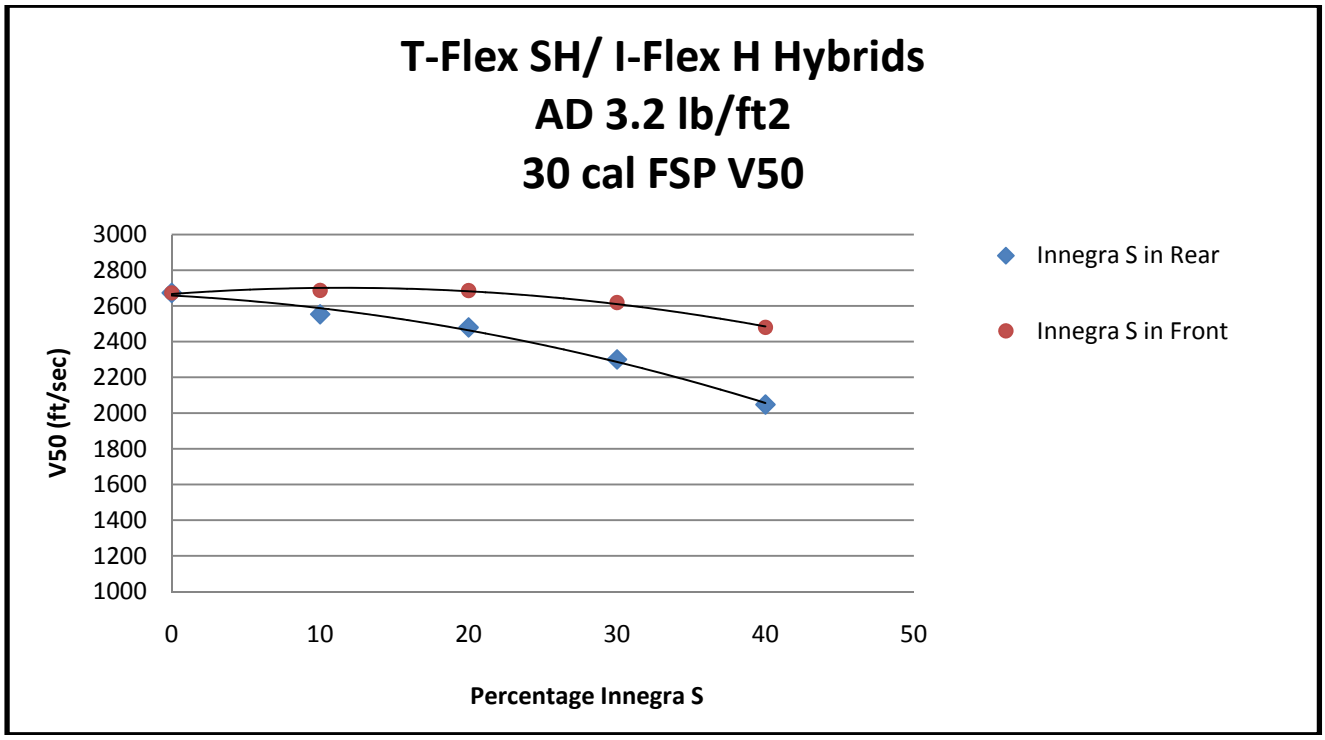
Cross Ply Unidirectional Innegra S/ Aramid Hybrid Semi-rigid armor

ABSTRACT: Innegra S high modulus polypropylene (HMPP) fibers were converted into 0, 90°cross ply unidirectional fabric. This fabric, along with an aramid fabric of similar construction were hybridized into semi-rigid panels containing 10, 20, 30 and 40% Innegra S by weight. These panels were tested for ballistic V_{50} performance against a 30 caliber Fragment Simulation Projectile

Method:

To test performance of Innegra fiber configured as a unidirectional material, we worked with Tech Fiber to make a 0, 90° unidirectional fabric. This 5.75 oz/yd^2 fabric utilized 940d 75 filament Innegra S fiber and a proprietary polyethylene based resin to stabilize the fabric. This fabric was combined with Tech Fiber's T-Flex SH fabric, also a 5.75 oz/yd2 0, 90° unidirectional material with polyethylene binder, to create semi-rigid armor panels. Both fabrics were cut into 15" x 15" plies then compiled into ballistic panels all with an areal density of 3.2lb/ft^2. Panel variants contained differing amounts of Innegra S ranging from 10-40% by weight. One set of panels were tested with the Innegra S plies in front and while the second set was tested with aramid in the front. This was done to test the best placement of Innegra S. Panels were consolidated at 290°F and 150 psi for a 45 minute dwell. Ballistic testing was conducted at United States Test Laboratory[1] according to Mil-Std-662F.

Results:



[1] United States Testing Laboratory, 7447 W 33rd St N, Wichita, KS 67205, (316) 832-1600.

	Innegra Placement		
% Innegra S	Back	Front	ΔV_{50}
	(ft/sec)	(ft/sec)	(ft/sec)
0	2673	2673	
10	2553	2687	134
20	2479	2686	207
30	2300	2619	319
40	2047	2480	433

Discussion

These panels were designed to have a V_{50} of 2700 ft/sec against the 30 cal FSP projectile. For a 100% aramid (T-Flex SH) package, this could be achieved with a 3.2 lb/ft^2 panel, so hybrid panels were made at this areal density and performance was judged by the amount of aramid that could be replaced while maintaining a V_{50} the same as or close to the aramid control panel.

These data clearly show that Innegra S fiber performs better on the strike face of the ballistic panel. Panels oriented with the aramid on the strike face show an immediate decay from our targeted 2700 ft/sec V_{50}, while the panels with Innegra S on the strike face exhibit similar performance to the aramid control panel up to 20% addition. The slow rate of decay would suggest that performance may be optimized between 20-30% by weight addition of Innegra S. These panels were consolidated at 150 psi. We expect better performance with higher pressure consolidation such as 500-1000 psi. This optimization work will be conducted in the near future.