OPTIMIZING THE FIBER-MATRIX INTERPHASE FOR CONTROLLED ENERGY ABSORPTION AND STRENGTH

D. Kissounko, J. W. Gillespie, J. Deitzel, A. Abu-Obaid, D. Pappas (ARL), R. Jensen (ARL)

University of Delaware . Center for Composite Materials . Army Research Laboratory, Abredeen, MD

MOTIVATION AND OBJECTIVES

Mechanical performance of fiber reinforced composite can be tailored by varying the interphase between fiber and resin

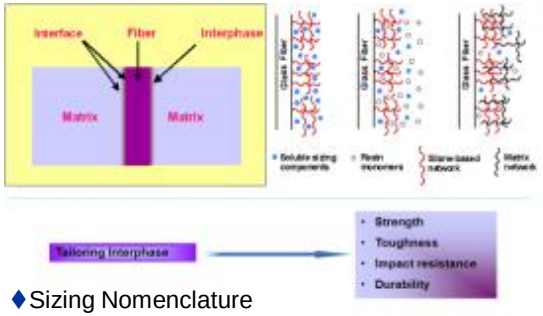
Two targets: higher energy absorption (improvement of antiballistic impact properties) and higher fracture toughness (improvement of mechanical properties).

- There is a delicate balance between energy absorption and fracture toughness properties: strengthening the interphase leads to improved mechanical properties reducing ballistic properties at the same time.
- **Old approach**: try to control the degree of chemical bonding between fiber and resin. **New approach**: try to tailor both adhesion and texture.

Objectives

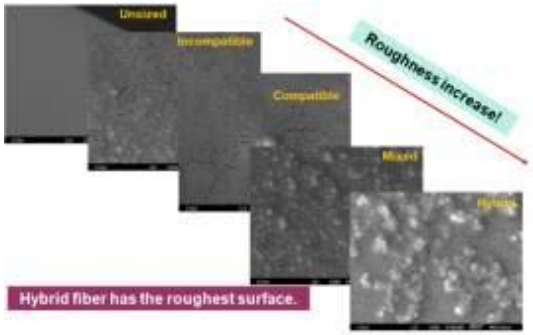
- Optimize sizing mixture composition for E-glass, Spectra and Kevlar fibers.
- Enhance multifunctionality through nanoparticle hybridization or chemical modification.

INTERPHASE IN E-GLASS FIBER/EPOXY RESIN

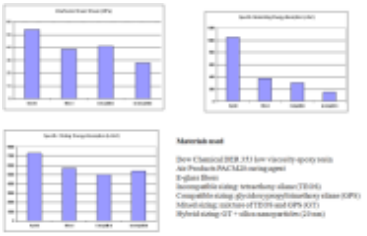


- Sizing Nomenclature
- Incompatible – non reactive with resin.
- Compatible – forms chemical bonds with resin.
- Mixed – blend of compatible and incompatible sizings.
- Hybrid – blend of mixed sizing and nanoparticles.

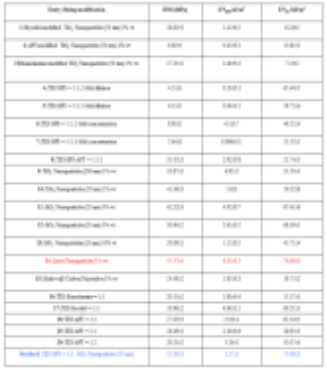
FIBER SURFACE – SEM IMAGES



PERFORMANCE OF SIZING MIXTURES FOR E-GLASS FIBERS



E-GLASS FIBER HYBRID SIZING OPTIMIZATION



SPECTRA AND KEVLAR400 FIBER SIZING OPTIMIZATION

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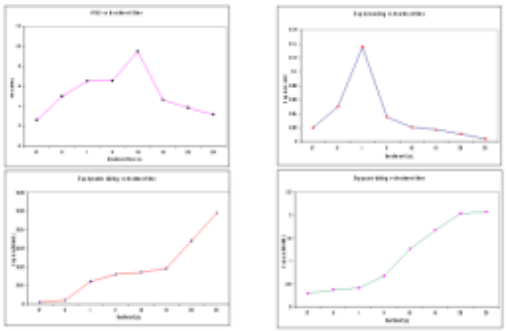
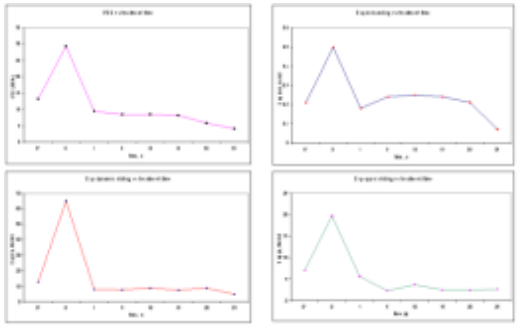
(Continued)

SPECTRA AND FIBERS SIZING OPTIMIZATION (CONTINUED)



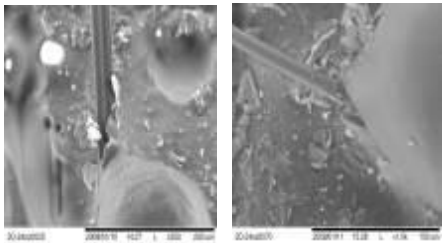
KEVLAR400 FIBER SIZING OPTIMIZATION (CONTINUED)



MECHANICAL PROPERTIES OF PLASMA TREATED SPECTRA FIBERS

	AS Received		Plasma Treated Fibers	
Property	Average	CV (%)	Average	CV (%)
Strength (g/den)	32.97±1.44	4.2	31.74±1.90	5.9
Modulus (g/den)	1406 ±41	2.9	1363 ±85	6.2
Strain at Failure (%)	3.02 ±0.31	10.2	3.35 ±0.22	6.6

FIBER FAILURE MODES – SEM IMAGES



Spectra Kevlar

CONCLUSIONS

- The combination of soft (Latex) and hard (silica) nanoparticles imbedded in hybrid polysiloxane sizing yields the best balance between IFSS and energy absorption.
- Plasma treatment followed by silica coating for Spectra fibers provides the best balance between IFSS and energy absorption. In the case of Kevlar 400 fibers the best results were obtained for silica coated fibers not subjected to a plasma treatment.
- Spectra fibers retain tensile strength properties after being exposed to a plasma treatment.

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