

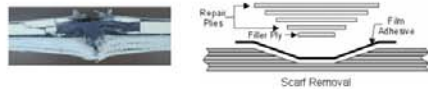
HEALING STRATEGIES FOR FIBER DAMAGE IN COMPOSITE MATERIALS

S. Patwardhan(Intern), K. Kiick, and S. Yarlagadda

University of Delaware . Center for Composite Materials . Department of Materials Science and Engineering

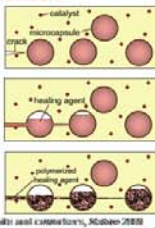
BACKGROUND

- **Damage in composite materials and structures**
⇒ Loss of performance (strength and stiffness)
- **Conventional repair schemes cumbersome**



- **Can we create self-healing composites?**

Matrix healing has been demonstrated.¹ This does not solve the problem as the composites gain their properties from reinforced fibers. Thus there is a need to explore strategies for healing fibers and is discussed herein.



APPROACH

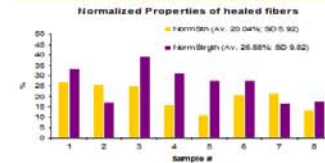
- **Use of sol-gel chemistry**²
 - For regeneration of fibrous network in the damaged area to *heal* the fibers, sol-gel chemistry will be used.
 - In order to measure recovery of strength, mechanical testing of *healed* fibers will be carried out.
- **Surface chemistry for higher kinetics**³
 - Surface modifications will be studied that will give higher rates for silica *overgrowth*.
 - The fiber surface will be characterized by XPS and SEM, silicification kinetics will be then studied and mechanical testing will be performed on surface-modified healed fibers.
- **Bioinspired / biomimetic strategies**^{4,6}
 - Further surface modifications include the use of various (bio)macromolecules derived from bioinspired strategies.

USE OF SOL-GEL CHEMISTRY

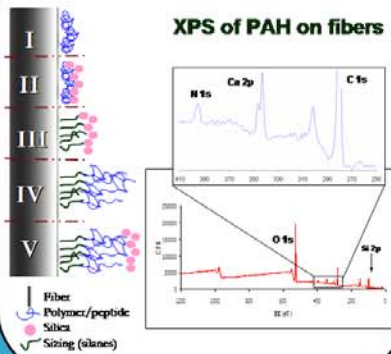
- **Silica Synthesis**^{2,7}
 - Silicic acid can be obtained by hydrolyzing alkoxy silanes, which then polymerizes to form silica (see figure).
 - This chemistry can be used to create fibrous network or *overgrowth* around damaged fibers.



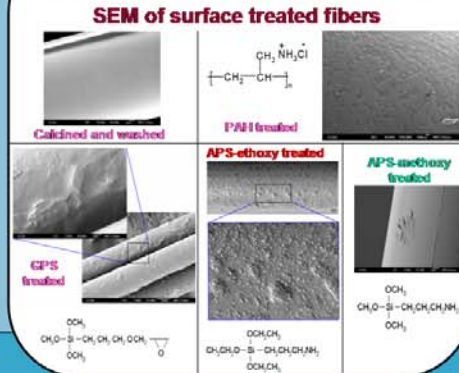
Recovery in strain -- 25% Recovery in strength -- 25%*



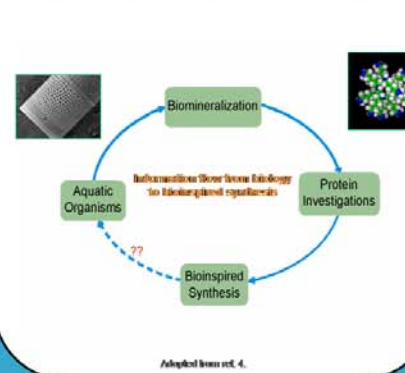
SURFACE CHEMISTRY



...Contd. SURFACE CHEMISTRY



BIO-INSPIRED SYNTHESIS



SUMMARY

- Sol-gel process can be used for healing fibers.
- *In situ* growth of silica was observed
- Mechanical Testing -- 25% strength regain
- Surface Chemistry -- XPS analysis indicates surface modifications.
- Bioinspired strategies lead to the use of (bio)macromolecules in surface modifications and silica growth.

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