Mechanochemically-Active Polymer Composites

Objective
• Design and construct composite materials that convert mechanical energy (e.g., physical damage) to useful chemical reactions

Approach
• Design mechanically-responsive compounds (mechanophores) that will respond to mechanical damage with different functionalities (e.g., color change)
• Incorporate mechanophores into polymers
• Characterize polymer-mechanophore composite’s response to damage

Technical Success
• First-ever demonstration of solid structure that senses mechanical stress and produces a visible color change
• Synthesized mechanophore that when damaged, is designed to release cyanoacrylate—the key ingredient of Super Glue®
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Application
- Concept has wide applicability across disciplines, impacting many fields in academia and for DoD
- Impacts research on self-healing materials, self-sensing materials, controlled-drug release, and tissue engineering

Potential Payoff
- Self-sensing parachute lines that can detect stress beyond a safety threshold and provide a visual indicator (e.g., color change) warning Soldier to replace lines before reuse
- Self-sensing armor that detects damage and indicates specific region of damage with color change
- Self-repairing personal or equipment armor that automatically releases chemicals to repair damage
- Wide range of mechanically-responsive composites can be designed limited mainly by designer’s imagination, such as
  - Building materials that automatically begin repair after natural disasters
  - Electronics that re-form connections after damage

One new mechanophores (SP) within an undamaged polymer is colorless, but when polymer is damaged (stretched), resulting chemical change in mechanophore (MC), produces red color shortly before failure