

Advancing Ballistic Protection for the Warfighter

Science and Technology Needs

Carolyn Westmark

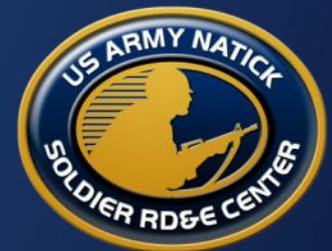
Natick Soldier Research, Development and
Engineering Center

Natick, MA 01760

(508) 233-4921

carolyn.s.westmark@us.army.mil

12 May 2011



Distribution A: Approved for public release; distribution is unlimited.

Personnel Armor Technology



Goals:
Lighter Weight
Enhanced Protection
Improved Fit and Wearer Mobility



S&T Objectives



... Develop and insert advances in materials technology to improve the protection and performance of armor systems against conventional and emerging ballistic and blast threats while minimizing penalties associated with the increased levels of protection.

... Provide tools to benefit the development, design, testing, and acquisition of personnel armor.



Next Generation Body Armor Research Focus

**Casualty Reduction
Analysis Model**

**Advanced Technology
Development**

**Human System
Integrated Design**

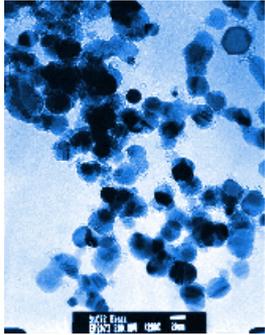
**Models for armor
system performance
from threat definition
to incapacitation
effect**

- New high performance materials and processing technologies
- Nanotechnology
- Advanced ceramics, metals, fibers
- Enhanced predictive modeling
- Material systems integration

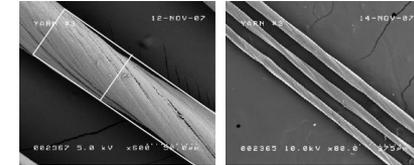
Includes :
Bio-Mechanics Modeling
Anthropometric Analysis

Materials Technology Development Areas

Advanced Materials



- Ceramics
- Fibers/Fabrics
- Composites
- Transparent Polymers
- Nanomaterials

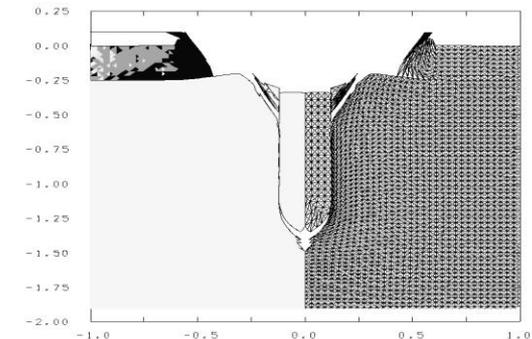


Materials Modeling

- Ceramic failure process
- Fabric/Composite behavior
- Projectile
- Multi-layered systems

Materials Systems Integration

- Architecture/Structures
- Optimize coupling effects
- Novel defeat mechanisms
- Improved processing



- Gain better understanding of the threats and consequences
 - Characterization of ballistic (small arms threats, including high rate mechanical behavior of projectiles). Influence of target properties on projectiles.
 - Characterization of projectile interaction with biomaterials (tissue/bone)
 - Characterization of threat(s) arising from blast events (Pressure, Projectiles, Thermal, Translation)
- Improve the understanding of materials failure mechanisms and behavior during impact (high or low velocity) or blast overpressure events
 - Effects of both rate and composition (target, projectile)
 - Fundamental fracture study for ceramics
 - Fundamental study of impact onto composites
- Build more accurate predictive modeling and simulation tools
 - Focused models (i.e., ceramic crack propagation)
 - Need to define model/simulation goals that are attainable and would have value to designers/integrators of armor materials/ systems

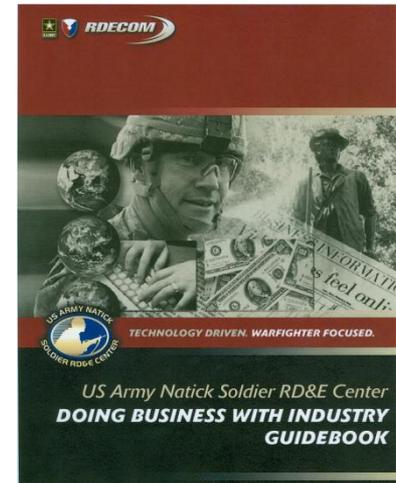
- Improve performance of ballistic and blast protection materials
 - Address the "performance gap" between theoretical and observed materials properties
 - Develop a new "class" of high performance fibers with tenacity > 60 g/d
 - Transparent armor materials performance goal is to approach opaque armor performance. Explore the fundamentals of transparency (e.g., does high strength preclude transparency in polymer materials)
 - Define effects of frequency response at high strain rate for materials of interest
 - Create innovative materials that utilize specific failure mechanisms (e.g. bond breaking, plastic collapse) to dissipate the energy transferred under blast loading
- Improve armor system ergonomics and fit, and develop weight versus protection tradeoffs for use in system designs with greater wearer mobility and comfort
- Develop appropriate/standardized materials characterization procedures, test methodologies and tools.

Potential Mechanisms for Doing Business with NSRDEC



<http://nsrdec.natick.army.mil/business/index.htm>

- **Broad Agency Announcement**
- **Cooperative Research and Development Agreement (CRADA)**
- **Memorandum of Understanding (MOU)**
- **Memorandum of Agreement (MOA)**
- **Unsolicited Proposal Program**



http://nsrdec.natick.army.mil/media/print/DoingBusiness-Guidebook_Web.pdf

- Looking for real breakthrough technology and for “out of the box” approaches with potential to make significant advancements in performance, reduced weight, and lower cost
- Finding the balance: Technical challenges ← → Tightening fiscal environment
- Enhancing the fundamental understanding of ballistic threats and defeat mechanisms → tools for cost effective development of optimized materials and designs
- Emphasis on Human Dimension
 - Focus on quantifying armor weight versus protection trade-offs
 - New approaches to improving wearer mobility through ergonomic design

Challenge: Finding cost effective solutions that balance Warfighter protection with tactical mobility and operational capabilities.



Personnel Armor

Balancing protection with operational capabilities



UNCLASSIFIED