



U.S. Army Research, Development
and Engineering Command

Protection Technologies-- Challenges and Opportunities

**2012 Science, Technology & Requirements Forum
17-18 October 2012**

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Purpose: Discuss challenges and opportunities in science, technology & manufacturing science for protection

Approach:

- Define protection from the RDECOM frame of reference
- Provide context for the roles of missions and threats
- Identify science & technology challenges & opportunities
 - Materials for protection
 - Ballistic mechanisms
 - Manufacturing sciences
- Discuss one of many success stories & its future directions
- Summary

How do we break through the paradigm of incremental advances to yield inventions & innovations?

Provide integrated research, development and engineering solutions to empower, unburden, protect and sustain the Warfighter.



Shoot



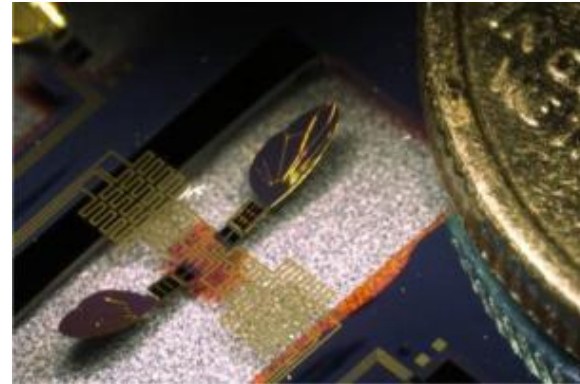
Move



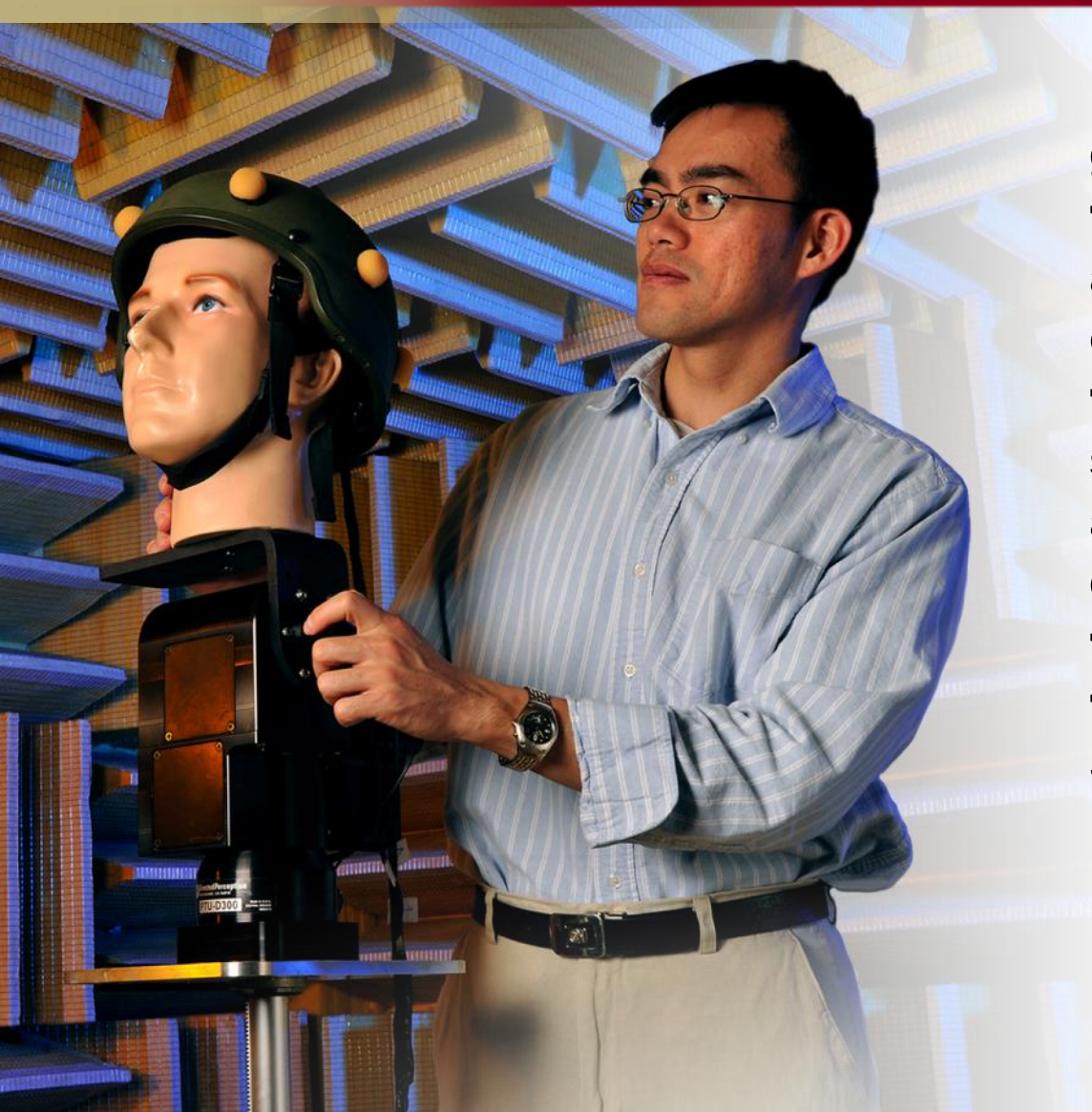
Communicate



Current



Future



RDECOM is the Army's go-to organization for the superior scientific and engineering expertise that defines the space between the state of the art and the art of the possible and delivers innovative technology solutions that ensure the United States maintains global battlefield dominance.



RDECOM Organization



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Incoming
DCG RDECOM

RFEC
Atlantic

RFEC
Pacific

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Americas



AMRDEC
Aviation &
Missile
Research,
Development &
Engineering
Center



ARDEC
Armaments
Research,
Development &
Engineering
Center



ARL
Army
Research
Laboratory



CERDEC
Communication-
Electronics
Research,
Development &
Engineering
Center



ECBC
Edgewood
Chemical
Biological
Center



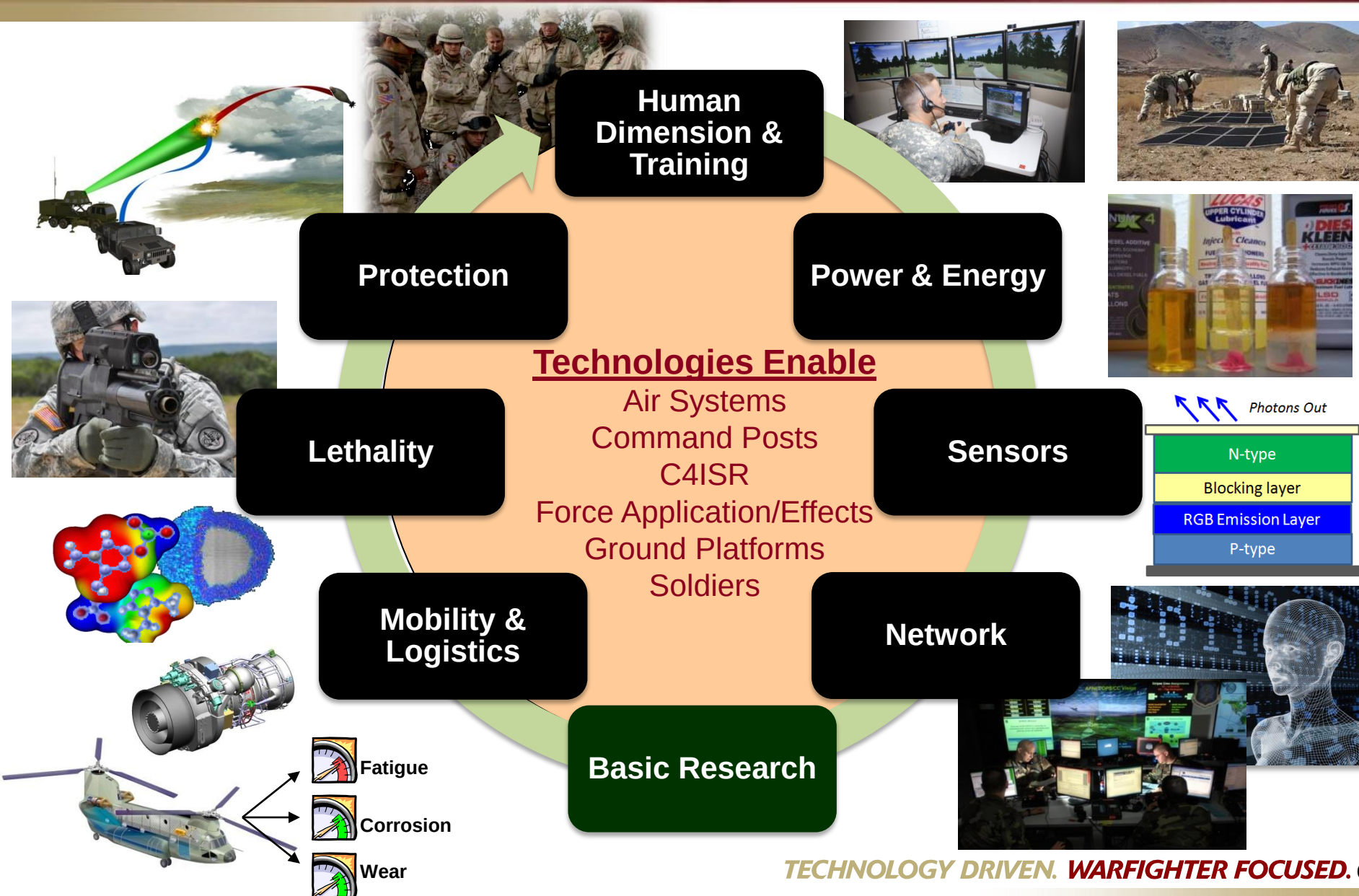
NSRDEC
Natick Soldier
Research,
Development &
Engineering
Center



TARDEC
Tank and
Automotive
Research,
Development &
Engineering
Center

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RDECOM Technology Focus Teams



Grain Boundary Microcracking!

Fundamentals of Ceramic Materials

Roof Armor

Side Armor

Skirt Armor

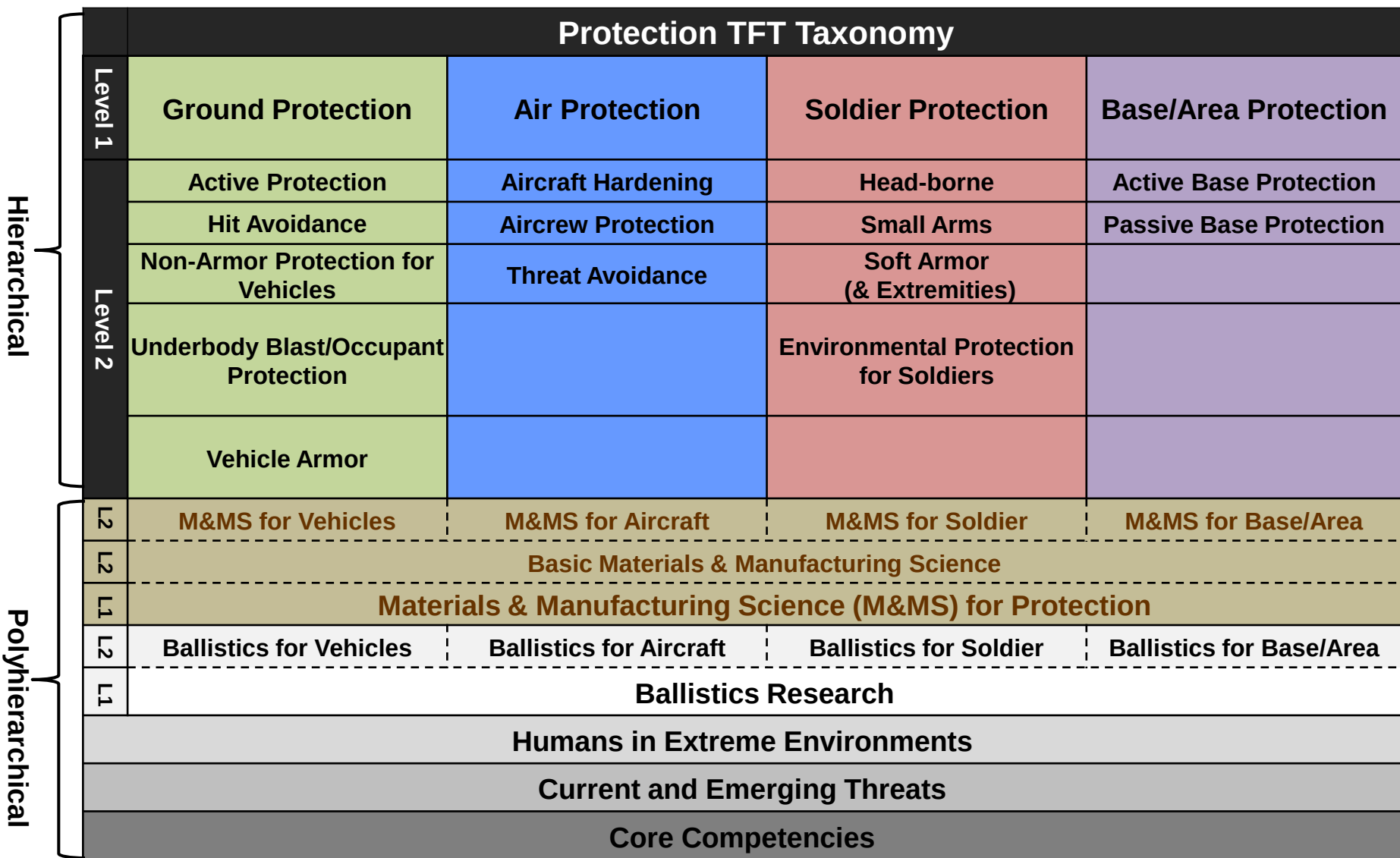
Multi-Threat Armor

Hybrid Protection

JAMES SCOTT 2011

Technologies principally focus on preventing, through physical means, acquisition and observation; avoiding contact; preventing penetration; and enabling Soldier/crew/vehicle survivability from threats.

Protection TFT Taxonomy

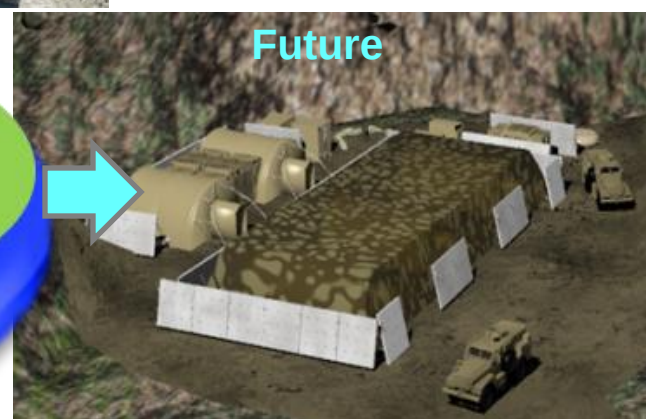


Diversity of Mission

- Within a Current Operation
- Other Operations in Other Regions
- Envisioning Future Operations



Current

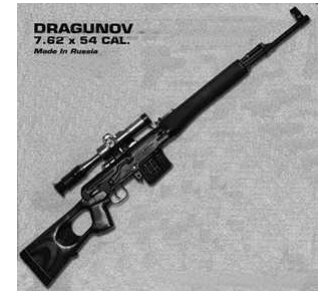


Future

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Current and Emerging Threats

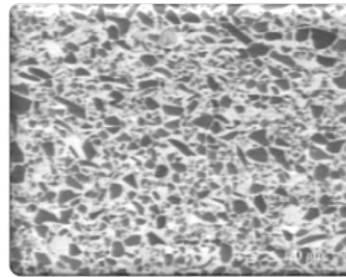
- Direct Fire
- Indirect Fire
- IEDs/mines
- Fragments
- Blast & debris
- Flame/thermal
- Non-lethal
- Chemical/Biological
- Obscurants
- Weather
- etc.



Materials breakthroughs offer opportunities for technical advances

- Lighter weight
- Advanced functionality & performance through nanoscience
- Thermal management
- Better adhesives/interfaces

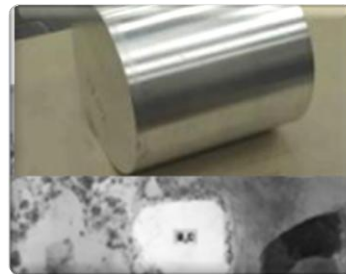
Materials are fundamental building blocks for protection systems



Novel composite development



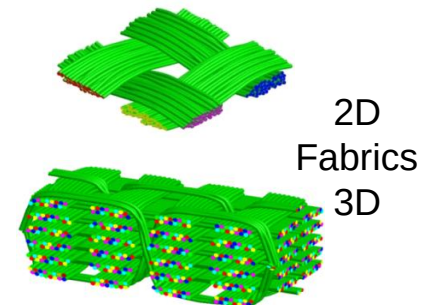
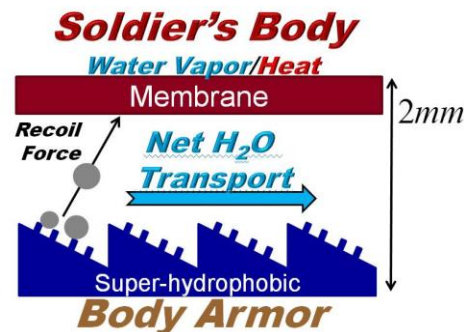
Failure and fracture ceramics



Tri-modal Al

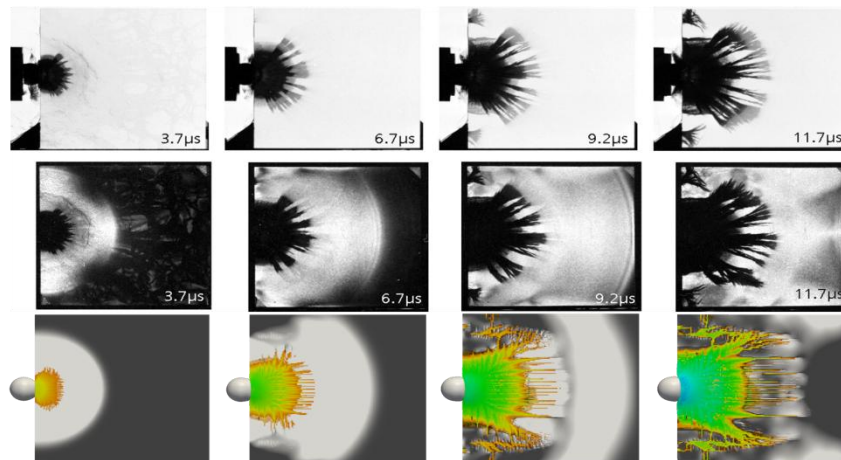
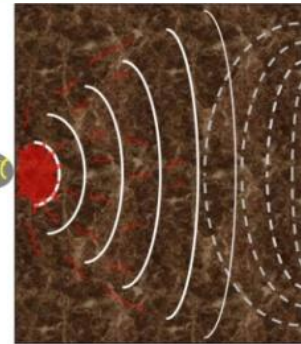
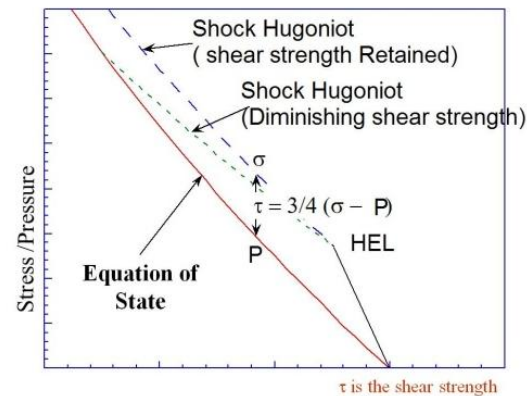


Multi-hit Improvement of Armor



Understanding terminal ballistics helps
makes materials into protective systems

- High rate behavior and failure
- Computational methods
- Shock physics and wave mechanics
- Material interfaces and damage propagation



Manufacturing science provides opportunities to achieve desired material properties and system architecture

- Virtual manufacturing
- Process modeling & improvement
- Novel manufacturing methods
- Processing of hybridized materials systems



Hot pressing furnaces with multiple heating and cooling chambers, and a central hot pressing chamber



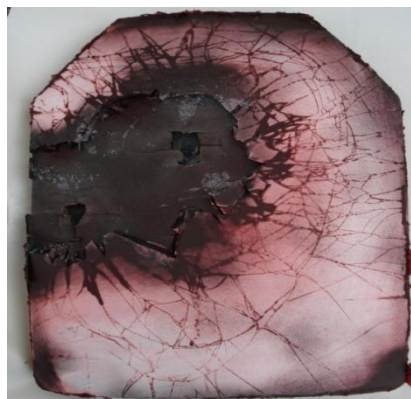
Equal Channel Angular Extrusion

PROVIDE INNOVATIVE PROTECTION TECHNOLOGIES

- **Lightweight Ballistic Protection**
 - *Ultra-lightweight and multifunctional materials*
 - *Next generation armor materials*
 - *Modeling and simulation tools for advanced threats, materials and mechanisms*
 - *Maturation and system engineering integration of technologies*
 - *Optimized multi-threat protection*
 - *Analytical tools to evaluate ballistic and high energy events*
- **Active protection technologies**
 - *Smart armors*
 - *Active protection systems*
 - *Extended area protection*
- **Soldier / Crew Protection Technologies**
 - *Vision protection*
 - *Advanced automatic energy attenuators, smart landing gear, advanced inflatable restraint system components, crashworthiness design criteria, & active energy attenuation control*
 - *Advanced structural survivability for ground platforms*
 - *Integrated Soldier protection technologies*

Innovative materials and architectures are leading to improved performance

Development of Improved Ceramic Compositions for Reduced Impact Damage



Torso Armor Plate
(baseline ceramic)

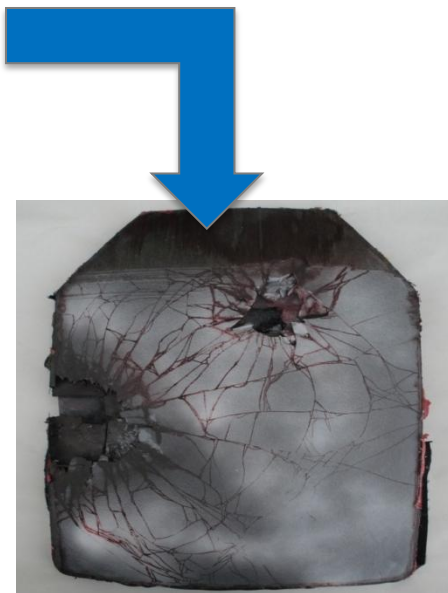
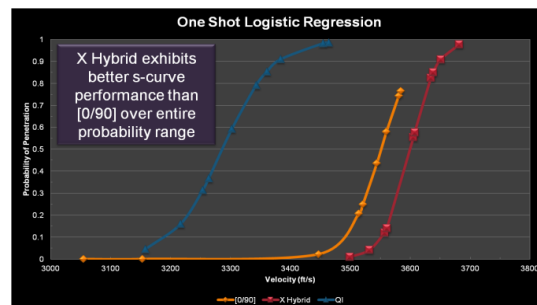


Plate with modified
material composition
and processing to
reduce cracking

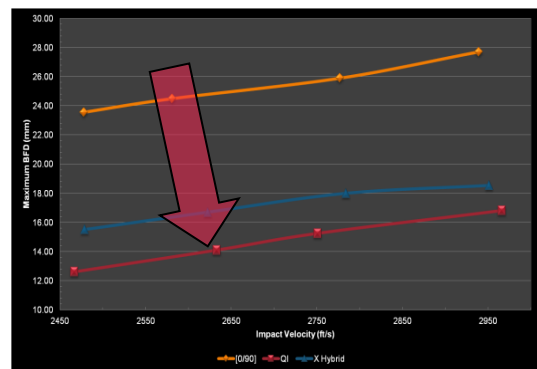
Influence of Backing Architecture on Ceramic/Composite Performance



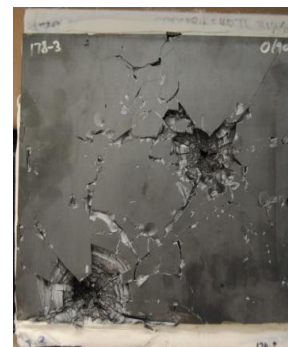
A hybrid exhibits better s-curve performance than [0/90] over entire probability range



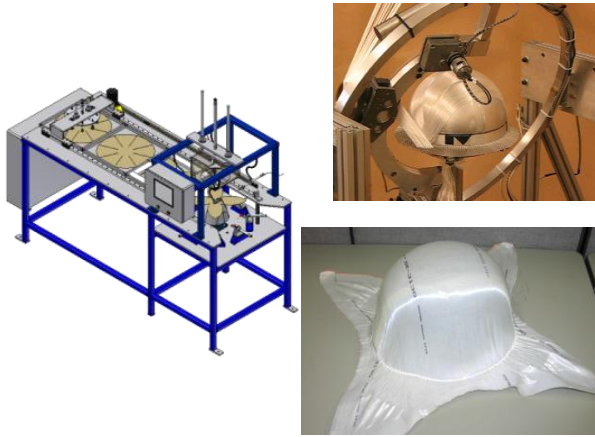
Armor package after
two-shot impact



Oriented backings lead to a lower maximum in back face deformation



Development of Helmet Process Technologies



Special Ops
FAST and Navy
SEAL Maritime
Helmet (fielded)



Marines/Army Enhanced
Combat Helmet (pending)



Development of Body Armor Process Technologies



FY15 Goal: 10% lighter ESAPI
System

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Collaborative Alliances

Partnership Methods & Opportunities

Technology Transfer

Small Business Opportunities

ARO Small Business Opportunities

Contracting

Facilities & Capabilities

Scientific Services Program

University Affiliated Research Centers

Multidisciplinary University Research Initiative

Home > Business > Partnership Methods & Opportunities

Partnership Methods & Opportunities

With the current pace of technology advancement, insular research and development (R&D) organizations will rapidly lose relevance and value. ARL has adopted business practices that have created a truly collaborative research environment between it and the private sector in select technology areas. ARL has also provided the Army access to private sector sources of research with the requisite diversity and quality. Currently, ARL outsources 80 percent of its research program to academia with over 250 academic partners in all 50 states and to industry through a mix of grants, cooperative agreements, other transactions authority, or contracts.

Click the links below to find out more on any of the following partnerships:

- ◆ [ARL's Single Investigator Program](#)
- ◆ [University Centers](#)
- ◆ [ARL's Collaborative Technology Alliances \(CTAs\)](#)
- ◆ [DoD Multi-Disciplinary University Research Initiative \(MURI\)](#)
- ◆ [Historically Black Colleges and Universities/Minority Institutions Program \(HBCU/MI\)](#)
- ◆ [Educational Partnership Agreements \(EPAs\)](#)
- ◆ [Cooperative Research and Development Agreements \(CRDA\)](#)
- ◆ [Patent License Agreements](#)
- ◆ [Small Business Innovation Research \(SBIR\) Program](#)
- ◆ [International Collaborative Activities](#)
- ◆ [Economic Development Organizations](#)

- **Official Call for Proposals (FY14 New Starts)**
 - Late October 2012 – early January 2013
 - Program executed through Army Science & Technology Organizations (RDECOM, ERDC, MRMC and SMDC)
- **Topics**
 - Materials and Components for the Soldier
 - Missile and Munitions Components
 - Communications and Electronics
 - Propulsion
 - Manufacturing Process Data Capture & Utilization
 - Power and Energy
 - Structures and Survivability
- **More information can be found at:**
 - www.armymantech.com

Advanced Mfg Technology Initiatives

Supporting Critical S&T Development

Affordable Sustainment of Current Systems

Ground Systems

- Affordable Armor Processes
- Sintered Spinel for Transparent Armor
- Advanced and Multi-Purpose Warhead
- IMX 104 Munitions Manufacturing
- Cannon Life Extension
- Guided Missile Antennas



Soldier Systems

- Lightweight Body Armor
- Chemical/Biological Resistant Fabric
- Energy Efficient Tent Liners



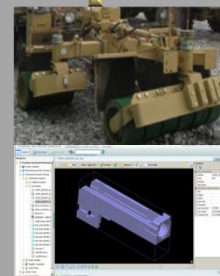
C3 Systems

- Large Affordable Substrates
- Chip Scale Atomic Clocks
- High Operating Temp FPAs
- High Definition FPAs
- Active Pixel Sensor
- Flexible Display



Enduring

- Net-Centric Model Based Engineering
- Accelerated Adaptive Fabrication Enterprise (A3FABE)
- Additive Manufacturing for Quick Tooling



Air Systems

- Advanced Ceramic Matrix Composite Machining
- Rotorcraft Blade Erosion Coating Application
- Reliable and Affordable UAV Propulsion
- Nano-composite Coatings
- Composite Structures for Aviation Systems



- Rate of technical progress will continue to slow with conventional approaches alone
- Multidisciplinary opportunities offer avenues for disruptive innovations
- Future challenge is linking disparate scientific disciplines & communities
- Collaboration is the process of bringing the contributions of all the partners together, to integrate them into a single coherent whole that is greater than the sum of our parts.





**RDECOM operates
between the state of
the art and the art
of the possible.**

