

Future Soldier Eyewear: Single- Lens System Considerations

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Soldier Vision Protection: The Current Situation



Soldier Vision Protection Elements: Ballistic, Sunglasses, Laser Protection

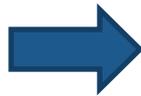
- Ballistic: Better transparent armor currently transitioning with more improvements underway
- Sunglasses: Variable transmission desired with manual and automatic control
- Laser Protection: Threat predicted for years, now it is here, though not as expected
 - Increased number of lasers available in different colors
 - Problem is mostly at night
 - Current, passive, fixed-line dyes and dielectrics darken the lens
 - Proposed frequency-agile, passive, nonlinear dyes darken the lens
 - Soldiers are not concerned enough about lasers to wear a dark lens at night
 - Dark lenses cannot function as variable transmission lenses
 - Single lens system is desired
- Laser eye protection technology must be high transmission
 - Must be appropriate for use at night
 - Must be considered as part of a single, multi-functional lens system
- An active lens format may be required in order to incorporate laser protection against a broad range of threats/hazards into a variable transmission format
- New technology should:
 - Be useful for cw, laser dazzle, flash, pulsed lasers
 - Allow for single lens system
 - Be a non focal plane format to allow for evolutionary approach to incorporation of new technology – new technologies combined with old technologies, such as dyes and dielectrics
 - Enables vision enhancement as well as vision protection
 - Allows us to redefine and expand the possibilities for a Soldier Vision System
- Bottom Line: Must be Big-Army affordable

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Technology is developed in series throughout current and future programs:
Vision protection to vision enhancement to vision networking

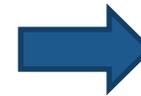
FY06-09

Vision Protection



FY10-13

Vision Enhancement



FY14-17

Vision Networking

***Soldier Integrated
Tactical Eyewear (SITE)***

***Soldier Active Vision
Enhancement (SAVE)***

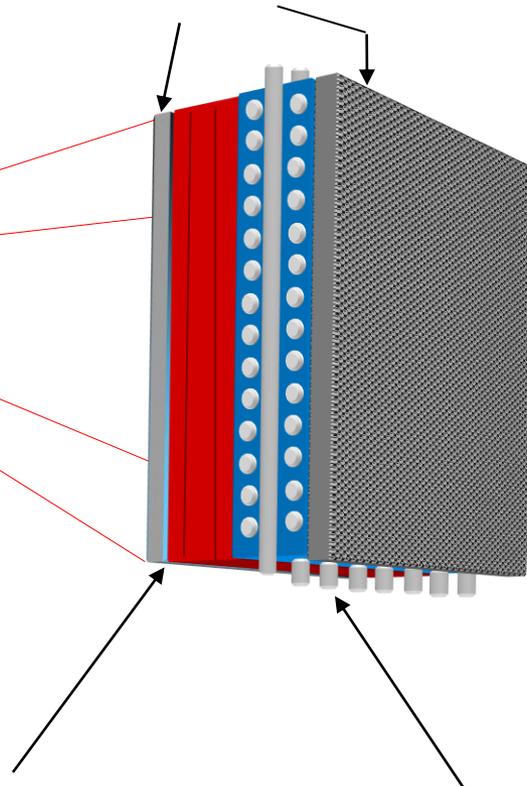
***Augmented Visual
Awareness and Target
Recognition (AVATaR)***

Integrate three levels of protection into a single eye-protection lens

**Improved Abrasion-Resistant Coating:
Including sand storm protection**

Requirements:

- Frequency agile laser protection
- Single system to protect against both pulsed and cw laser threat throughout visible spectrum
- No focal plane
- Ballistic protection
- Low/no power requirement
- Sand storm abrasion resistance
- Must interface with weapons systems
- Low bulk/weight
- Must maintain peripheral awareness, color differentiation and visual acuity



**Laser Protection:
Multiple wavelengths, pulse widths and beam shapes**

**Improved Ballistic Protection:
Greater level of protection with less weight**

Research and transition new light-transmission control technology into a single, high-transmission lens that also provides ballistic protection, abrasion resistance and anti-fogging



Variable Transmission Lens (PM-SPE SBIRs)

- High light-dark contrast ratio (85%-15%)
- Fast light-dark transition time (<1s)

High Optical quality

- Color neutrality
- ANSI Z87.1 compliance
- Minimal optical distortion
- UV protection
- Haze < 3%
- Maintain peripheral vision

Frequency-Agile Laser Protection

- Can be combination fixed-line/tunable
- Laser eye protection required against
 - Laser Dazzle
 - Continuous wave lasers
 - Pulsed Laser

Ballistic Platform Integration

Environmental Hardening

Anti-fog

- Vision Enhancement:
 - Active pixelated lens technology
 - Flexible display technology
- Vision Networking:
 - Wireless component interface
 - Shared vision
 - Enhanced Target recognition and designation
- Leverages current R&D programs
 - Soldier Active Vision Enhancement (SAVE)
 - Army:
 - Helmet systems integration program
 - Soldier personal area network program
 - NSRDEC funded by DARPA, MTO in FY-10 to explore capabilities, technologies and participants for new vision protection program.
 - Now plan to leverage new DARPA, DSO Program: Soldier Centric Imaging via Computational Cameras (SCENICC) that has similar goals

Soldier Centric Imaging via Computational Cameras

SCENICC begins FY-11

- 360 degree, three-dimensional field of view
- 10x zoom capabilities
- Operates via voice commands
- Augmented reality
- Target ID and tracking
- Projectile tracking
- Weapons lock-on



- Wanted: Revolutionary technology that can be transitioned via an evolutionary approach
- New vision protection and enhancement technology that can “do it all” in a single lens format:
 - High level of performance
 - High-transmission and optical quality
 - Environmentally robust
 - Low penalty: bulk - weight - power consumption – cost
- For a given set of capabilities or performance requirements, general levels of technology achievement may be characterized as:
 - Good: Technologies that can meet current requirements
 - Better: Technologies that can meet current requirements and that are mutually compatible or synergistic
 - Best: Single technology that meets all current requirements
 - Super: Single technology that meets all current requirements and that also provides an enabling platform or system to address future eyewear goals

- Technologies related to lamination
 - Adhesion concerns
 - Index matching considerations
 - Interface quality
- Film application techniques
 - Materials compatible: solvents
 - Fabrication systems compatible: dip vs. spray coat
- General Manufacturability
 - On-shore manufacturing capability
 - Flexible transparent display technology

Thank you!

Questions?

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Transparent Armor Materials for the Warfighter

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- **Develop improved transparent armor material systems for the Warfighters.**
 - Near Term: At least 20 - 30% improvement of current systems
 - Long Term: Achievement of the Opaque Armor Level.
- **Potential benefits of this effort**
 - Reduced weight and bulkiness with equal or better ballistic performance
 - Technology developed from this effort will be applicable to all types of Warfighter transparent Armors (Spectacles, Goggles and Riot Protective and ABS EOD Face Shields... etc.)

- Crystal formation of a microcrystalline TROGAMID CX-7323, and its properties.
- Effect of lubrication on injection molding process to the fracture behavior of CX-7323
- Investigate Feasibility of Fiber Reinforced Transparent Composites with Various Materials.
- Gradient and/or hybrid Composites for Transparent Armor Applications.
- Effect of Compression on the Ballistic Properties of Polymer for Transparent Armor Applications.

- Transparent Armor Polymer Composites Utilizing Thermoplastic Particles as Energy Dissipators
 - University of Nevada (U. Delaware)
- Pre-stressed Transparent Laminates for Enhanced Impact Performance & Ballistic Protection
 - UMASS Amherst
- Real-Time Full-field Deformation Analysis on the Ballistic Impact of Transparent TROGAMID Nylon Materials Using High-speed Photogrammetry
 - MIPR (ARL)
- Two SBIRs on Hard Coating Material Development
 - Nanosonics
 - Acer
- Two SBIRs for Light weight advanced Bomb Suite Face Shield.
 - Frontier Performance Polymer
 - Safe

- Developed new coating material for TROGAMID CX-7323 through CRADAs with industry
- Significant improvements of ballistic performance (19–31%) at reduced weight (15–33%) were achieved with TROGAMID CX-7323.
- Riot Protective Face Shield Technology with TROGAMID CX-7323 was Transferred to PM
- Technology Transition of Goggles and spectacles with TROGAMID CX-7323 is under way.
- UOPP exhibited best ballistic impact resistance and excellent optical properties.
- Development effort of UOPP is continued through Commercialization Pilot Program (CPP)

- Drastic Improvement of Materials and Material Systems.
 - Fiber Reinforced Transparent Composites
 - Advancement of film Lamination Techniques.
 - Gradient hybrid systems
 - Multifunctional systems (transition lens, UV...)
 - New Materials
 - Nano Technology for Substrate Materials as well as for Coating Materials
 - Ductile Ceramics