The Future of Laser Eyewear

Honeywell

Present Laser Eyewear Technology

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- Traditional laser eyewear is based on either
  - Absorption or
  - Reflection

  - Absorption is further broken down into dye based technology or Glass based technology

Today's LEP technolgy..Absorption or Reflection

Characteristics of Absorbing laser eyewear

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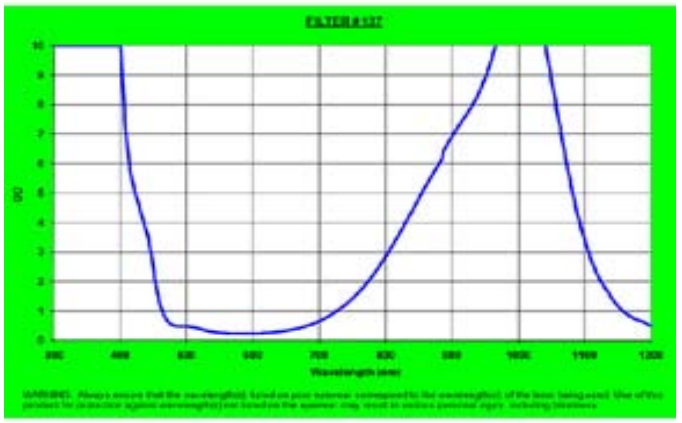
- **Dye absorbers**
  - **Since every dye has a color, the filter will have a tinit.**
  - **The higher the protection level required, the darker the tinit / color of the filter**

Advances have been made with notch dyes to minimize the darkness of the color but it still reduces colors you can see



Dye absorbers = tinited lens

Absorbing Glass Technology

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- **In the IR portion of the light spectrum, glass filters provide a ‘clear” lens vs a tint for dyes**

Downside to this technology is

- weight
- limitations on shapes
- minimum impact resistance

Glass technology= clear lens, less impact

Reflective Technology

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- Advantages
  - Lightweight
  - Very good VLT
  - Disadvantages
    - Angle sensitive
    - Limited to shapes it can be applied to

Reflective technology= clear lens, shape limitations

New Military Requirements

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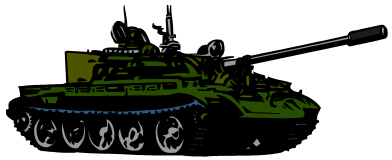
- Military is driving new technology as they are not satisfied with existing products on the market
  - Ideal specifications
    - Agile laser eyewear…reacts to any wavelength
    - Non angle sensitive
    - “clear”
    - Ballistic grade



US Military is leading initiative

LEP using absorbing nano structures

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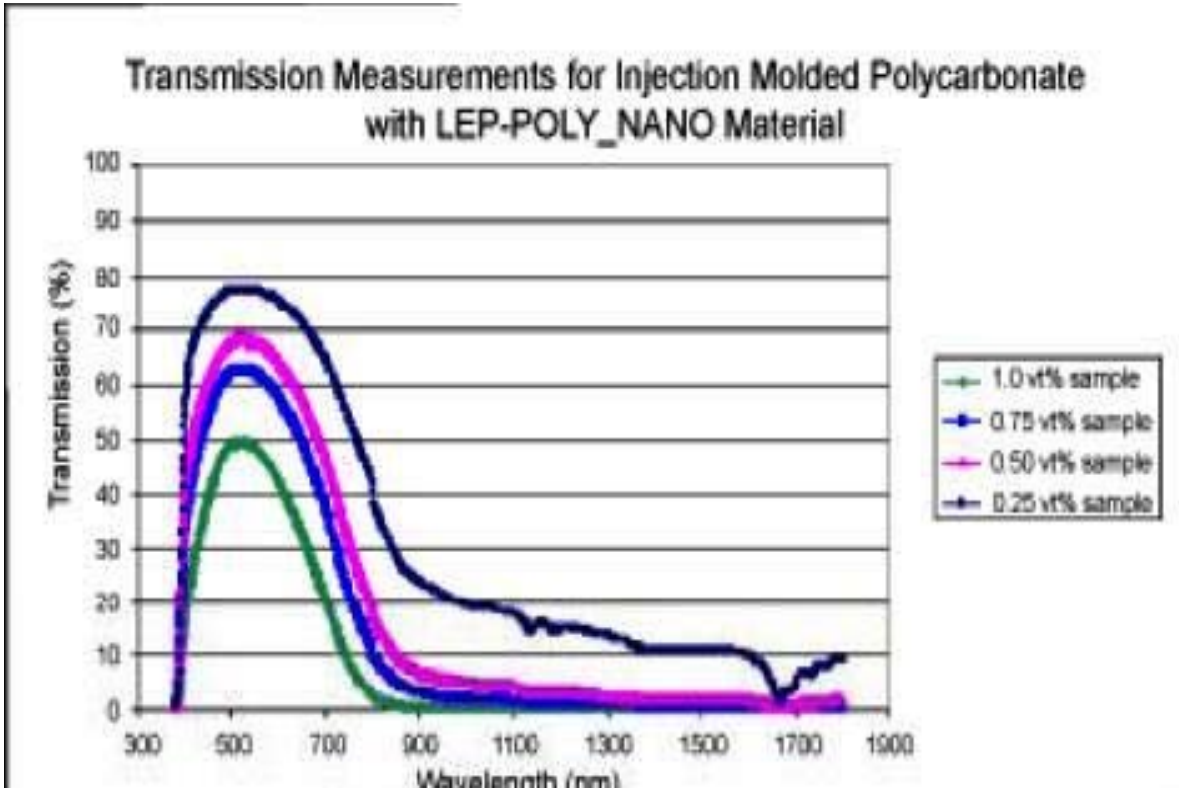
- Transmission of LEP at various concentrations



Nano technology enables advancements in LEP

Actual injection molded parts

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2 mm Thick Polycarbonate Prototypes Fabricated via Injection Molding of LEP-POLY_NANO Material

2 Luminit Proprietary

Luminit
SHAPING LIGHT AS NEEDED

Multi material approach

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- ***The technology***
- *Active medium*: Novel nano metal oxide particles in a composite texture format
- *Multiple laser attenuation mechanisms*: reflection, scattering, absorption over visible to NIR spectral range with sub-ps response time; targeting at OD > 4, VLT > 60%, color neutral, 0.5mJ/cm2 (*ns*-pulse)/7mW/cm2 (CW) threshold, and all angle protection
- *LEP structure*: quasi-solid state structure coated on ballistic-proof lens

Ultrafast Self-Reactive Laser Eye Protection

Current Achievements

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- Demonstrated a prototype LEP spectacle made on double curvature ballistic-proof lens
- Synthesized and characterized the baseline optical limiting material, i.e., a quasi-solid-state composite coating containing the nano-particles (NPs)
- The NP composite coating lowered the optical limiting threshold by *19X* as compared to the device made from the same nano-particles but in liquid suspension, reaching to <.7mJ/cm2 at 7ns pulsed at 532nm frequency-doubled Nd:YAG laser wavelength
- Increased contrast ratio (CR) by *14X* as compared to the device made from the same nano-particles but in liquid suspension; reaching CR = 34:1 [optical density (OD) =1.53], and laser damage threshold = 140J/cm2
- Demonstrated the feasibility of achieving sub-100 fs response speed to laser radiation.

Nano / Active LEP

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Actual LEP achieved, OD 1.53 400-2000nm

VLT 60%!!

Conclusions

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- Driven by Military requirements the LEP of tomorrow could cover
  - Vast majority of commercial laser
  - VLT of greater than 60%
  - Be agile to laser exposure

  - Note, most projects are just now starting SBIR Phase II, a 18-24 month process