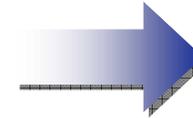


*Borrowing from nature to develop optical systems that demonstrate impressive performance at a reduced size and complexity*

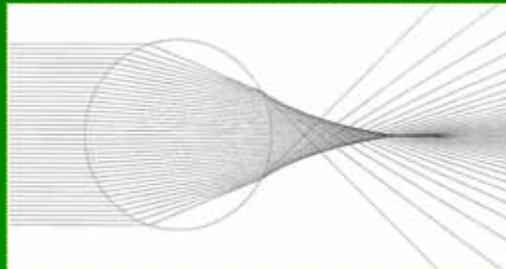


Fish Eye



Man-made Lens

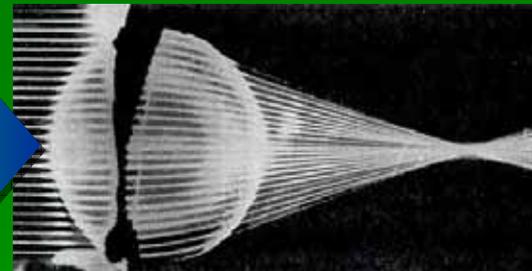
## Standard Lens



Today—

- Fixed index lens
- Limited field of view
- Single function optics

## Octopus Lens



Beyond—

- Variable index lens
- Dynamic field of view
- Multifunctional optics

Dynamic Control of Refractive Index

Wavelength Variable Reflectance

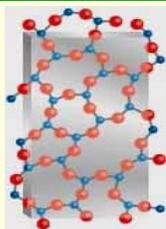
Hierarchical Material Structure

*Better vision through chemistry*

**Materials** → **Structure** → **Systems**

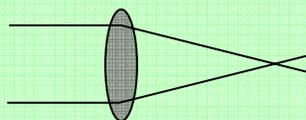
## Conventional Approach

**SiO<sub>x</sub> Based Glass**

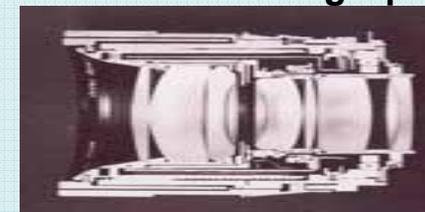


Monolithic/Homogeneous

**Fixed Properties**

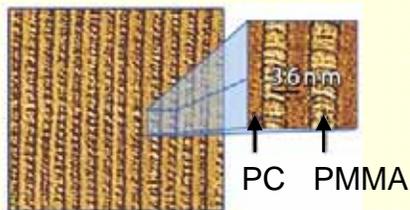


**Zoom Lens -- Moving Optics**

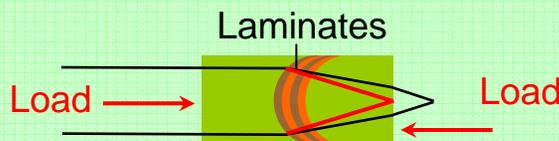


## BOSS Concept

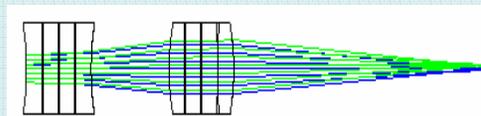
**Hierarchical Structure**  
**Nanolaminated Systems**



**Variable Focal Length**  
**Stress Field**

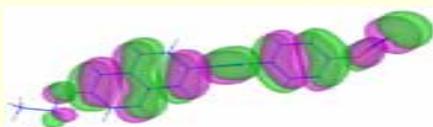
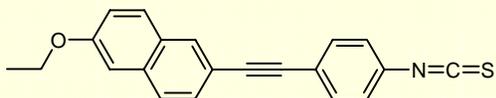


**Solid State Zoom Lens**

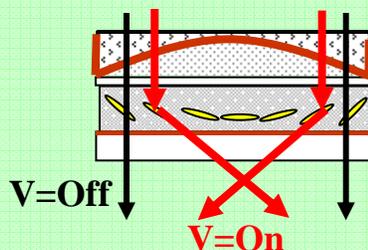


**Focal Length Changed**  
**via Applied Stress**

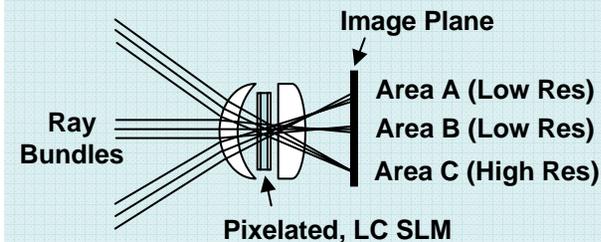
**Materials Development**  
**Liquid Crystal**



**Variable Focal Length**  
**Electric Field**



**Foveated Vision**



## Bio-inspired Optics Phase II

### Change in Refractive Index

#### *Foveated Imaging Sensor*

- U Central Florida
- Sandia
- Boulder Nonlinear Systems
- Narrascope
- AFRL

### Change in Shape

#### *Dragoneye*

- Case Western
- NRL

#### *Pointer*

- Rockwell
- MIT
- UC San Diego
- Ceramics & Metal Composites
- Aerovironment

### Compound Lens

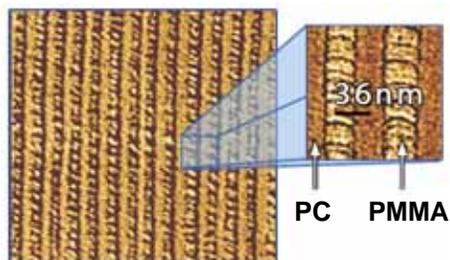
#### *MRM*

- U of Florida
- Raytheon
- ITC

## Bio Inspired Optics for UAVs

Case Western | NRL-Chemistry | NRL-Optical Sciences | NRL-TEW

**Solid State Lens**



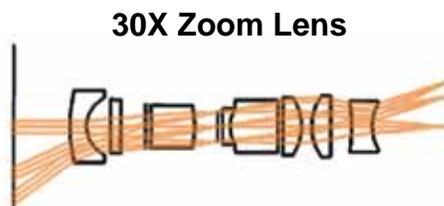
**Dynamic GRIN lens**  
light weight with variable FOV



## Highly Compact Variable Field-of-View Lens

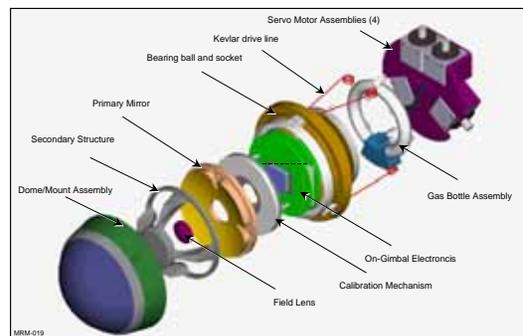
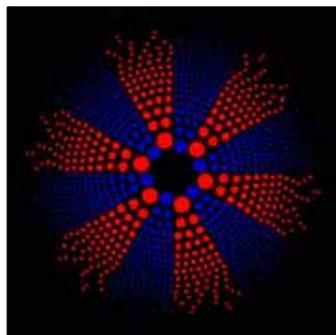
Rockwell | MIT | UCSD | AeroVironment

**Liquid State Lens**



## Photon Sieves

U of Florida | ITC | Ravtheon



**2-color lens that eliminates gimble for medium range munition**

## Foveated Imaging

U of Central Florida | Sandia | AFRL-Kirkland | Boulder Nonlinear Systems | Narrascope

