Anteryon / WLOPT

WaferOptics chances & challenges

Content

1. Company introduction
2. Markets & trends
3. Consumer market focus
4. MicroOptics roadmap
5. MicroOptics challenges & requirements

WLOPT / Anteryon at a glance

OUR BUSINESS

- Established in 2018, Suzhou Industrial Park, CH
- In 2019 acquired Anteryon Optical Solutions B.V and Anteryon Wafer Optics B.V (ex. Optical Division of Philips)
- We offer industry leading Optics design know-how and mass production expertise for 3D sensing solutions, which cover structured light, active stereo camera and ToF
- Focused on driving innovation and growth through strategic customer partnerships
- Proven high-volume optical technologies
- State of the art consumer optics manufacturing factory in Suzhou and customized optical components production line in Eindhoven
- Broad in-house developed and acquired technology & IP portfolio

BY THE NUMBERS

- Approximately 500+ employees worldwide; around 200 engineers
- 2 design centers, 2 manufacturing factories

OUR END MARKETS

- Consumer, Security, Automotive, Industrial and Medical

Technology and Operational sites

Optics Center , Eindhoven , NL

Design and Manufacturing of Customized Optical Components, Projection Optics and Module Assembly

Invent, develop, and commercialize unique optical components and system level miniaturization technologies

Wafer Optics, Suzhou, CH

Design, Development and High Volume Manufacturing of Consumer Optical Solutions

Laser modules for Sensing, Detecting , Industrial measurement applications, 2D, 3D Vision Visual Perception & Analytics, Structural light components

Anteryon @ Brainport Industries Campus

Brainport Industry Campus, Eindhoven, NL

Facilities 4000 m^2 manufacturing

Clean Room 1800 m^2 (classes ISO 7, 6, 5)

Employees 180 FTE

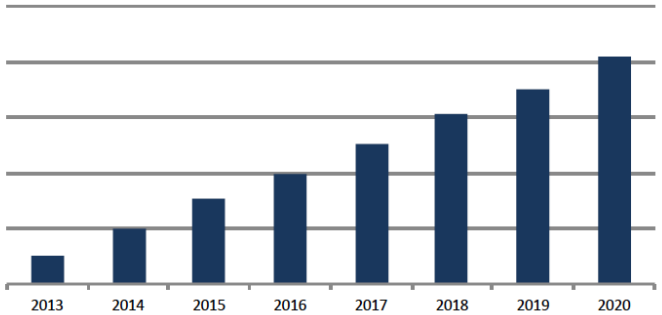
WLOPT @ Suzhou Industrial Park, Suzhou, China

Clean Room 20.000 m^2 (classes ISO 5)

Employees 500+

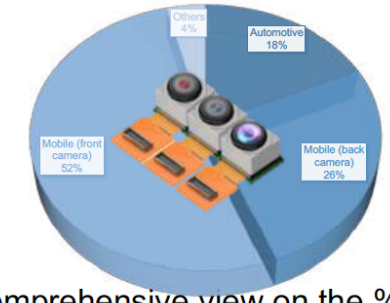
Global 3D Camera Market

Global 3D Camera Market is Expected to reach ~$8B million by 2020



Growing at a CAGR of 39.4% (2014-2020)

Global 3D Camera Market by type



The comprehensive view on the % share of segment (2020)

Global 3D Camera Market by technology

The comprehensive view on the % share of Technology segment(2020)

Drivers & Restraints

Drivers:

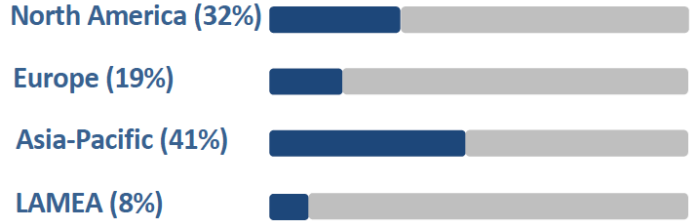
- Growing demand of 3D Content from entertainment industry
- Enhancement in 3D scanning technology
- Improved user taste & preferences

Restraints:

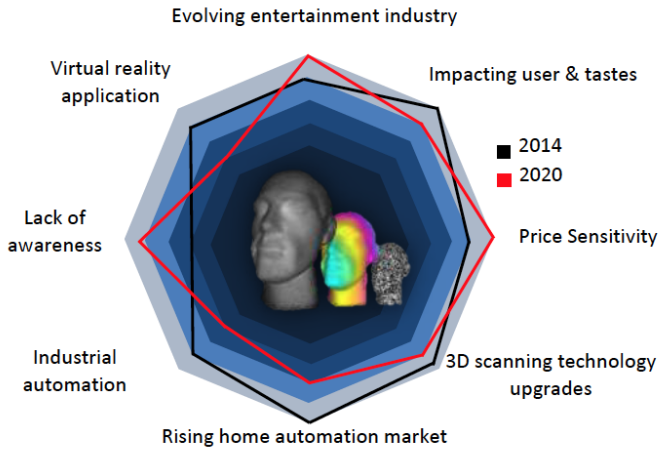
- High prices
- Lack of supply chain

Global 3D Camera Market by Geography

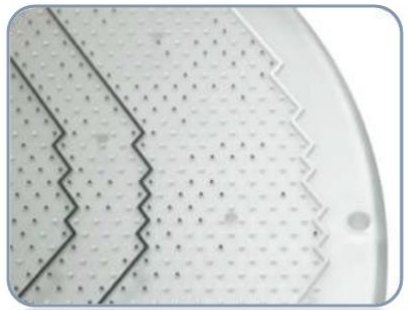
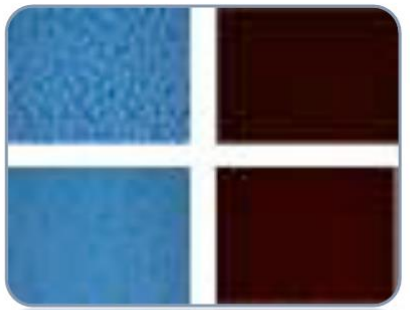
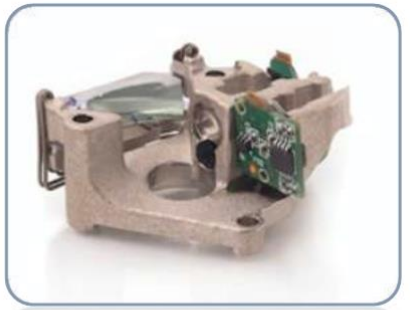
Asia Pacific is expected to be highest revenue generating region by 2020



Top Impacting Factors

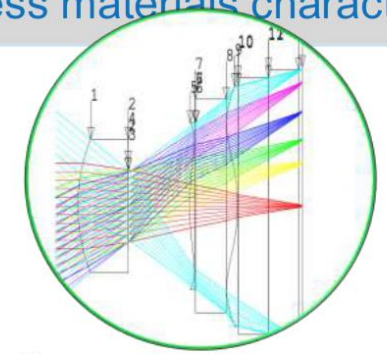


Product lines

Replicated Lenses / Mirror Prism	Structured Glass	Structured Ceramics	Spot and Random Pattern MLA	Hybrid – Multilayer Lenses
				
Optics and Scan Head	**Triple Laser System**	**High Precision Laser Module**	**ToF and Structured Light Modules**	**FFU-MINI Spectrometer Products**
				

Engineering

- ✓ Full design and optical verification
- ✓ Mechanical systems and tooling design
- ✓ Optronics design
- ✓ Mechatronics design
- ✓ 3D components assembly
- ✓ Optical materials lab
- ✓ Process materials characterization



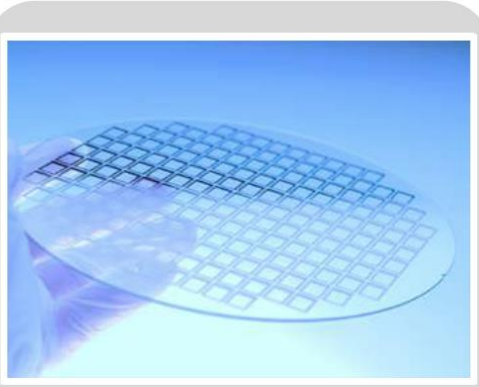
Design Logistics

- ✓ Design chain management
- ✓ Design for Manufacturing (DFM)
- ✓ Design for Cost (DFC)
- ✓ Quick turn prototyping

Manufacturing

- ✓ High volume lens manufacturing
- ✓ Custom build product lines
- ✓ Propriety equipment and tooling
- ✓ Mastering and replication
- ✓ Single and multilayer optics
- ✓ Optical coatings and adhesives
- ✓ Metrology and testing
- ✓ FA and reliability

20.000 m2 Cleanroom for high volume lens manufacturing



CLASS: 10 to 1K






- Milling micron accuracy
- Optical bonding
- Polishing
- HF Etching
- 3D Lithography
- Replicating

- Black chrome
- AR coatings
- Reflective coatings
- Optical adhesives
- Electrical adhesives
- Ni, Au deposition

- Opto-mechanical assembly
- Opto-electrical assembly
- Optical modules

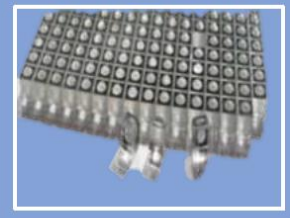

- Fused silica, BK7, YAG, Saphir, Filter glasses, Opal, Lead glasses (X-ray), Zerodur, Aluminium mirror coating

- Optical density, Transmission measurement, 3D measurement, Zygo interferometer, Taylor Hobson, AOI

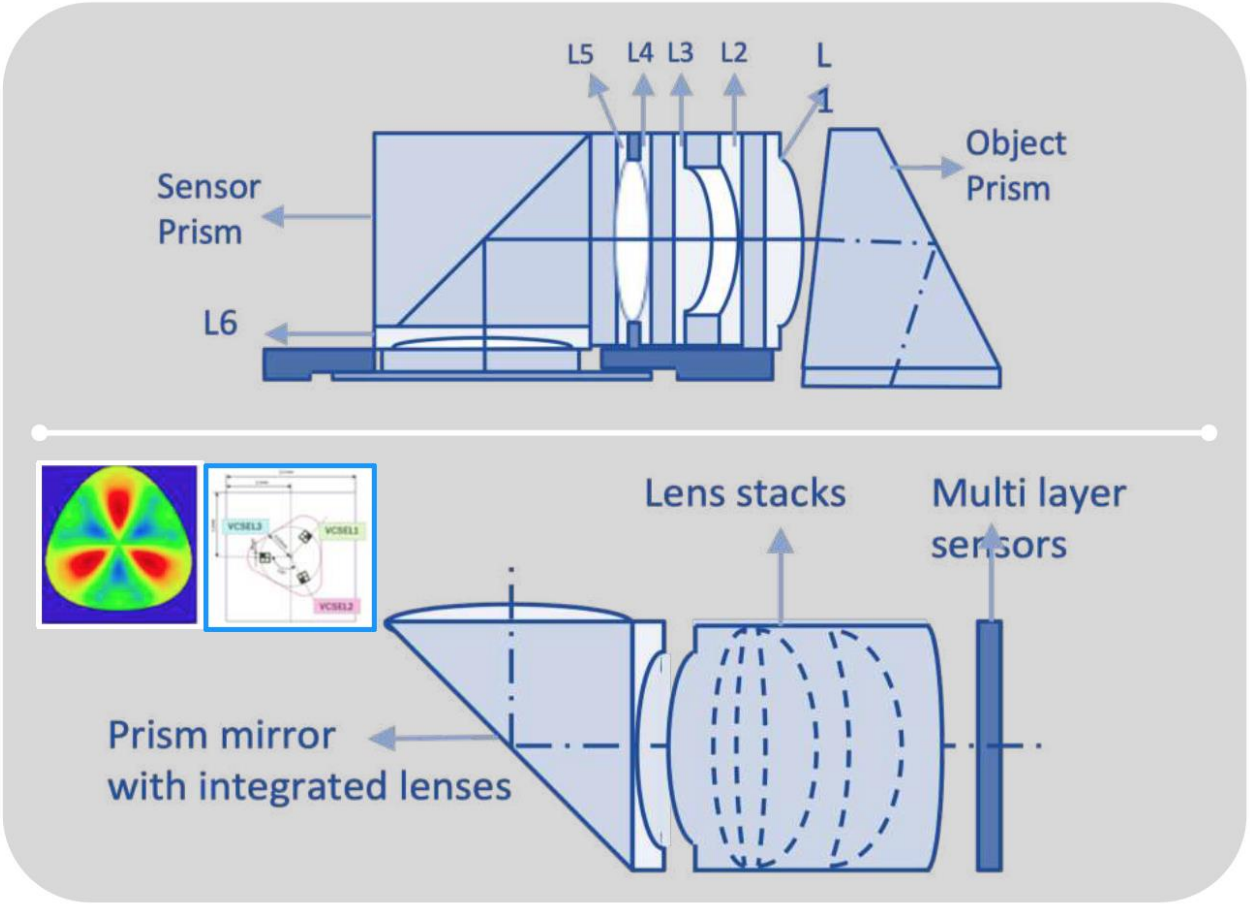


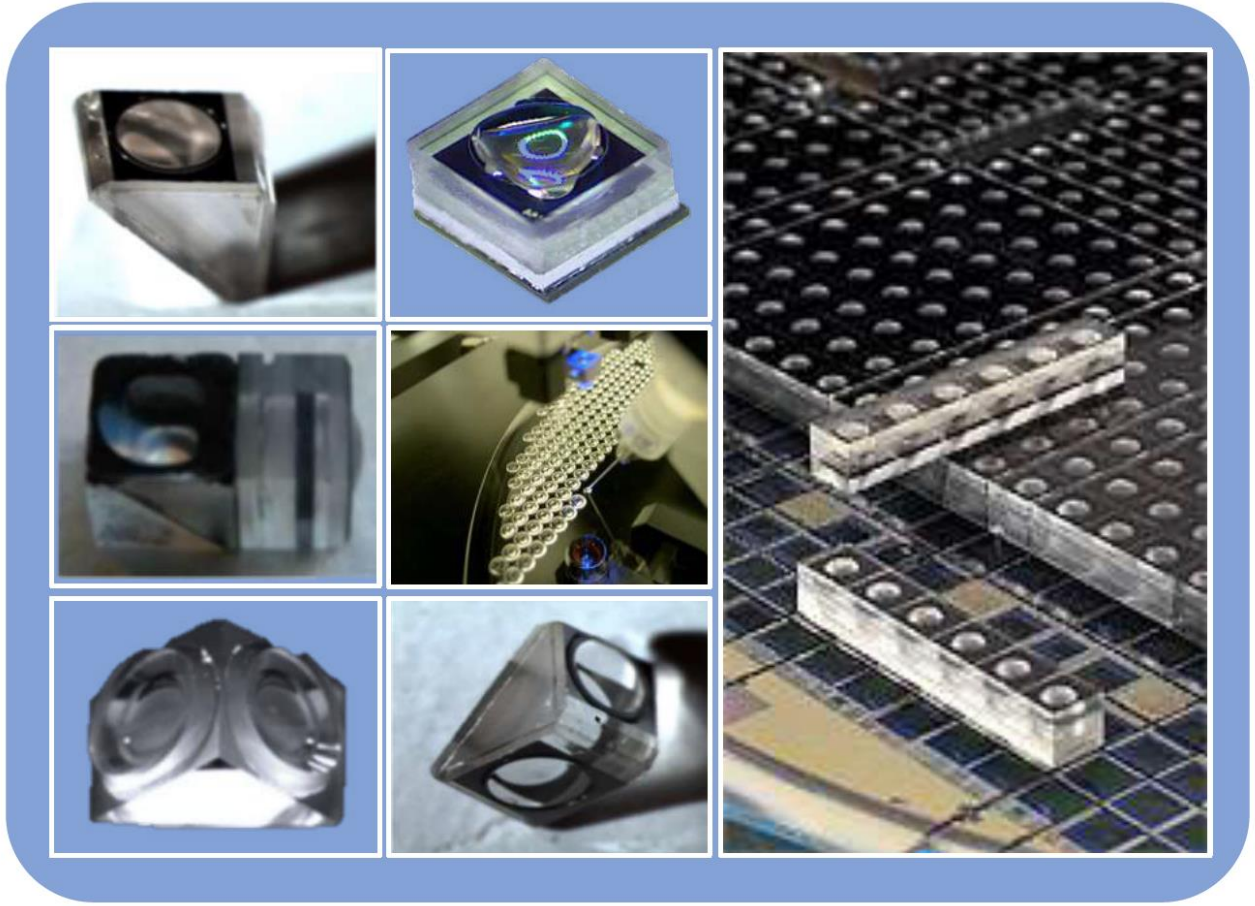






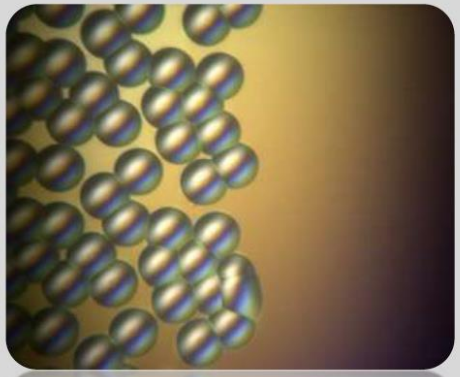
Folded optics – wafer based



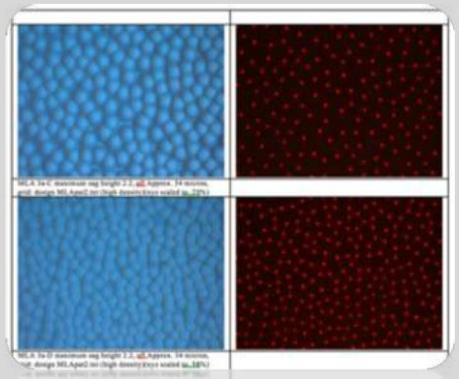


For Structured Light Projectors and Low Light Cameras

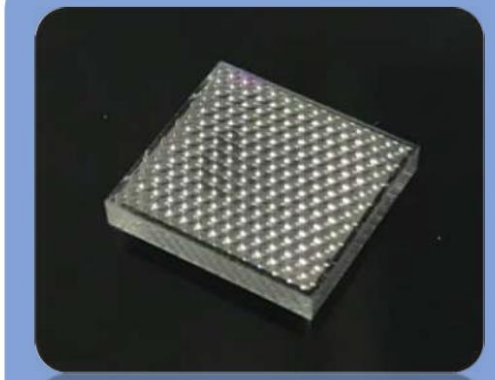
MLA – Design & Application



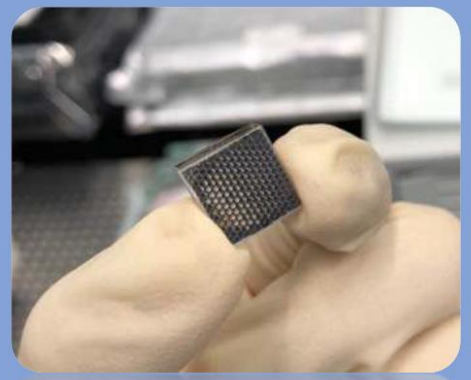
Random Pitch



Spot pattern



Multi-aperture camera module



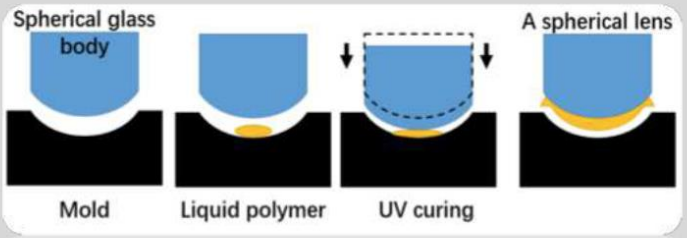
Mobile projection system

Automotive projection system

- Lens diameter 10..200µm
- Lens uniformity < 100nm
- Lens sag 0..100µm
- Accuracy <+/- 0.2µm
- Pitch accuracy < +/- 0.1µm

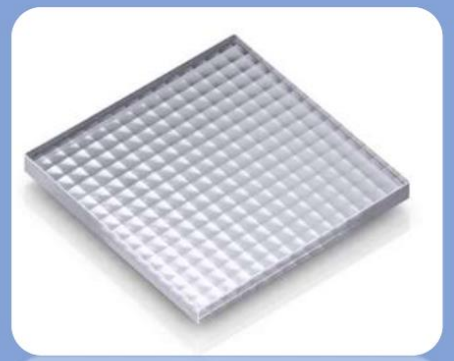
Coating: AR and / or IR
Reliability: JEDEC level 2 & 3

Hybrid lenses – design & manufacturing process



Complete in-house design & manufacturing

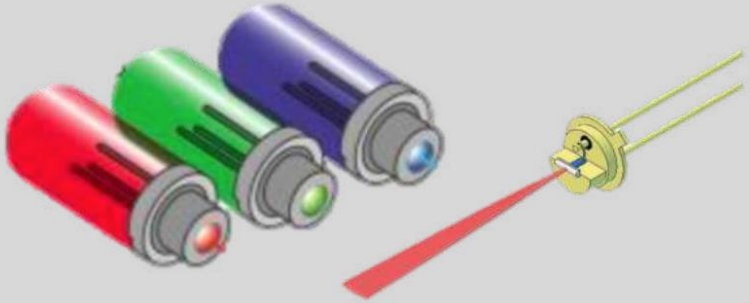
Simulation: Zemax, ASAP, LightTools
In-house AR or reflective coatings



Replication of optical structures for lens, gratings or mirrors

Diffractive, Aspherical, Freeform & Powell
Diffraction limited lenses (shape deviation accuracy between 20-50 mlambda RMS)
Free form shapes possible

Superior design for unmatched optical performance



Module assembly & design capabilities

Zemax, ASAP and LightTools

Active x, y, z and rotation alignment

In-house optics

Customized Solutions

Customized solutions

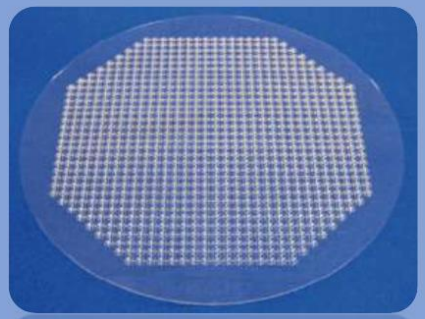
Pointing-, line-, illumination and cross-functions

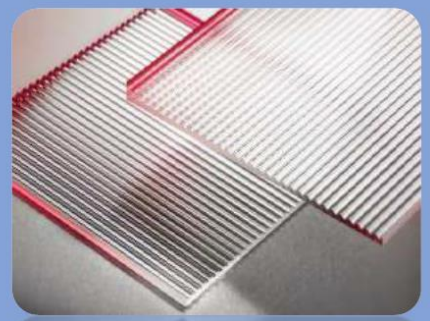
405nm-2000nm available

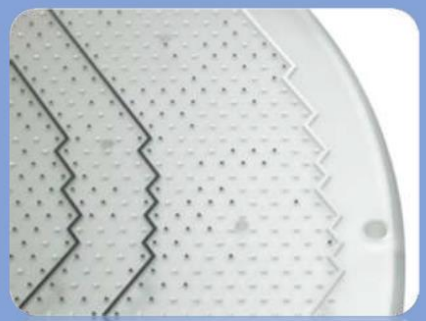
Designed for industrial, security and automotive applications

Structuring Options

- High precision polishing, grinding and sawing
- High precision powder blasting
- CNC machining (3 and 5 axis)
- Optical coatings, AR, metal on glass, etc.
- Glass etching
- Lithography
- Laser structuring
- High precision glass assembly







Qualified Materials

- Technical glass
- Optical glass
- Glass ceramics (zerodur)
- Ceramics
- Crystals
- Fused silica
- Silicon
- X-ray protection glass

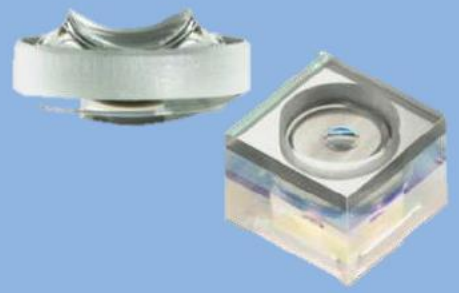
Qualified for industrial and automotive applications

Operational capacity

OPTICS

Replicated Lens ~ 150M units

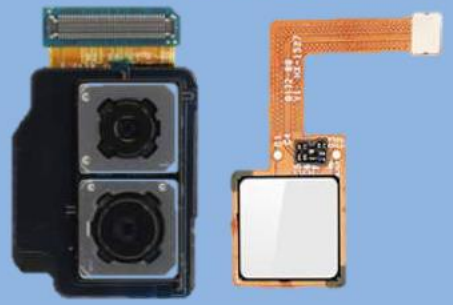
Hybrid Lens ~ 50M units



MODULES

Imaging & Fingerprint ~ 100M units

Structured light (VCSEL) ~ 100M units



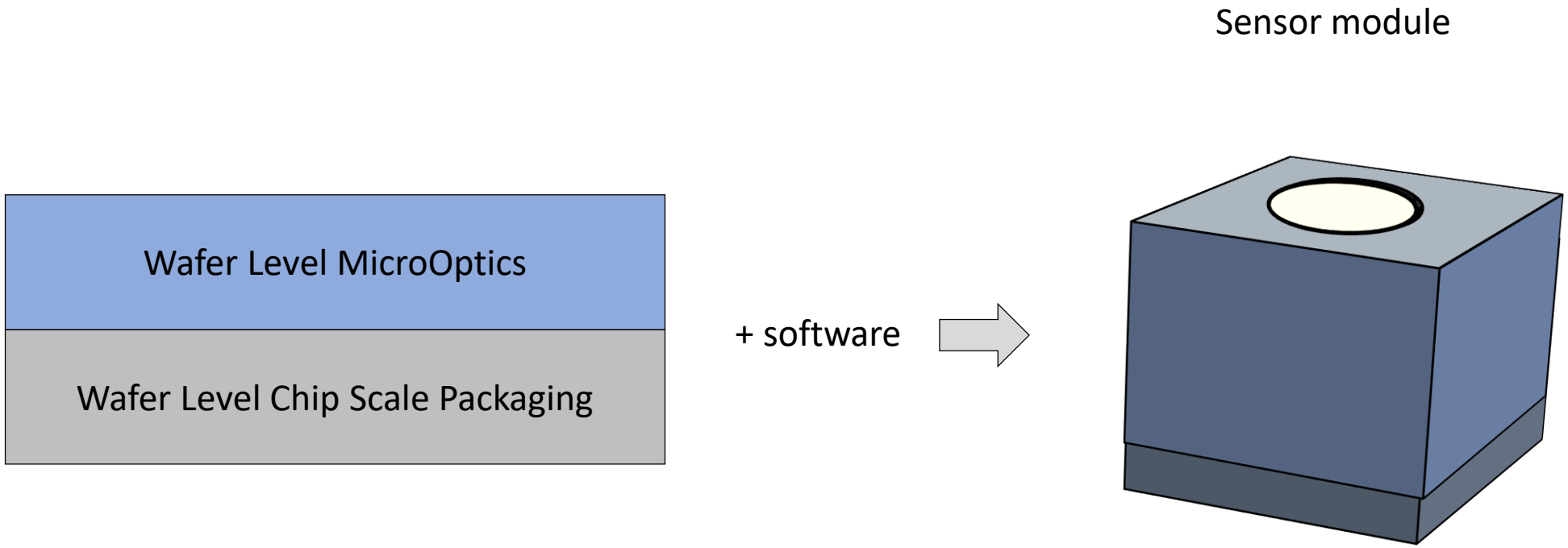
FUNCTIONAL TEST

Optics~ 200M units

Modules ~ 200M units

Major capacity expansion driven by customer volume requirements.
Exclusive supply agreements signed with Tier 1 customers

Sensor modules enabled by Chip Scale Packaging + Wafer Level Optics



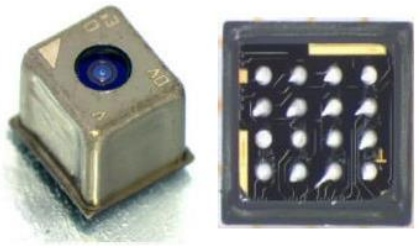
The combination of Wafer Level packaged Chips and Wafer produced Optics provides compact integrated modules

For low resolution, CIS have adopted 3D WLCSP packaging

The technology formerly known as "Shellcase" uses the chip's edge to route the signals

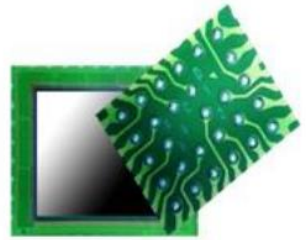
TSV allows for "fan-in" packaging

Developed from 2005 - 2010, but no longer used in mobile



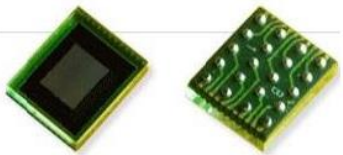
STMicroelectronics WLCamera with TSV/ WLP

OnSemi/Cypress 3D WLCSP in medical CMOS image sensor

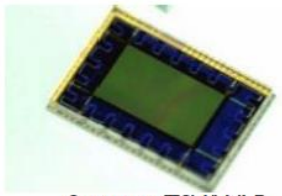


Galaxycore 3D WLCSP in CMOS image sensors

Toshiba WLCamera with TSV/WLP

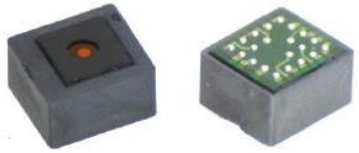


SK Hynix WLP/TSV in CMOS image sensors

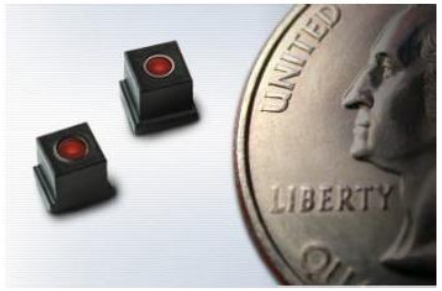


Samsung TSV/WLP in mobile phone CIS

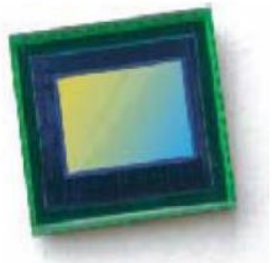
BYD CSP camera module



Sharp WLCamera with TSV/WLP



Omnivision WLCamera with TSV/WLP



SuperPix TSV package in 2MPixels' CMOS image sensors

Courtesy Yole/Epic

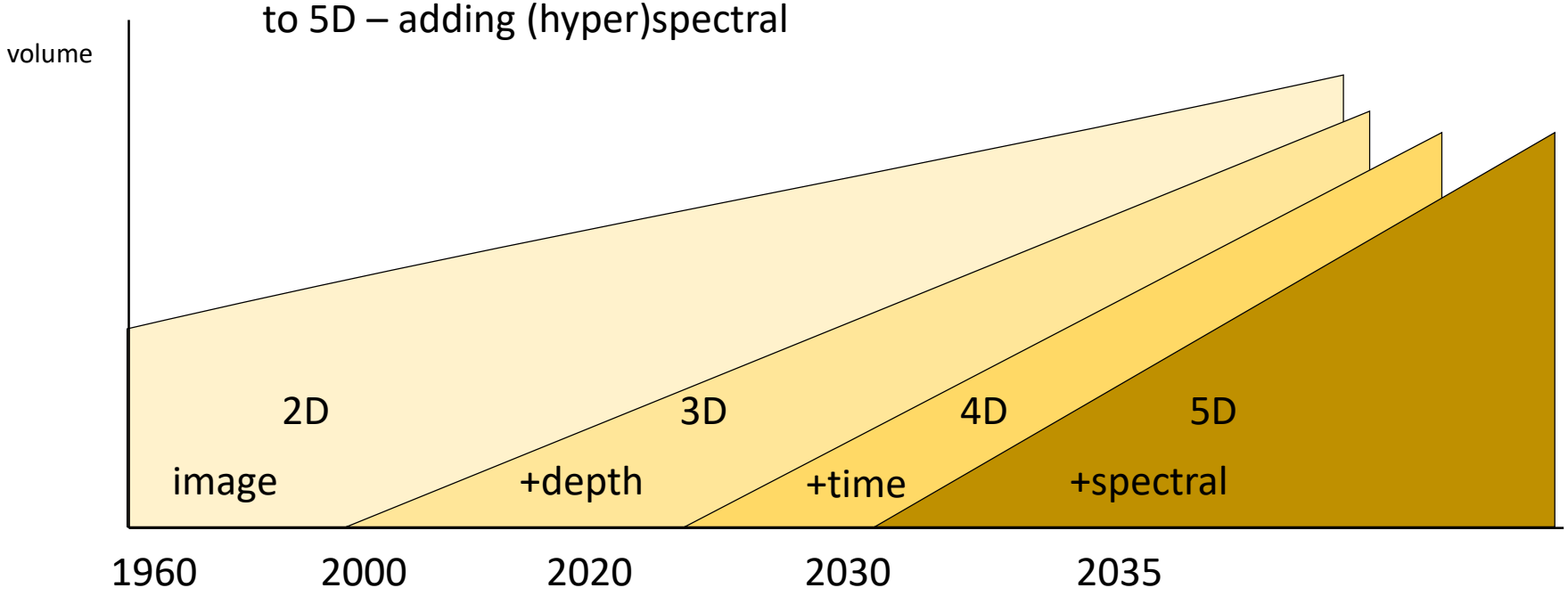
Markets & Common Trend

Consumer
Automotive
Industrial

Common trend:

from 2D cameras
to 3D - adding depth
to 4D - adding time
to 5D – adding (hyper)spectral

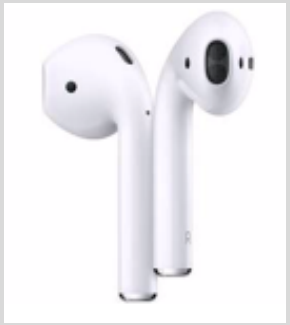
Consumer market will drive this trend →



Focus on Consumer market Wearable devices

watches
+ sensors

Neckless
+ sensors



earpods
+ sensors

Smartphone
-Limited basic functionality,
-Additional functions by modules
-Click on

Glasses
+ sensors + 3D cameras
+ projectors

Clothes + sensors

Wearables, with integrated sensors

What functionality should the devices have?

Current & Future Functionalities for Wearable devices

Current

Browsing the web

Photo & video

Listening to music

Watching Youtube

Voice interaction

Voice assistant

Social media

Playing games

Visual assistance/guidance

Future

Health

Food & Drink

Environment

Materials

Location & guidance

Payment

Fingerprint

Is this actually you?

Face recognition

Security

Current & Future Functionalities for Wearable devices

Current

Browsing the web

Photo & video

Listening to music

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Voice interaction

Voice assistant

Social media

Playing games

Visual assistance/guidance

Future

Interaction with medic

Medics on distance

Glucose

Temperature

DNA analysis

Health

24-7 monitoring

Biomedic info

Visual interaction

Blood pressure

Heart rate

Pesticides

Can I trust this food?

Micro-plastics

Food & Drink

Is this drinking water?

What is it what I see?

Oxygen level

Visualization help

Air quality

Environment

How big is that?

Sun UV skin exposure

What is that shape?

What type of plastic is this?

Temperature profile

Materials

Selection

Surfaces

Is this drug trustworthy?

Location & guidance

Payment

Fingerprint

Is this actually you?

Face recognition

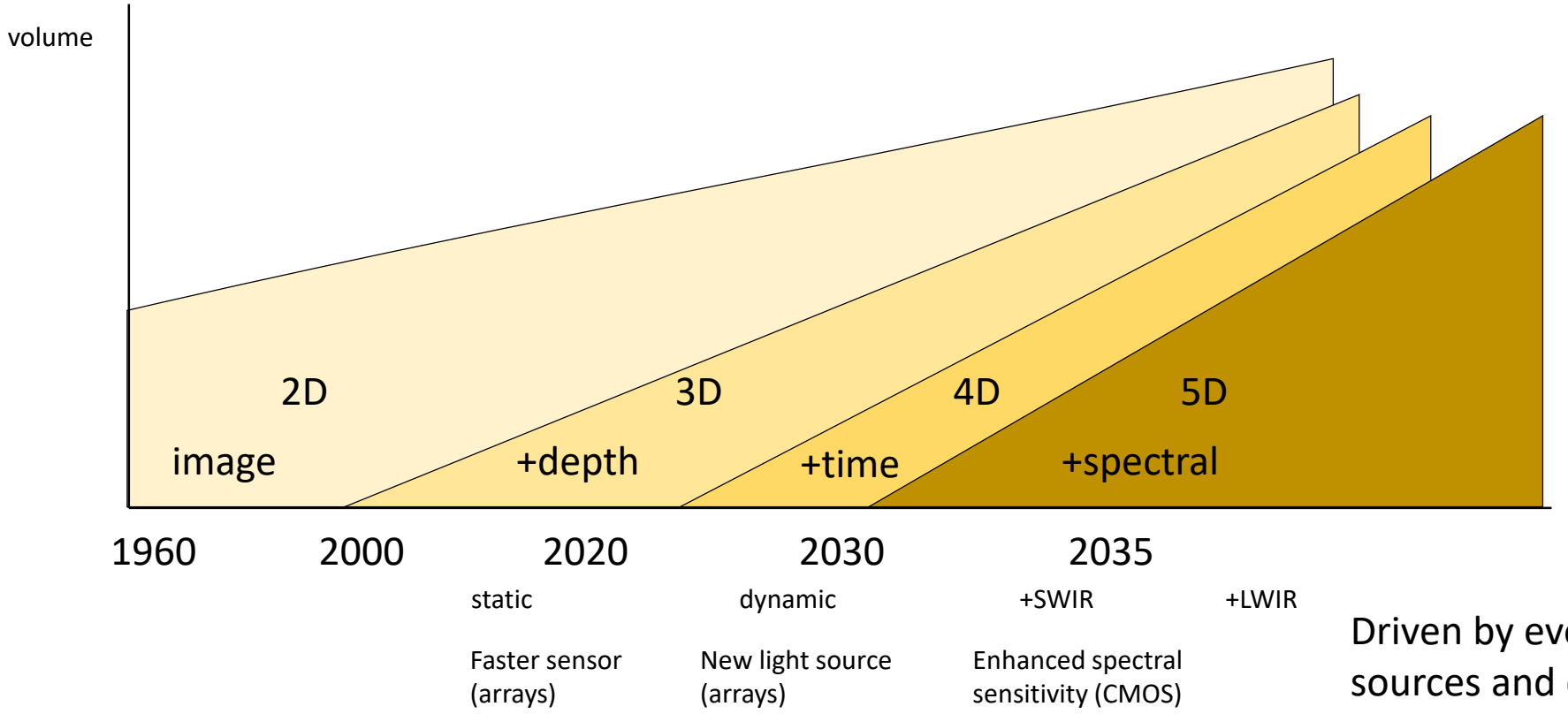
Getting access

Security

Iris scan

Skin properties

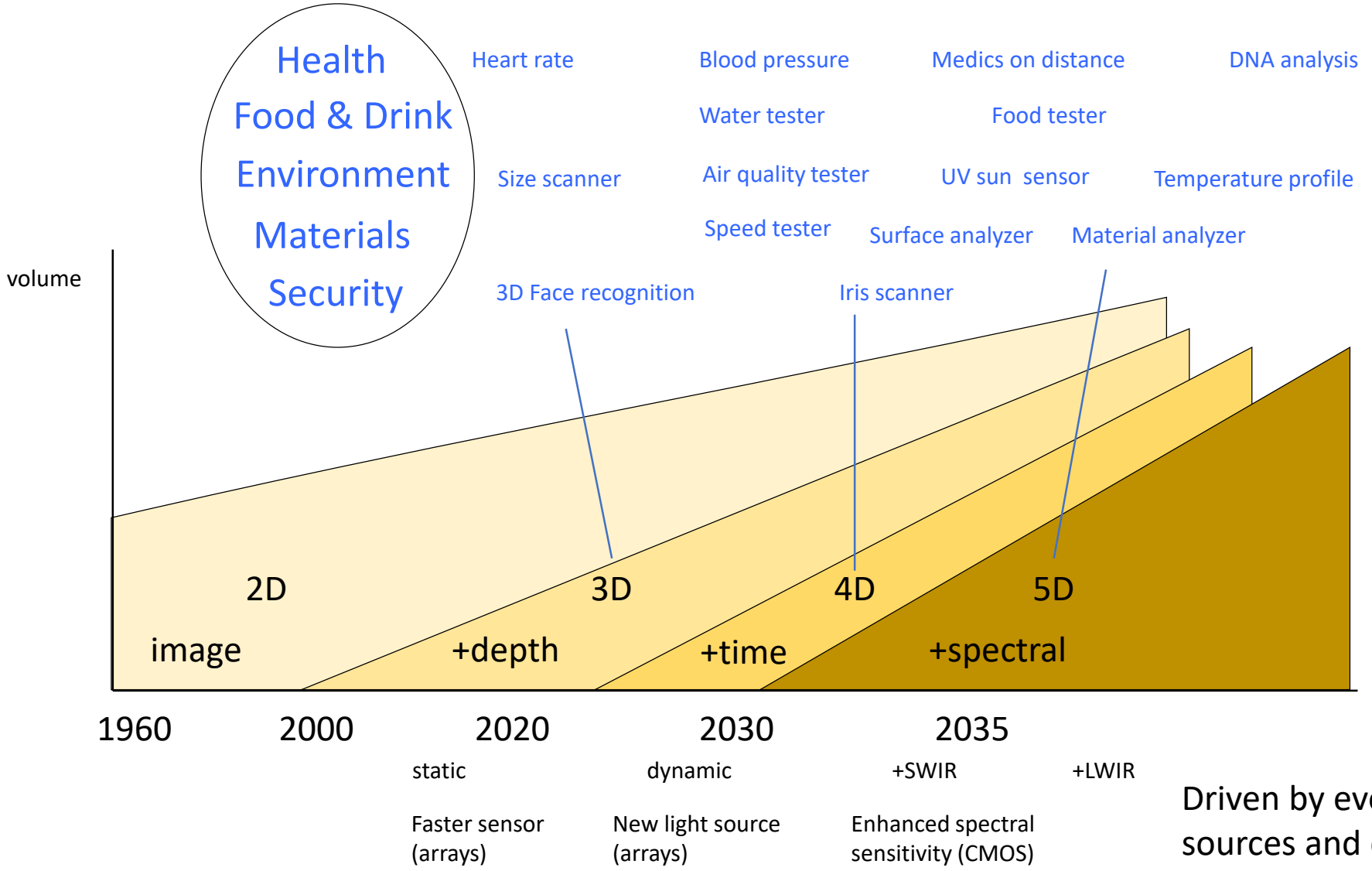
Imaging & Sensing Modules will enable new functionality



Adding dimensions to cameras and projectors will enable new functionality

Driven by evolution in new light sources and detectors

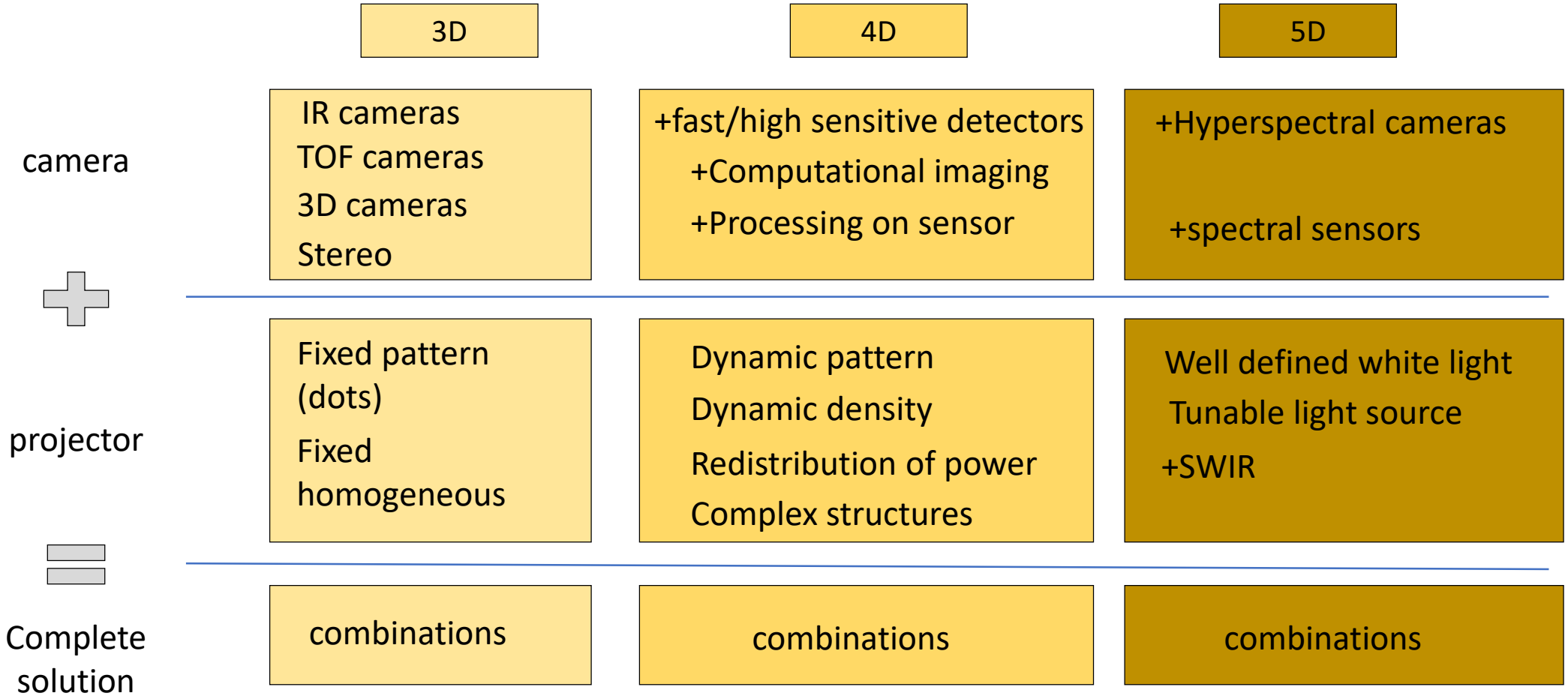
Imaging & Sensing Modules will enable new functionality



Adding dimensions to cameras and projectors will enable new functionality

Driven by evolution in new light sources and detectors

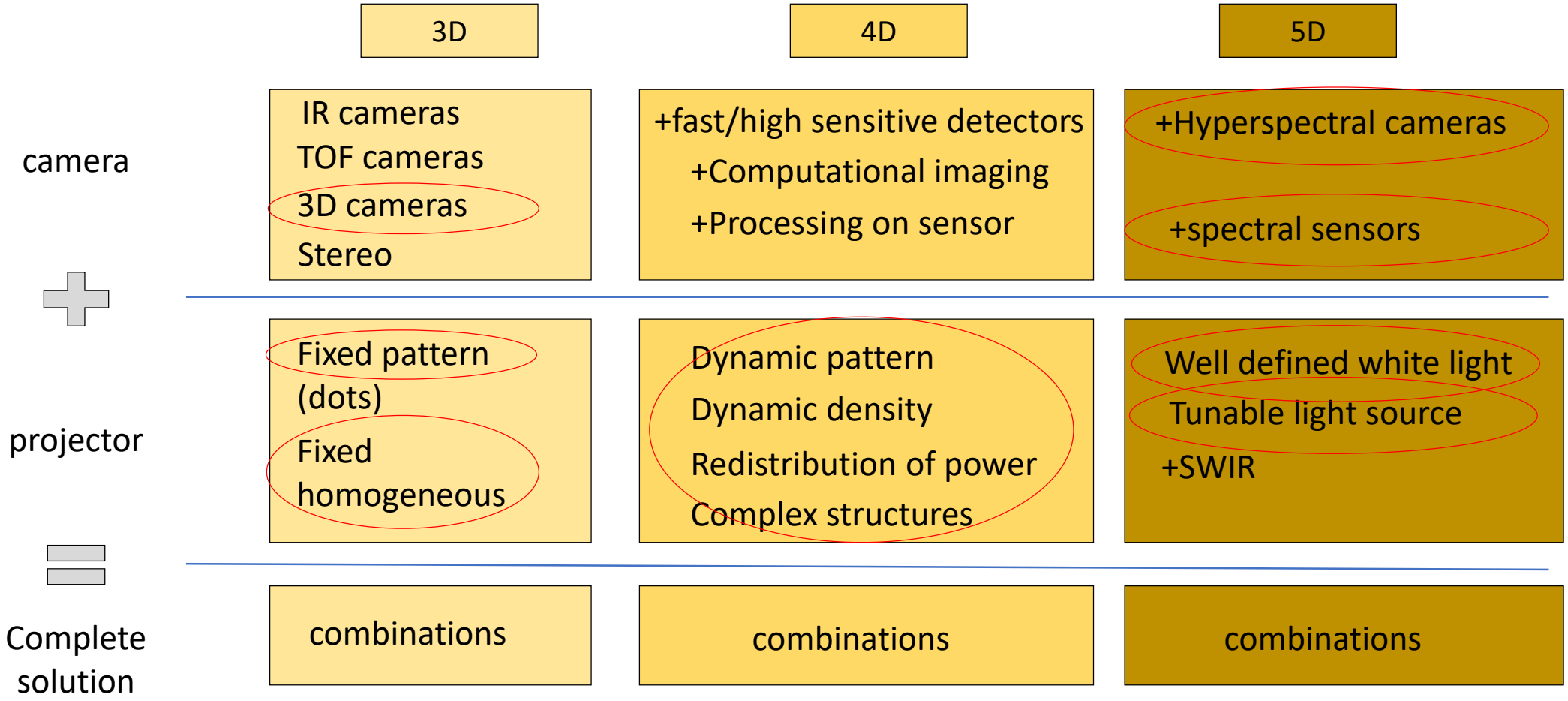
MicroOptics – key components for 3D-4D-5D roadmap



Key for 3-4-5D cameras and projectors are Software and MicroOptics →

New generation of MicroOptics is enabled by Wafer-Based technology

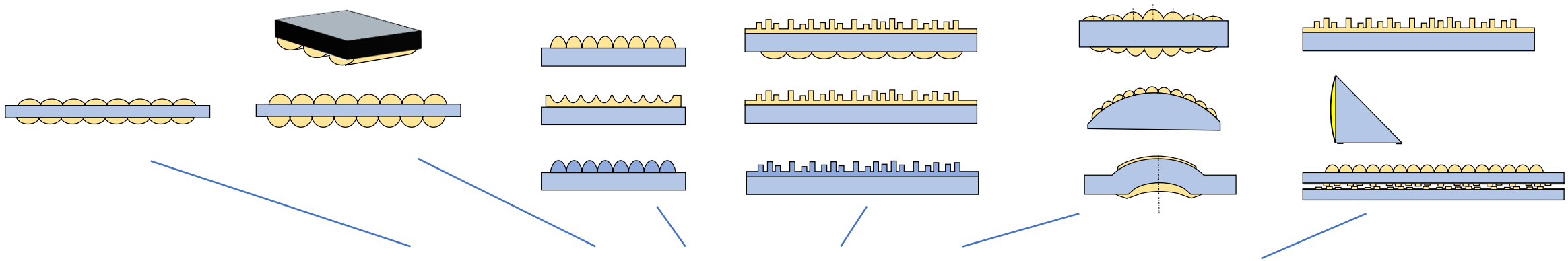
MicroOptics – key components for 3D-4D-5D roadmap



Key for 3-4-5D cameras and projectors are Software and MicroOptics →

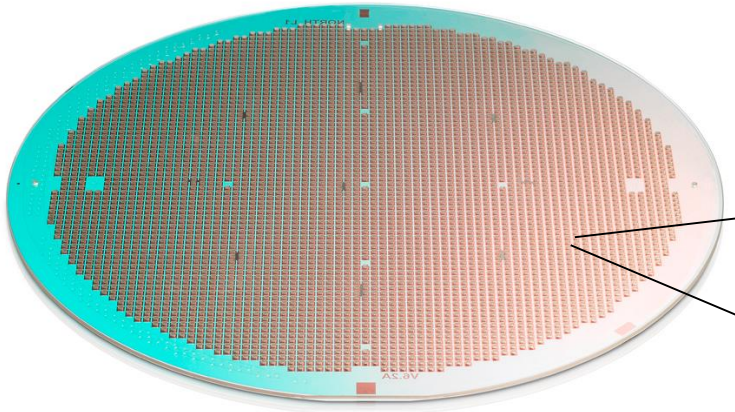
New generation of MicroOptics is enabled by Wafer-Based technology

MicroOptics - roadmap



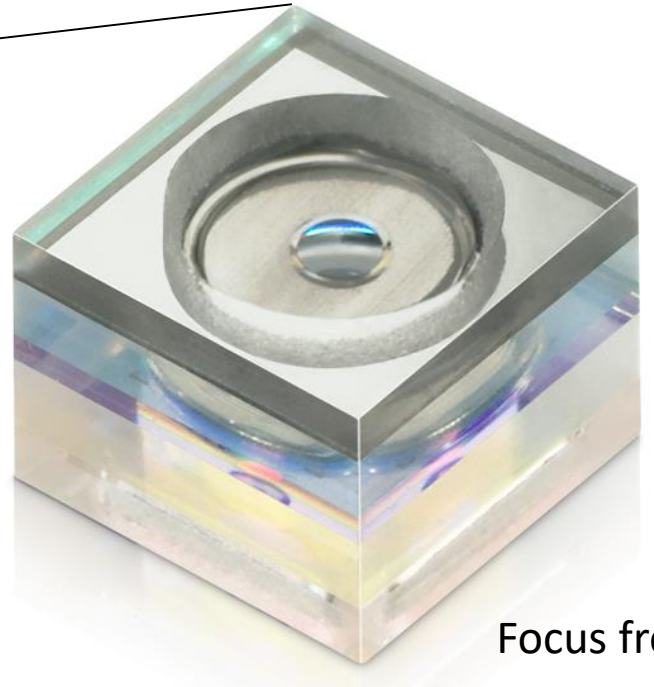
MLA Refr	Spheric	Aspheric	Freeform	+Diffr
structure steepness [deg]	20	60	70	90
Structure pitch acc. [um]	0.1	0.1	0.08	0.08
Diffractive structure	binary	multi level	any shape	holographic
Substrate	flat	prism	curved	active/+electronics
Structure	polymer	increased range	+ glass/quartz	+ GaAs/InGaAs
Materials index	1.4-1.6	1.3-1.7	1.3-1.8	1 > n > 2 meta?

MicroOptics by WaferOptics



Reflowable 260 ° C

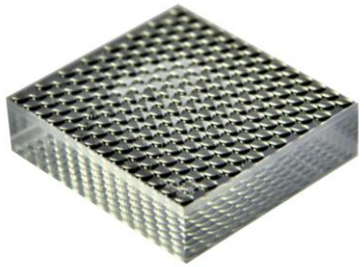
Die-bonding compatible



WaferOptics lenses provide optical base for small optical modules

Integrated filters and apertures

Focus free assembly

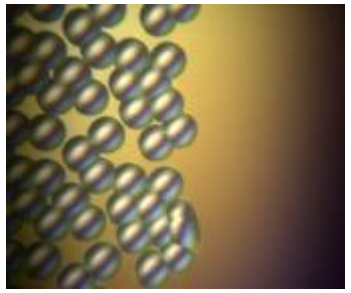


Automotive qualified

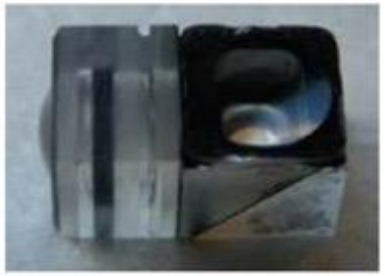
Examples of developed MicroOptics

2x2 optics array with integrated channel blocking

Two-channel optics for sensor (send/receive with integrated packaging and channel blocking)

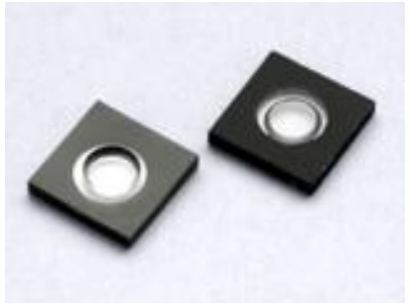


Random pitch MLA

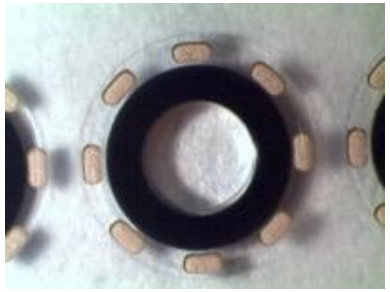


Folded optics lens unit for 20 Mpix camera

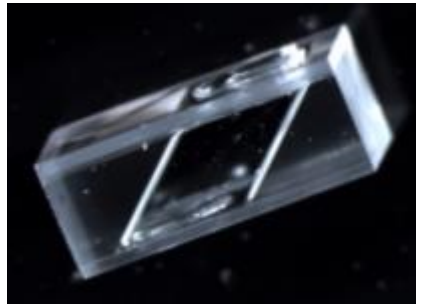
Ultra thin (50 um) aspheric lens



Fresnel lens with integrated black standoff

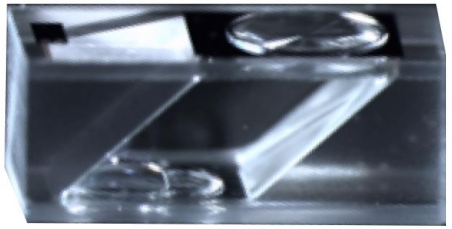


Lens with integrated electric contact

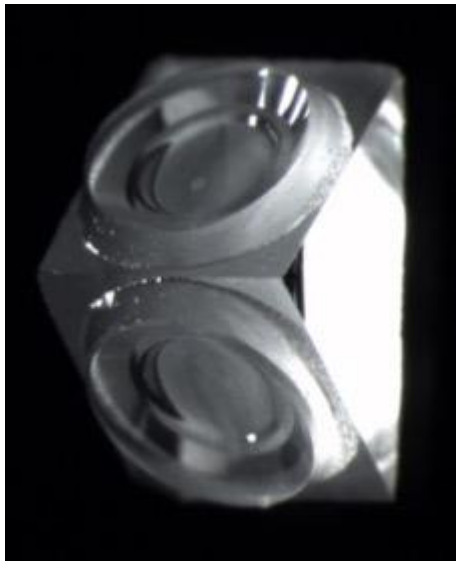


Folded optics periscope lens unit

Folded optics



periscope



freeform lenses on prism mirror, integrated aperture

Free-form lens is the logical next step to address some current issues:

- Illumination optics
- Zoom optics
- Periscope optics
- 180° panoramic optics

DynaOptics

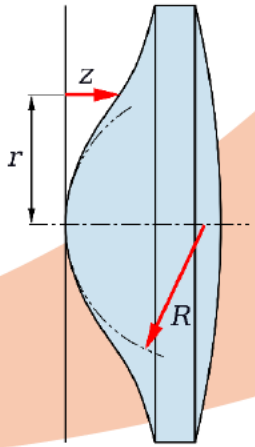
IMMERVISION

Anteryon

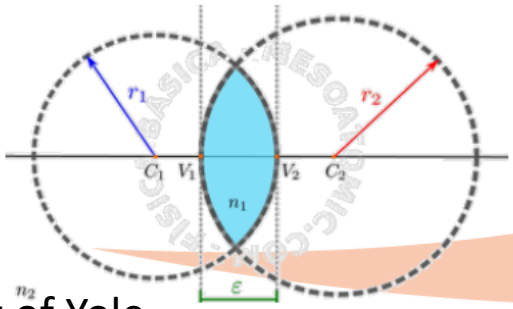
Freeform lens

courtesy of Anteryon

Aspherical lens



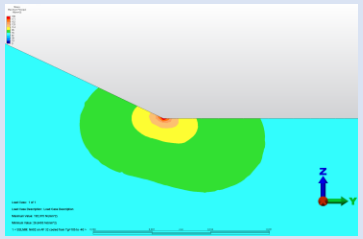
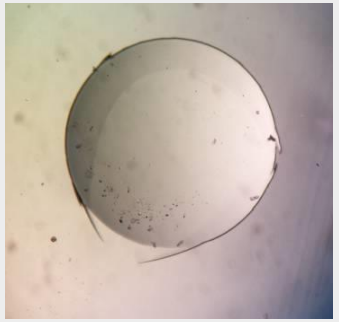
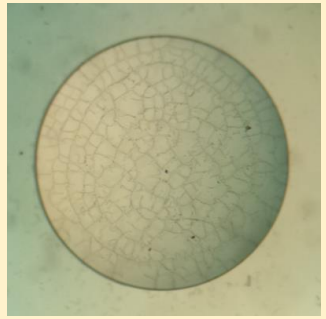
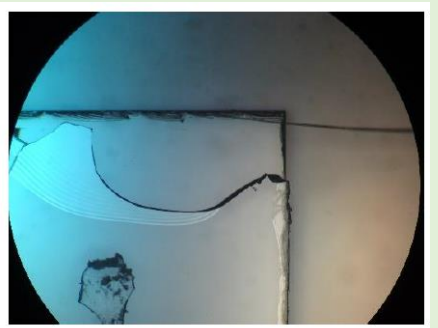
Spherical lens



Courtesy of Yole

Material and Coating challenges at MicroOptics

Higher demands on Temperature range and reliability drives need for wider range of material and coating solutions

Mastering	UV curing polymers	Coatings	Substrate-polymer interaction
Higher T-range demand improved reliability → Well defined edge quality of MLA molds required	Index range 1.4 – 1.6 → 1.3 to 'as high as possible' UV curing	Many low Tg polymers not suitable for AR coating	Delamination Glass cracking → Well defined & controlled glass-polymer interface
			

Material and Coating challenges at MicroOptics

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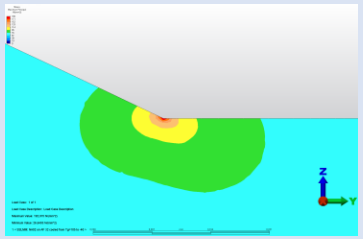
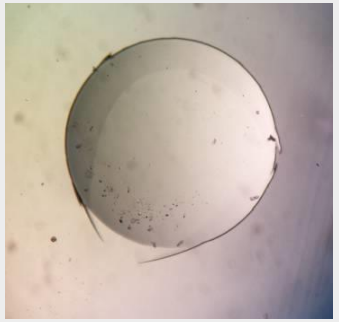
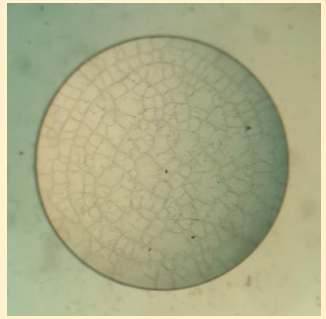
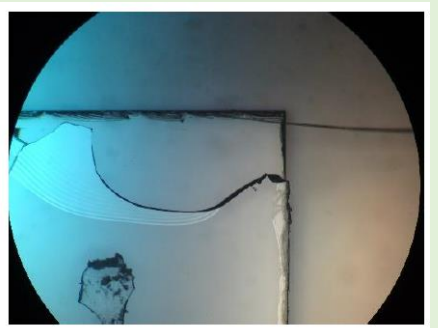
Mastering	UV curing polymers	Coatings	Substrate-polymer interaction
Higher T-range demand improved reliability	Index range 1.4 – 1.6 → 1.3 to 'as high as possible' UV curing	Many low Tg polymers not suitable for AR coating	Delamination Glass cracking
→ Well defined edge quality of MLA molds required	→ Wider range of polymer & coating combinations required (focus on reliability vs T and moisture)		→ Well defined & controlled glass-polymer interface
			

Cooperation required

Materials	- need more polymers with wider range of properties - high (and low) refr index
Coatings/AR solutions	- increased range of polymer/coating solutions
Equipment	- coating - bonding - etching - (laser) dicing - testing / inspection - measurement of micro-optics - replication
DOE design	- design - prototyping
Prototyping	-2PP, ion/ebeam etching

Many opportunities,

strong partnerships required

Conclusions

WaferOptics technology is used in Mass Production for refractive and diffractive applications, for consumer and automotive applications.

WLOPT and Anteryon joined up, currently creating a high volume lens and module manufacturing in Suzhou, China.

Future applications include MicroOptics for Sensing & Projection modules, enabling the roadmap from 2D to 5D sensing & imaging.

Cooperation required on polymer material development, coating, equipment, metrology, DOE design.

Polymer failure types

Bubbles

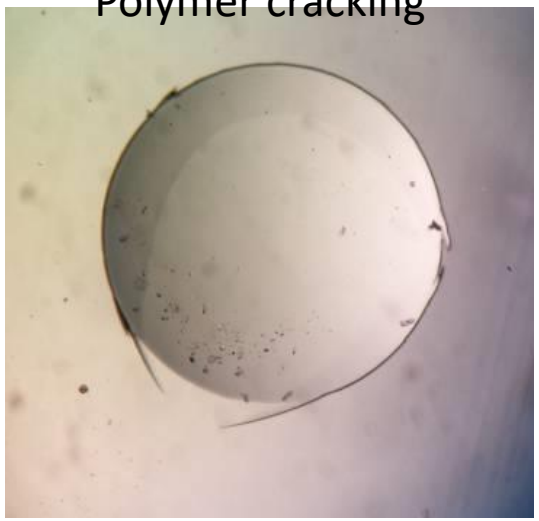
Orange peel

Results after exposure to high temperature
Bubble/orange peel skin

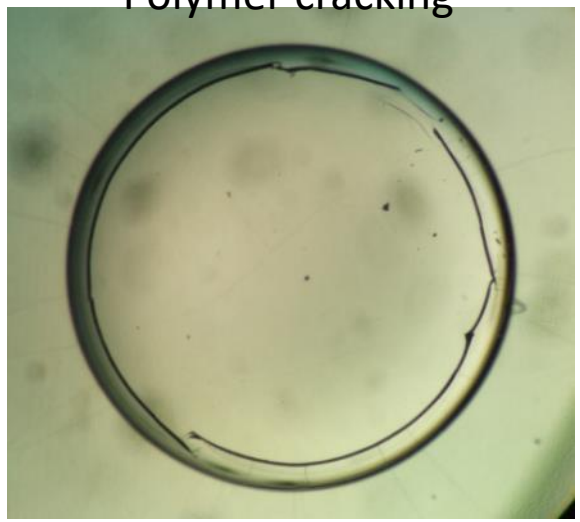
Status: solved for limited number of polymers

→ Need wider range of polymers with proven realiability

Polymer cracking

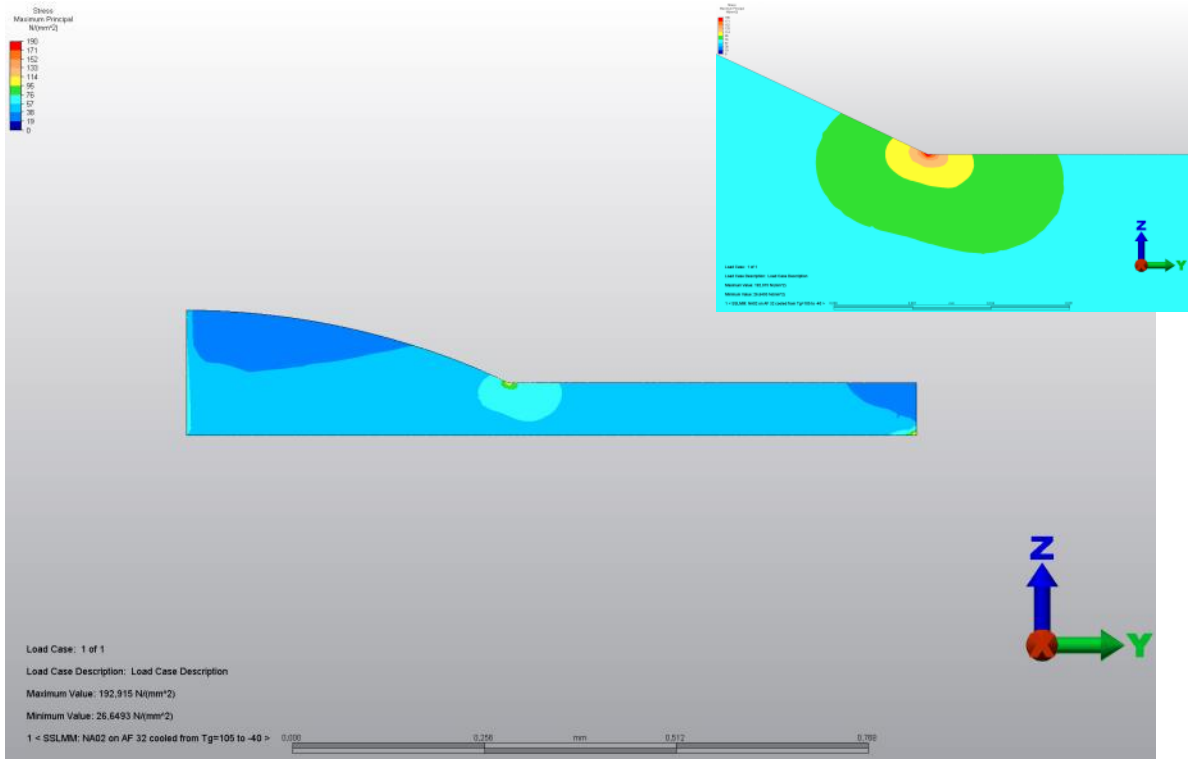


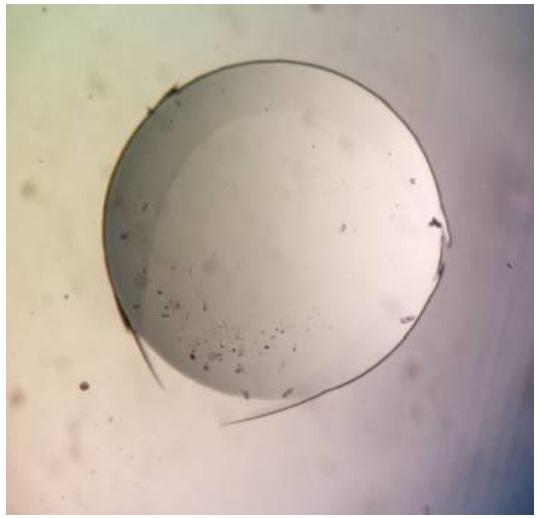
Polymer cracking



Results after T cycling tests -40..85C, 1000 cycles

Lens crack prevented by rounded edges



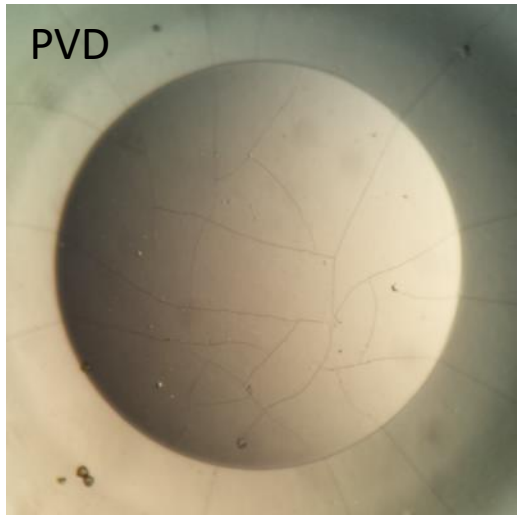


Sharp transitions introduce stress peaks → crack
Status: solved for single lenses, to be addressed for steep & big MLA

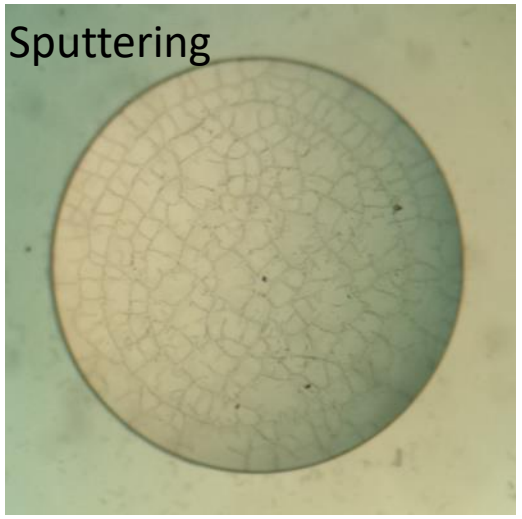
→ Well defined rounding of edge required
→ Mastering challenge

AR coating failure types

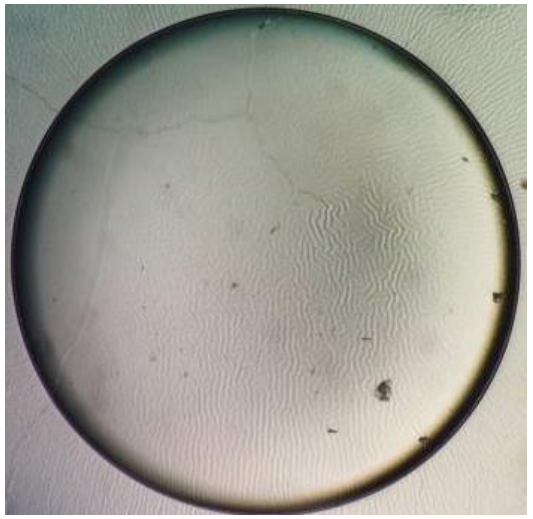
cracking



cracking



buckling

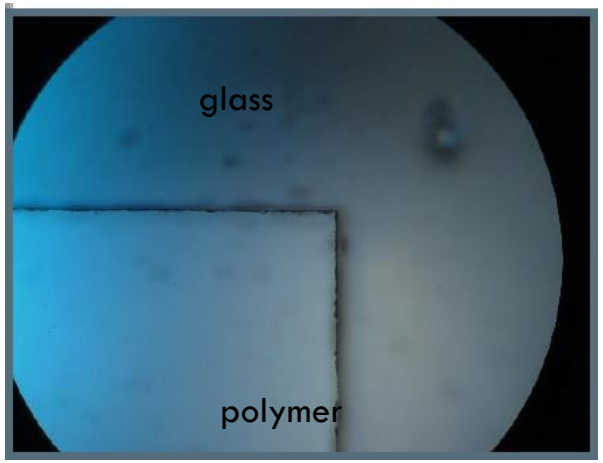


Failure modes after exposure to T cycling (-40..85C) test and/or high moisture testing (85RH/85C)
Status: Solved for limited number of polymer/coating combinations

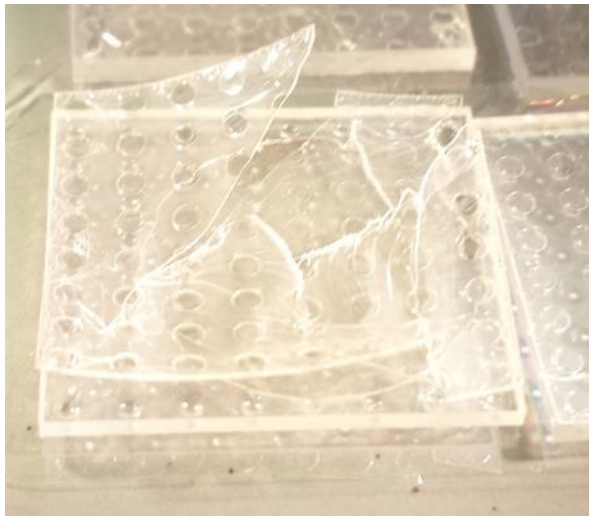
→ need broader set of material & coating combinations

Glass-polymer interaction

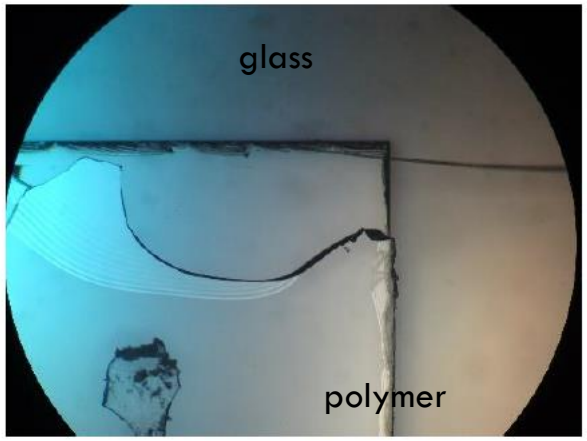
Reference



Glass fracture



Polymer crack & delamination



Status:
Solved for limited number of polymer/coating combinations

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