Sensing is life

Spectral sensing

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ams-OSRAM: key technologies and company figures

Key technologies

Emitters

- LEDs
- µLED (Micro LED)
- EEL/VCSELs
- Lamps

Optical components & micro-modules

- Optical elements: Lenses, light guides, DOEs
- Micro-optical packaging
- Optical modules

Detectors

- Light sensors
- Bio-sensors
- Image sensors

Integrated circuits & algorithms

- Emitter driver ICs
- Sensor interfaces
- Sensor processors (incl. algorithms)

Micro-Optical Solutions & Lamps

Sensing

Illumination

Visualization

ams OSRAM at a glance

5.04bn
EUR revenues 2021

5,500+
Engineers

~40/33/27%
AUT/IM/Consumer revenue split FY 2021

IM – Industrial and Medical, AUT - Automotive

40+
Major R&D locations

20,000+
Customers

~24,000
Employees worldwide

15,000+
Patents granted and applied for

110+
Years design + manufacturing

Optical sensing covers nowadays a broad field of applications

Leading market position,
driving industry innovation

Strategic positioning

3D sensing, light sensing, behind OLED,
image sensing, spectral sensing

Key technology areas

Consumer

– 3D sensing (face recognition, gesture recognition)
– Display management
– Camera enhancement
– AR/VR

Automotive

– ICS (In-cabin sensing)
– Advanced Driver Assistance Systems
– Adaptive cruise control
– Autonomous driving (LiDAR)
– Rain, kick sensor, night vision

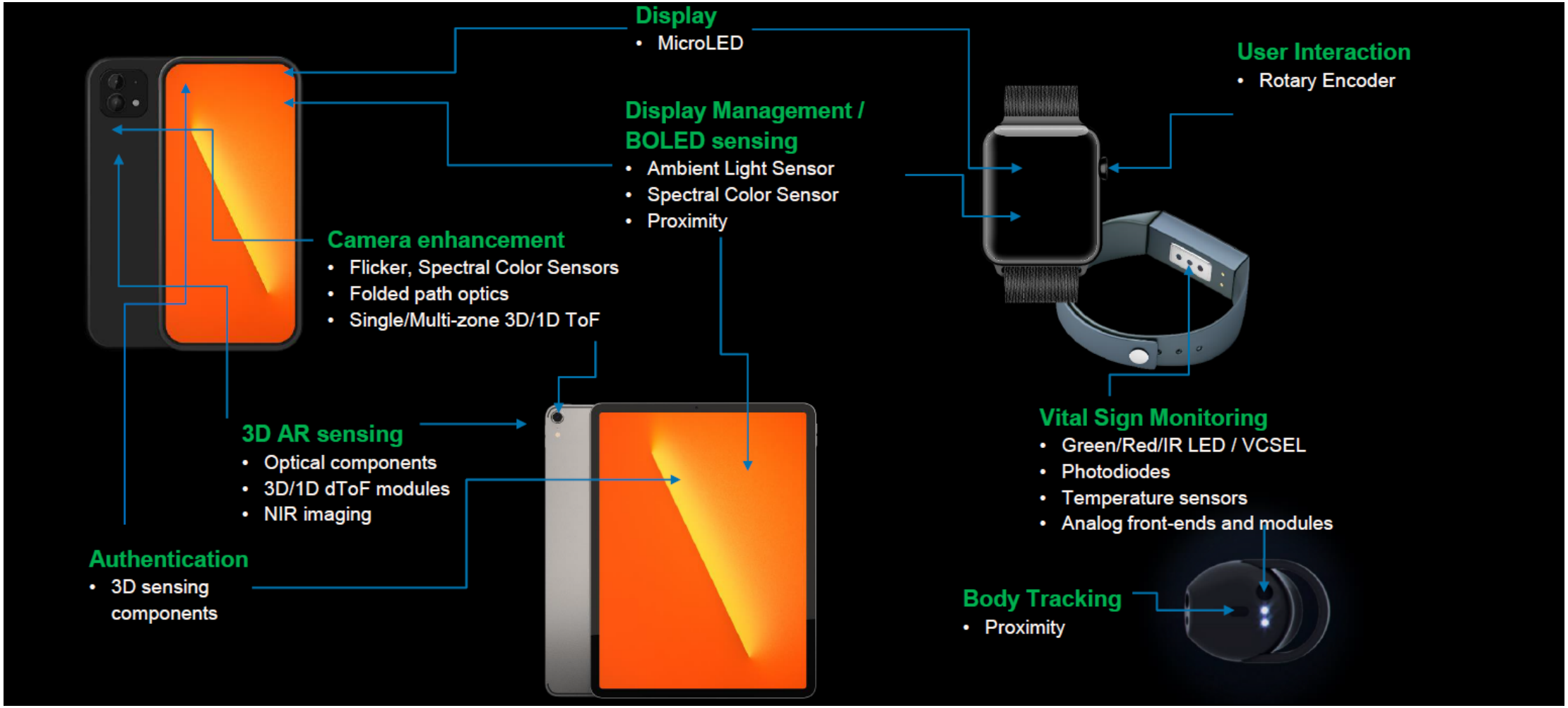
Industrial

– Imaging
– Automation
– 3D sensing
– Security
– LiDAR
– Spectroscopy

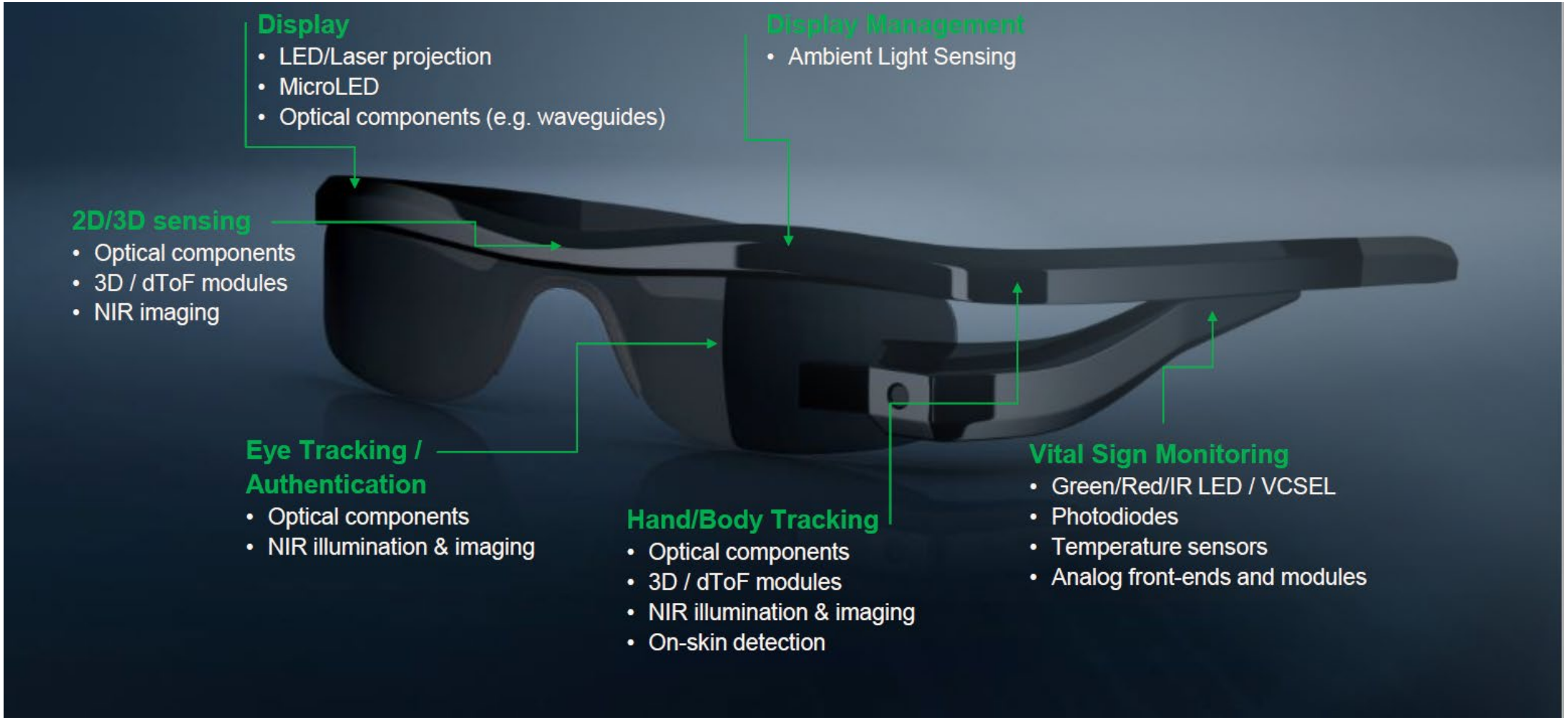
Medical

– Imaging
– Biosensing/LFT (Biometric identification)
– Health monitoring

Sensing portfolio for phones, wearables, and tablets

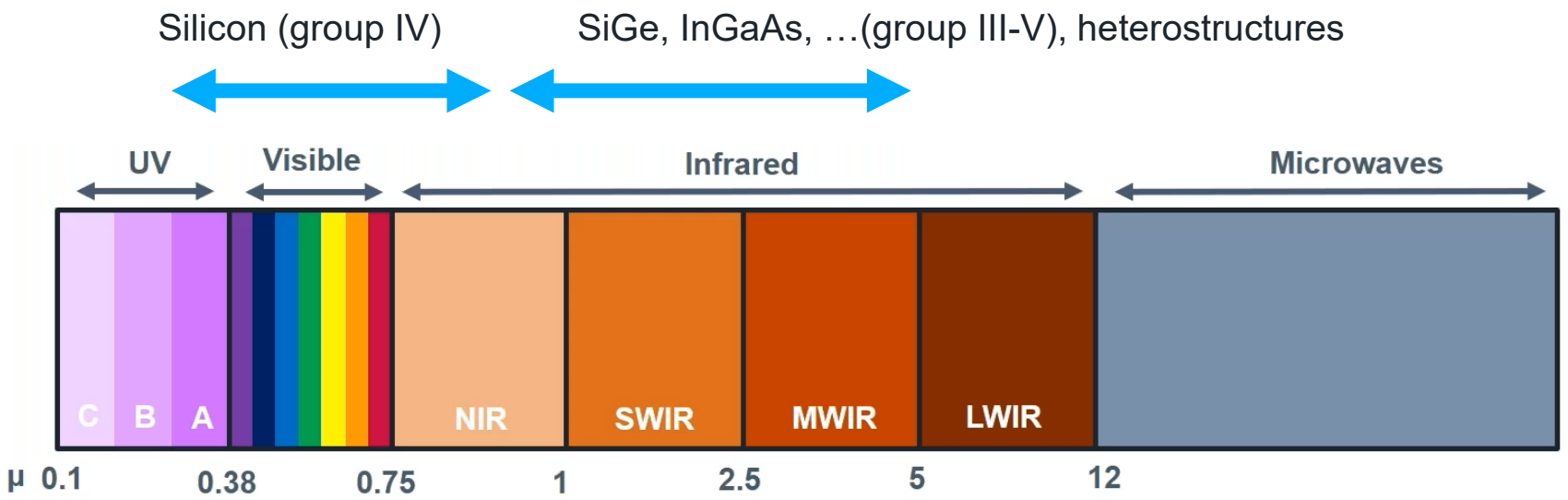


Sensing opportunities in future AR/VR glasses



Spectral sensing: Technology development key to cover spectral range

How can we make sensors available for every market: Imaging that spectrometer cost just a few USD?



UV: New Product development implementing a 3-channel sensor with UV A,B & C capability (2022/23)

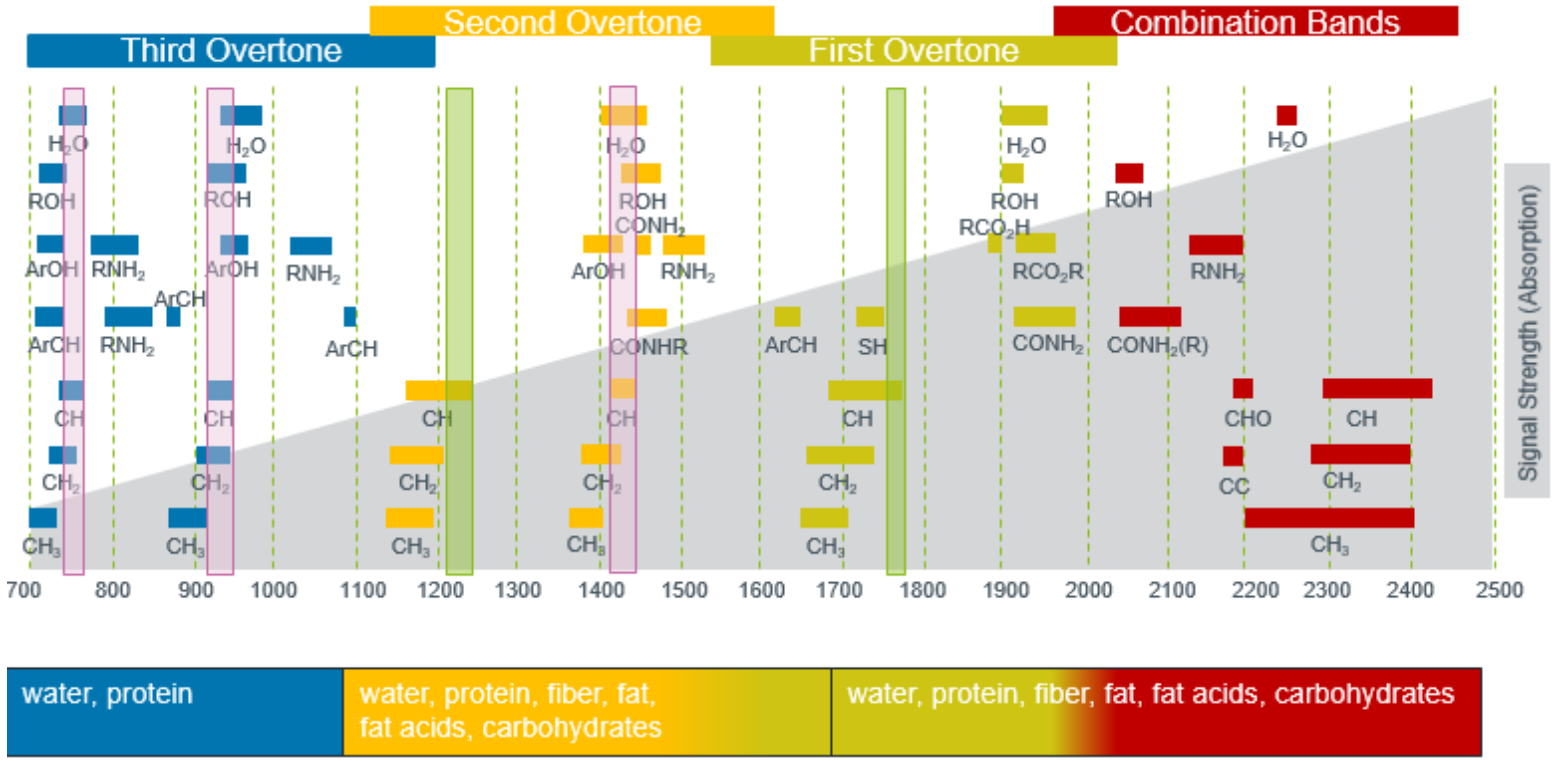
VIS/NIR: Broad range of multi-channel products ranging from 6 to 14-channels on one chip (available now)

SWIR: Technology developments for the near future (2023/24)

- Quantum energy of IR Photons (0.001 to 1.7 eV) matches the energies separating quantum states of molecular vibrations.
- Signatures from organic materials
- (Organic : carbon and H, N, O, …)
- At room temperature: vibrations arise as molecular bonds are not rigid and behave l
  ike springs
- And each type of molecule group…

  … has it's own fingerprint

Enabling SWIR/MIR spectral sensing is key to increase performance



Longer wavelengths increases signal strength but leads to higher noise, thermal noise →

Name of the game

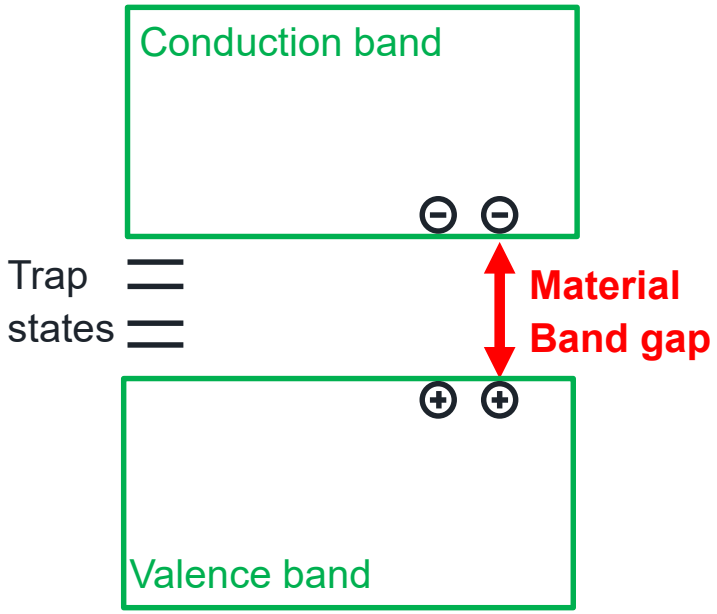
Maximize signal to noise ratio

NIR/SWIR. Broad, overlapping bands, not too specific. 10-100x weaker than MWIR, samples ~ mm thicknesses. Samples can be examined neat in reflectance. A number of instruments have been developed, mostly in NIR.

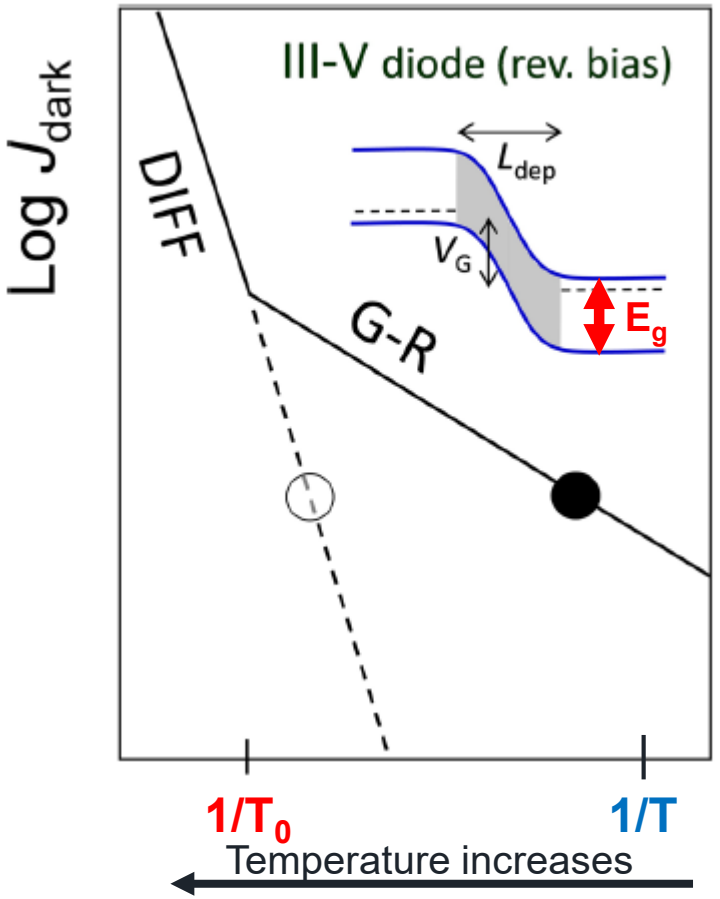
MWIR/LWIR. Very specific/characteristic spectra. Difficult to do portable. Samples need to be thin (< 50 µm for Liquids/Polymers). Attenuated total reflectance (ATR) provides few µms pathlegths. Interferometers are temp and vibration sensitive

The larger the wavelength the smaller the bandgap: Room temp. operation gets more difficult

Schematic band gap diagram including defects



Schematic dark current for a reverse biased III–V photodiode



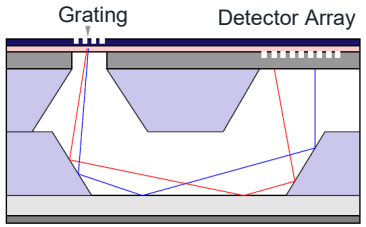
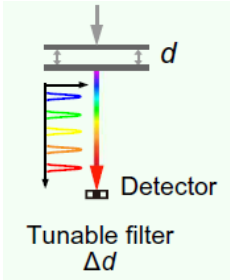
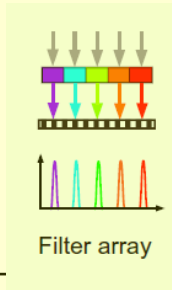
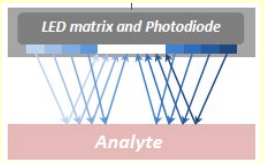
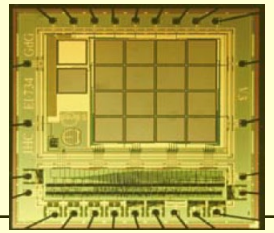
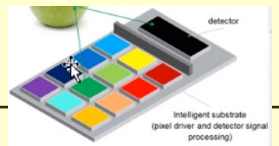
The transition from absorber for UV-VIS to absorber for SWIR-MIR spectral range makes the bandgap smaller leading to more temp. dependent GR dark current

Name of the game

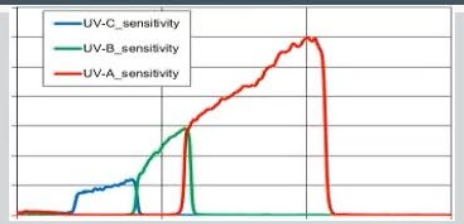
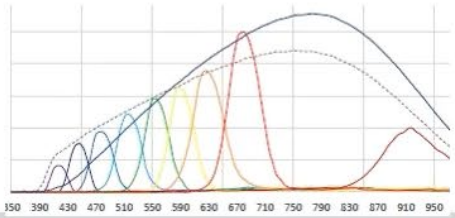
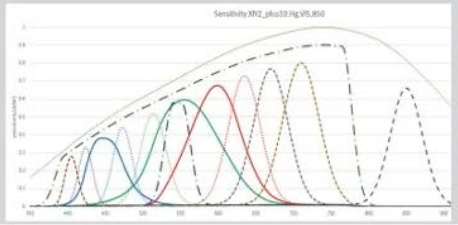
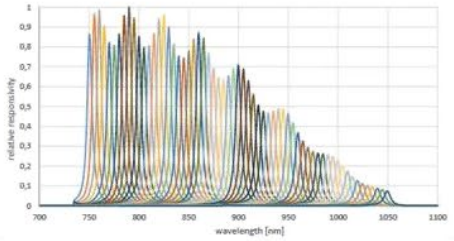
Maximize signal to noise ratio

Portable infrared spectroscopy system concepts

NIR (0.8-1µm)/SWIR(1-2.5µm) /MWIR (3-5µm).

Dispersive Optics	Tunable filter	Filter Array	Variable Emitter (LED/filter LB)
			
			 
PD-array Only NIR Broadband Silicon PD array Difficult in mobile setup	Single-PD SWIR Narrow ~ 300nm Single InGaAs PD High-resolution	PD-array NIR Broadband Silicon PD array Limited # channels	Emitter array and single PD. No filter. SWIR Broadband

Available products covering UV-VIS-NIR spectral range

Range	Spectrum	Type	Details
UV		UVA/B/C	▪ UVA/B/C filter characteristic (238nm – 415nm)
VIS/ NIR		8-ch Vis+NIR	▪ 11-ch total: 8 visible channels + Near IR within 400-1000nm, Clear and Flicker
VIS/ NIR		12-ch XYZ, VIS + NIR	▪ 14-ch total: 12 spectral channels within 400-1000nm (XYZ, VIS + 1 NIR)
NIR		64-ch NIR	▪ 64-channels ranging from 700-1050nm (NIR)

Infrared Spectrometer products

Multi-spectral design. AS7421

Key features

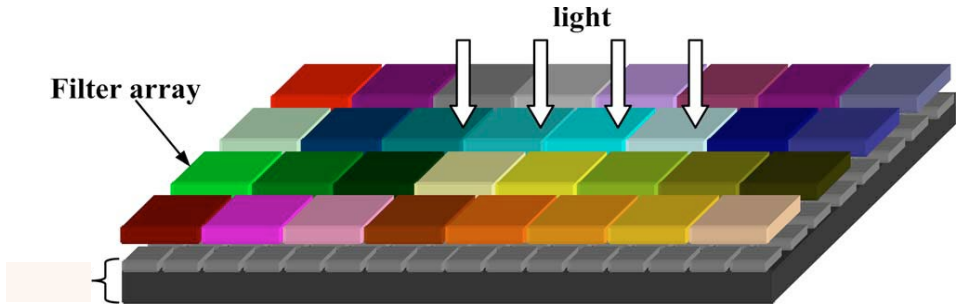
- 64 channel PD matrix
- NIR spectral range 750-1050nm
  (61 wavelengths, 5nm separation, 4 corner pixel with 830nm) FOV: ±6°
- Complete module with light source & micro-optics
- 16 ADCs with independently programmable gain
- Power consumption (typ): 2,5mA active, 2µA sleep
- Module size 6.6 x 6 x 2.2mm (OLGA 10 package)

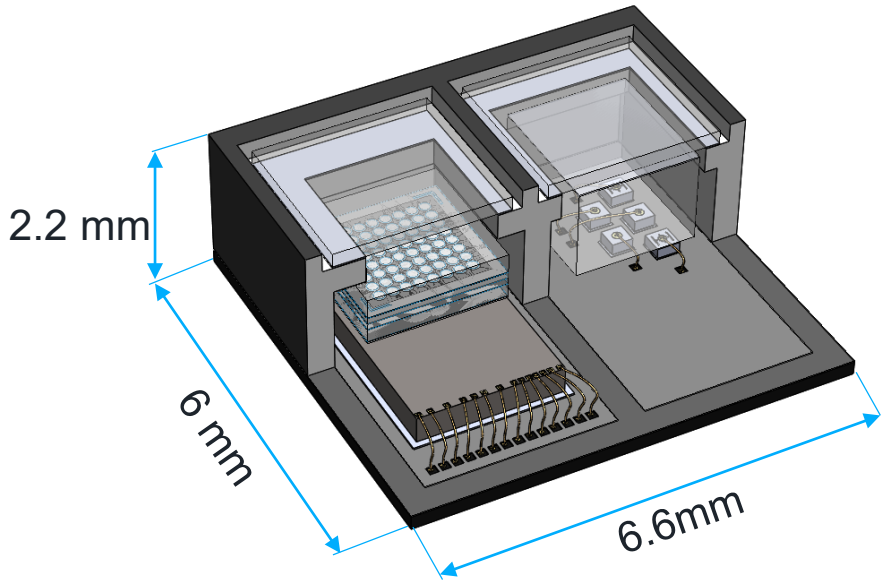
Benefits

- Future developments with different filter sets possible (VIS 400-700nm)
- High channel count will enable a detailed detection of the spectral response in the range of 750-1050nm

Applications

- Reflective object spectral sensor for substance/material analysis for consumer electronic devices





Infrared Spectrometer products

Tunable Fabry-Pérot spectrometer. AS7520

Key features

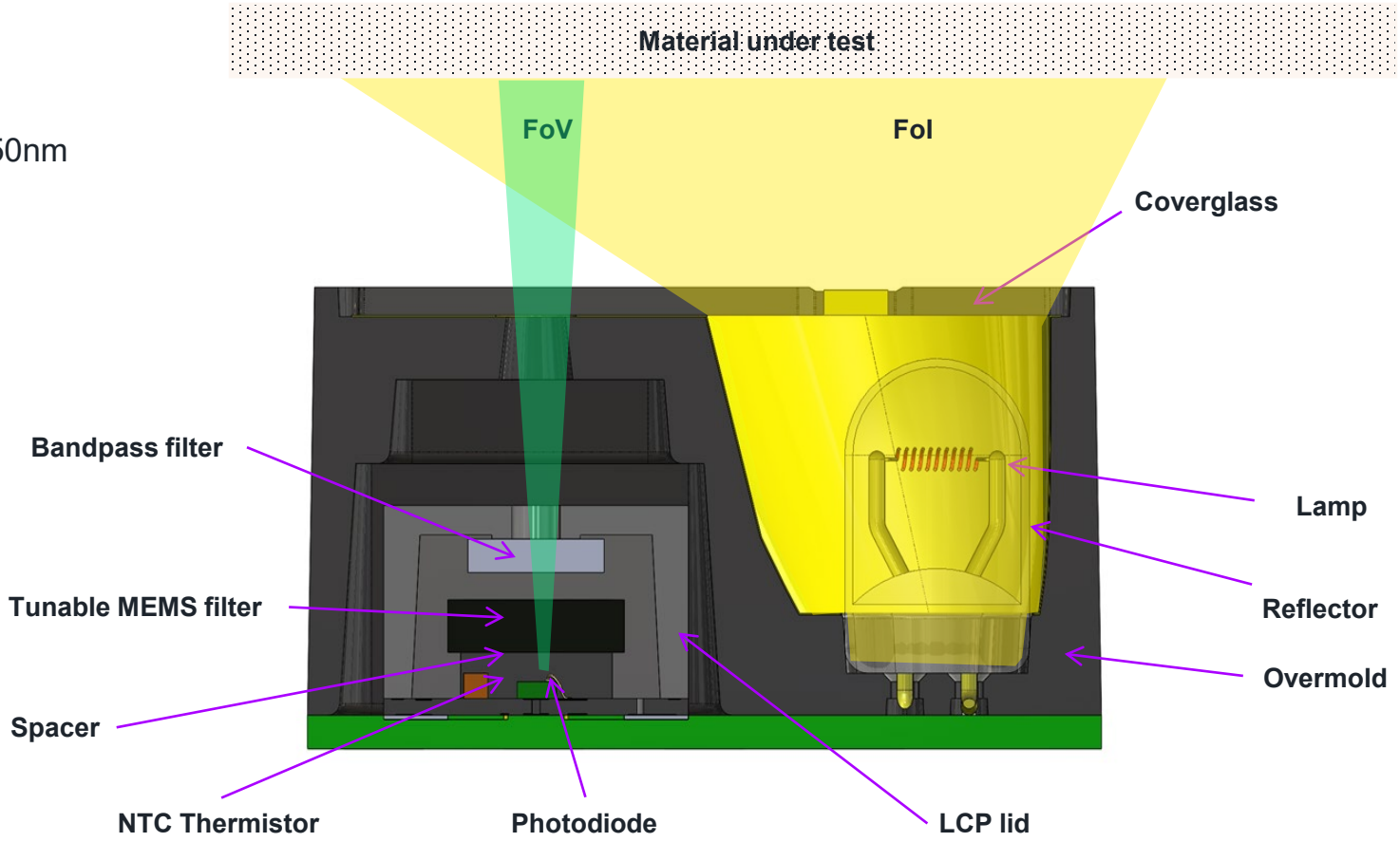
- Tunable Fabry-Perot band-pass filter from 1350nm - 1650nm (1nm steps with 8 nm resolution @ 1500nm)
- Capability to extend to 2150nm with same packaging concept (1550 – 1850nm or 1750 – 2150nm)
- InGaAs photodiode detector
- Light source: W-vacuum bulb, ~2000K; 52mA @ 2.4V
- Precision-designed packaging (aperture) to control angle-of-incidence of incoming light (FOV=12°)
- Package size analog unit 9.9x6x5.1mm³
- Calibration & algorithms running locally on MCU

Benefits

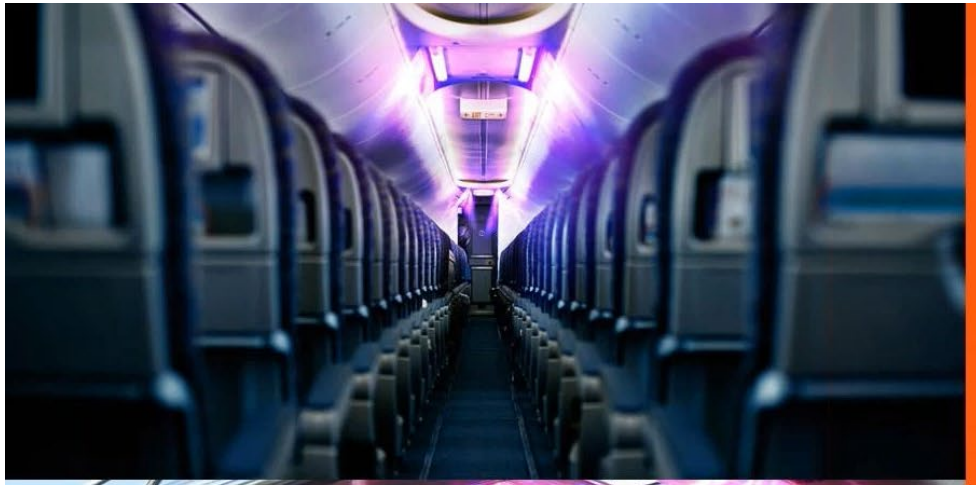
- 10x smaller than today's available products
- Lower cost & complete solution for NIR spectrometry
- Faster time to market with complete system solution
- Stepwise detection of spectral fingerprint within near-infrared spectrum above 1µm

Applications

- Food scanning
- Material / fraud detection
- Moisture content detection
- Industrial process control
- Personal health



UV sensing allows disinfection and horticulture monitoring



UV-C Disinfection

- Ultraviolet light is a chemical-free, efficient disinfectant which can eliminate up to 99.9 percent of viruses and bacteria and sensing enables accurate dose control
- Strong demand push also due to the Covid-19 pandemic
- Seeing increase of UV-C technology for a range of consumer health, industrial and medical applications – e.g. UV-C disinfection and pathogen decontamination

Horticulture

- LED light and spectral sensing technology enable real-time monitoring of total illumination at the plants to manage targeted growth lighting recipes
- Chip-scale spectral sensing technology extending from the visible to near-infrared (NIR) opens all-new areas of condition and plant-growth monitoring
- Crop-sprayer controls, plant detection, plant health, drone optimization and imaging, grain harvesting, storage monitoring

NIR sensing allows non-invasive Fruit Freshness measurement

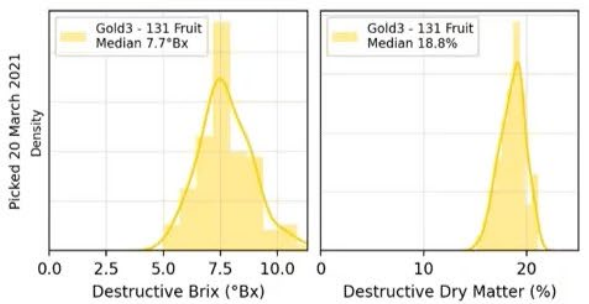
Based on Brix and Dry Matter content

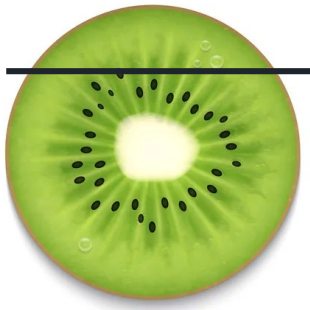
Existing solution:

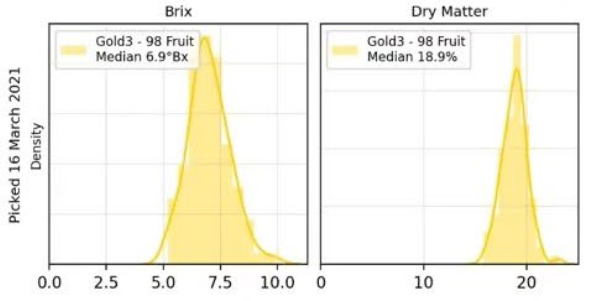
- Based on destructive refractometer
- Fruit needs to be destroyed and juice is measured
- Kiwi for example are harvested at very low Brix level (similar to lemon juice)
- Typically ripen en-route to market or at large facilities at the final destination
- Therefore exact point of harvest is critical

New solution using NIR chip-scale sensors:

- Non-invasive NIR spectroscopy
- Machine learning model (AI) used to derive parameter BRIX (SSC) and Dry Matter (DM)
- 1000+ Kiwis used for data modeling



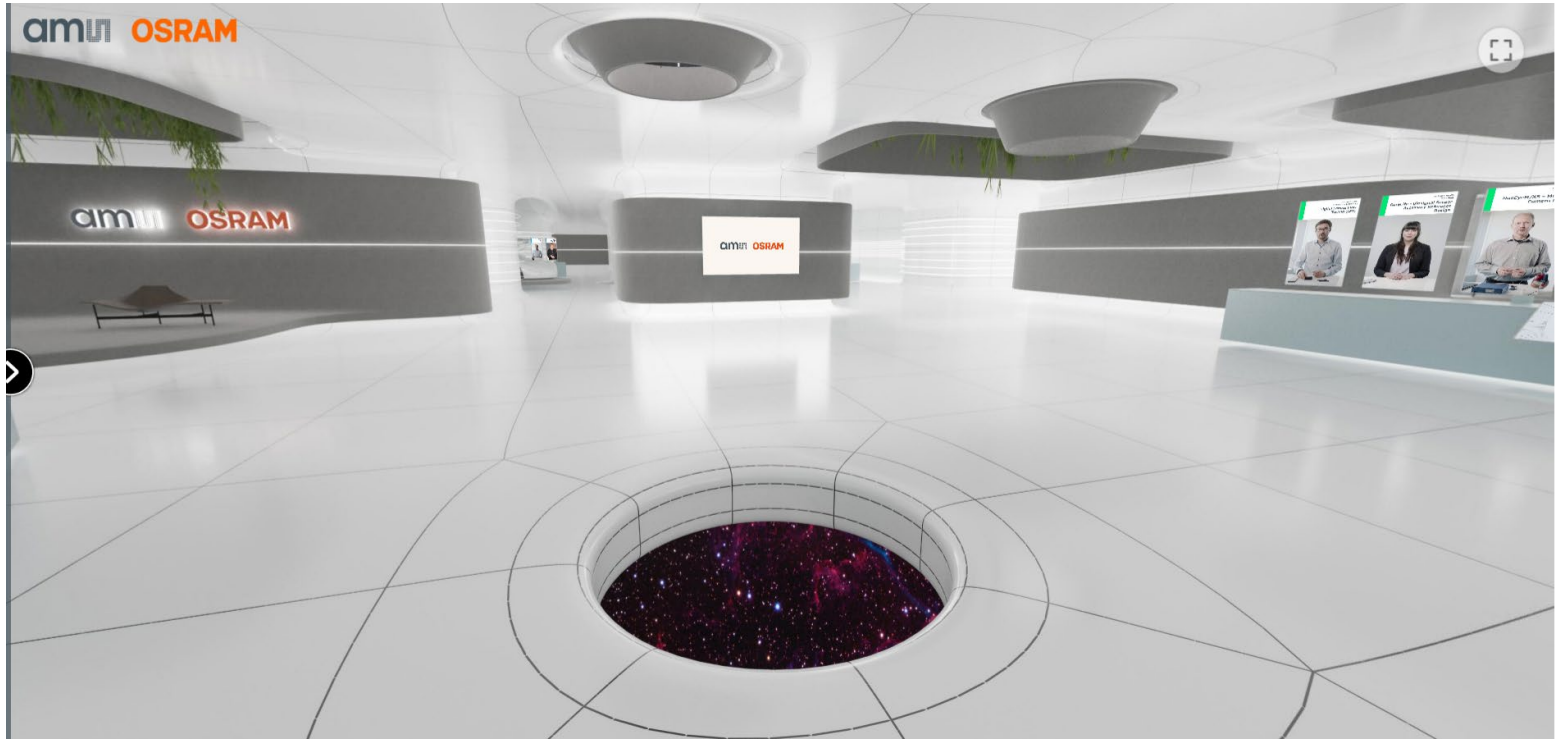




Top: Destructive measurement results
Bottom: Kiwi-meter measurement results

Please explore many more sensor solutions online

[ams OSRAM Virtual Showroom -EN (ams-osram.com)]



Thank you

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