

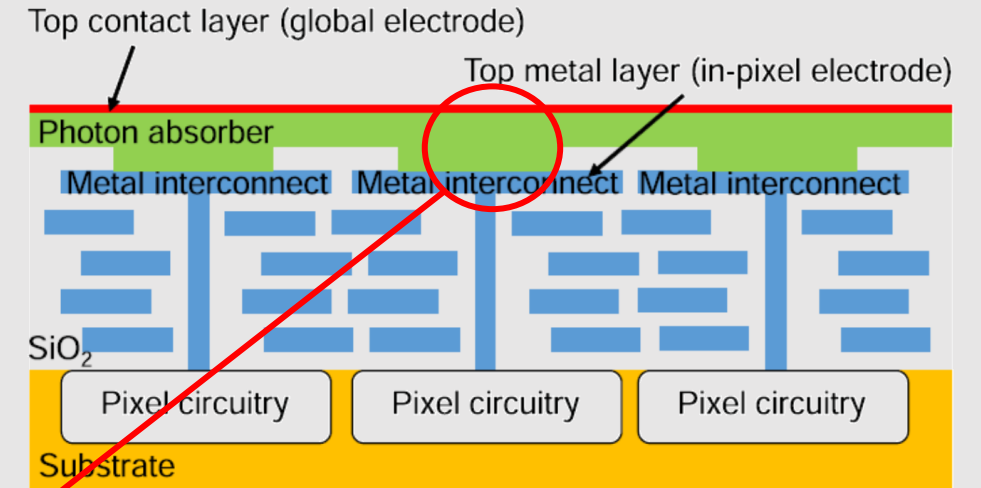
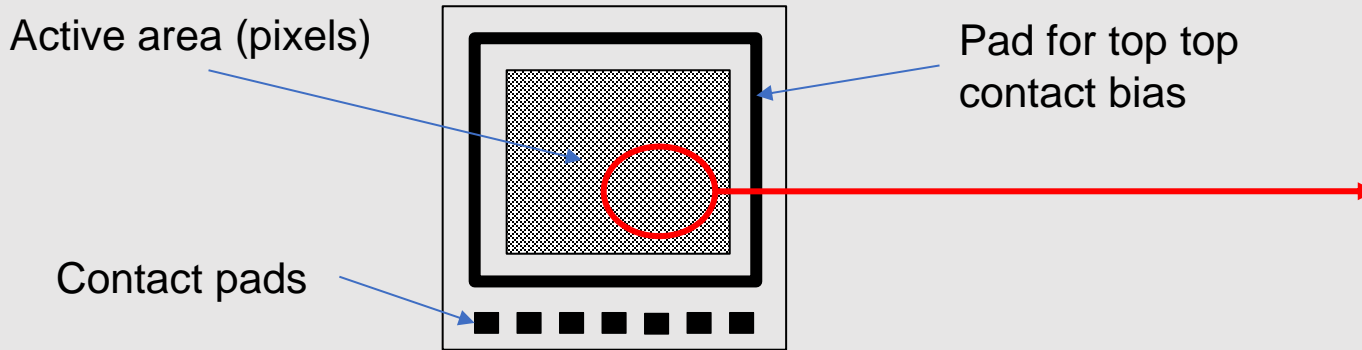


Next generation  
Quantum Dot  
SWIR sensors:  
Computer vision applications

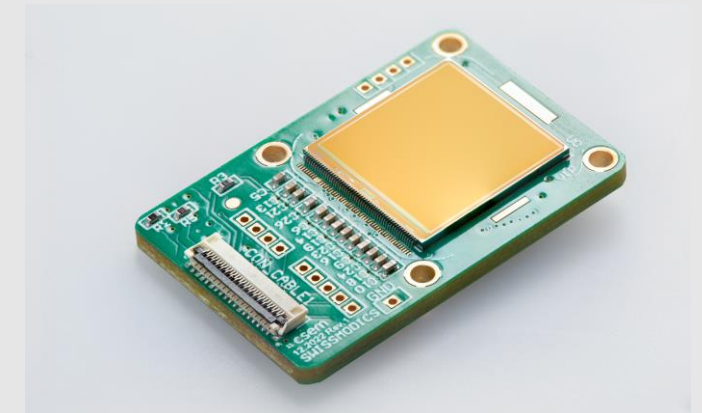
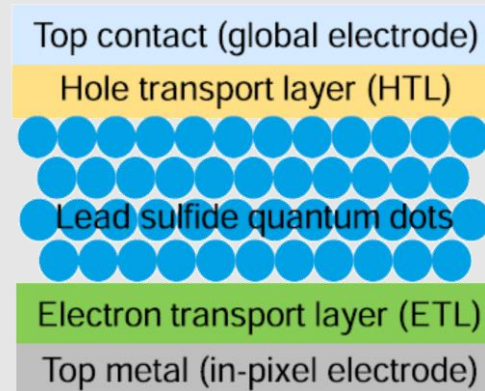
Artem Shulga, Founder and CEO

# QD SWIR sensor technology

## CMOS ASICS for quantum dot technology



- Resolution: 512 x 512 pixels
- Pixel pitch: 22.5  $\mu\text{m}$
- Global shutter
- Dynamic range: > 100 dB
- Maximum frame rate: 30 fps



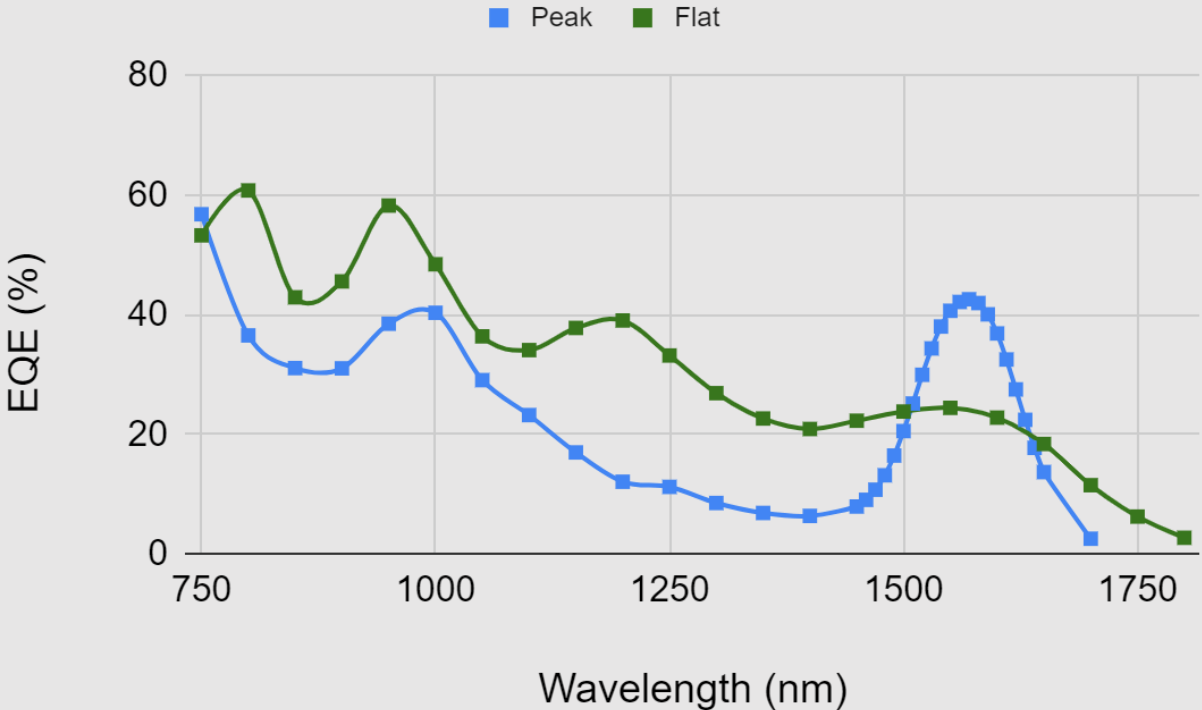
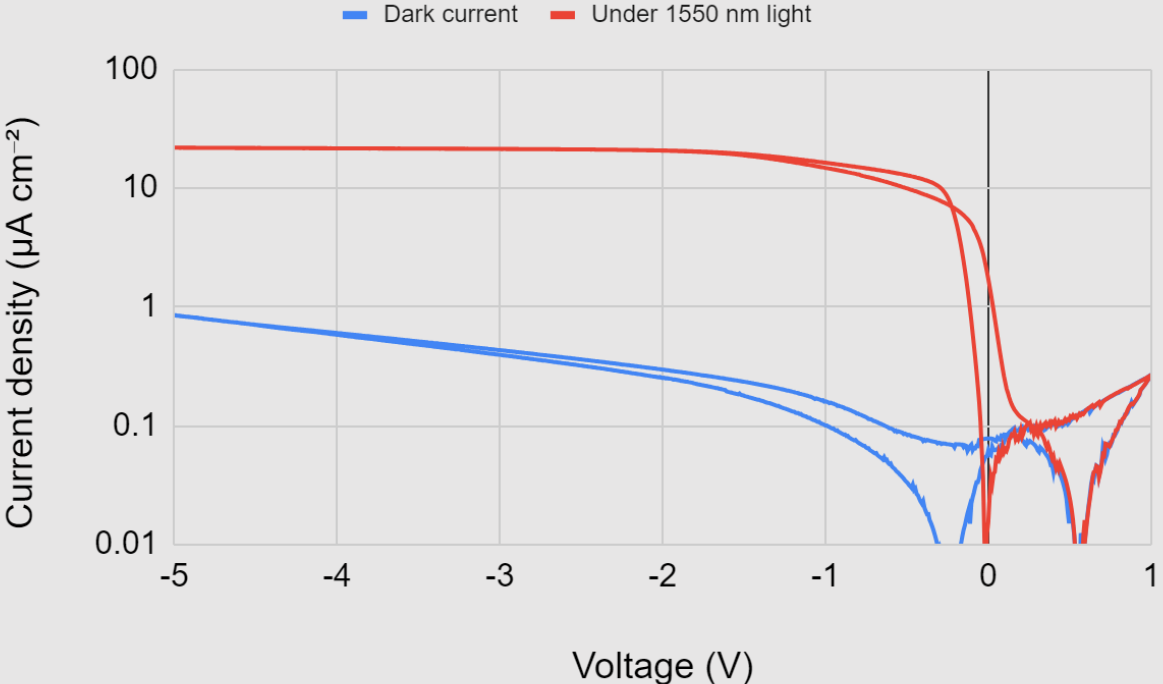
C. -M. Zhang, R. Quaglia, A. Shulga, V. Goossens, P. B. Cruz and P. -F. Ruedi, "A Quantum-Dot-Coated Image Sensor With a Wide-Spectral Sensitivity From X-rays to SWIR Photons," in *IEEE Sensors Letters*, vol. 8, no. 8, pp. 1-4, Aug. 2024

# QDI SWIR demonstrator camera

- Solution processable QD SWIR photon absorber
- QD stack deposited on a single chip
- No cooling
- ROHS compliant
- No image processing software
- Spectral range: 350-1700 nm (up to 2500 nm)
- Also in X-ray detector configuration



# SWIR reference photodiode performance



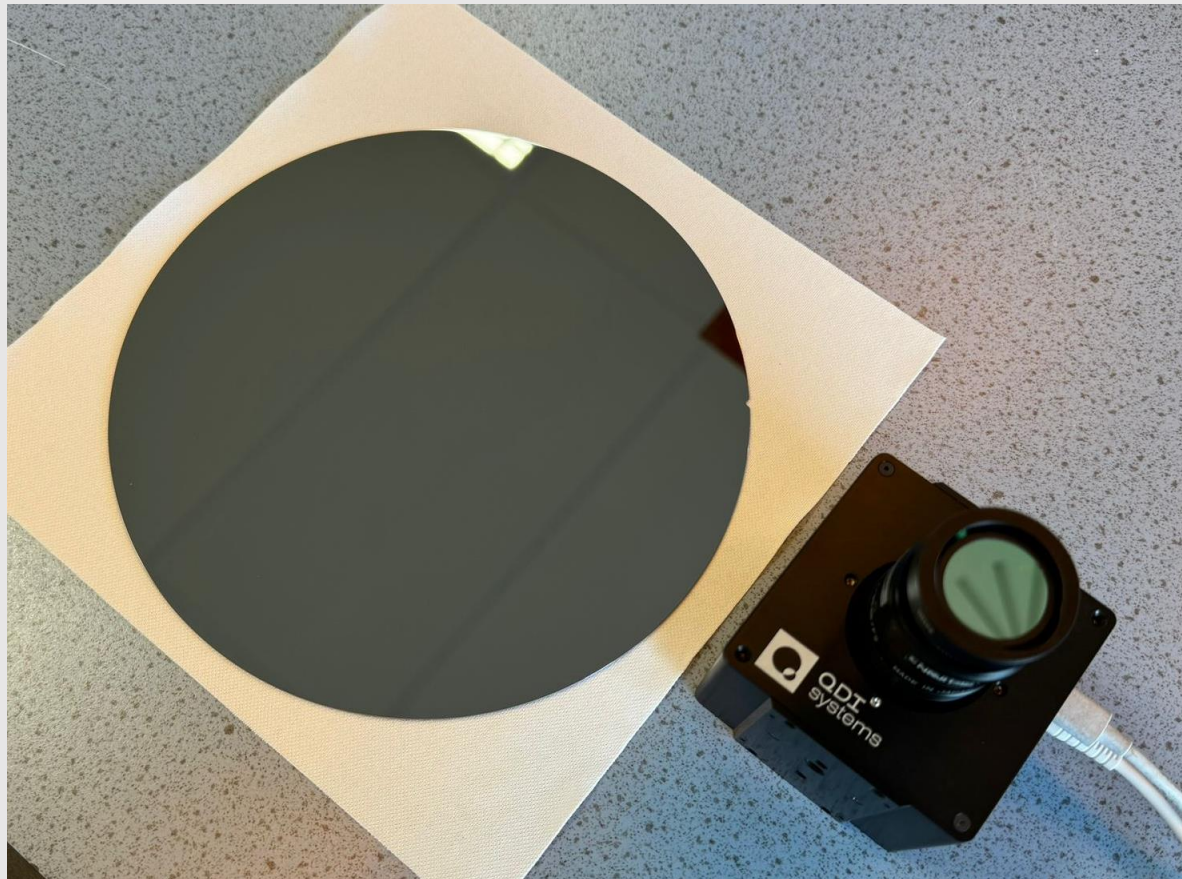
- Dark current of  $\sim 100 \text{ nA/cm}^2$ ,  $>40\%$  EQE at 1550 nm
- Option with  $>20\%$  EQE in the entire range

# APPLICATION EXAMPLES

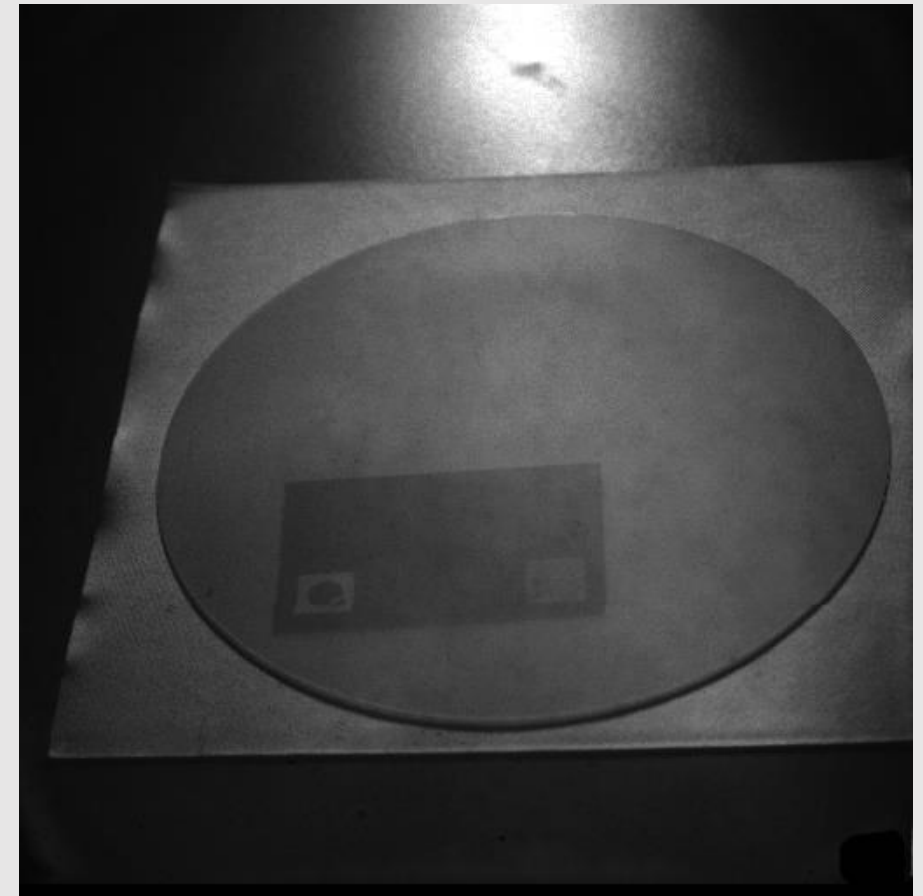


# Silicon wafer inspection (1550nm)

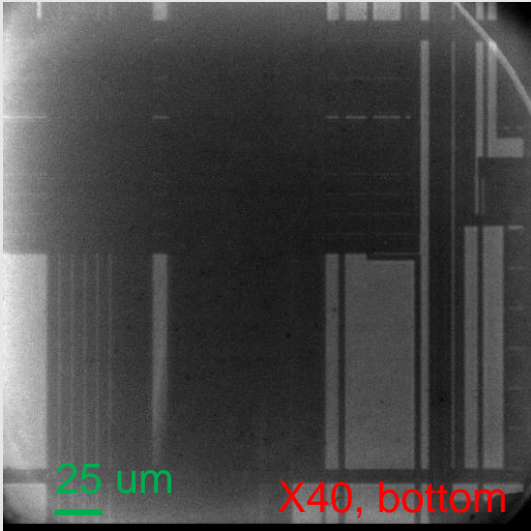
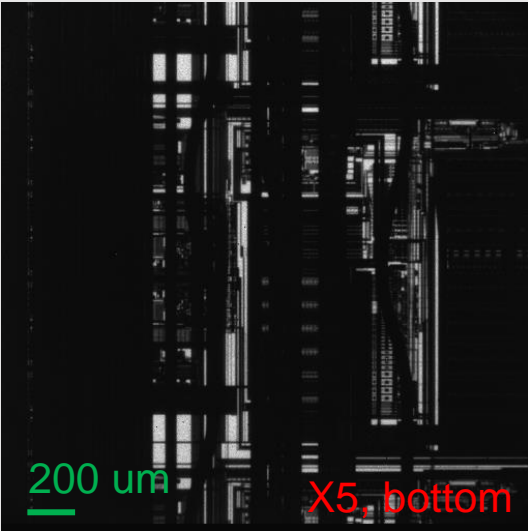
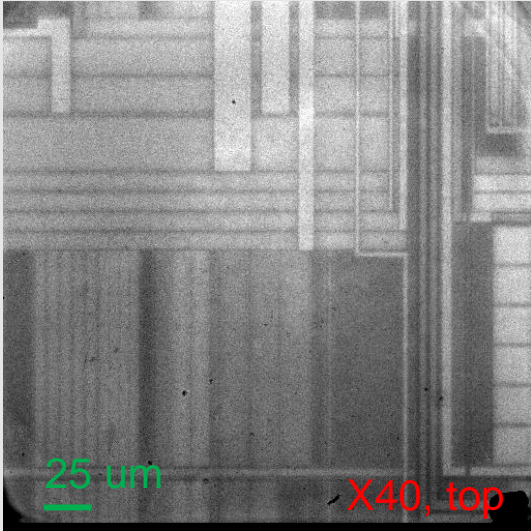
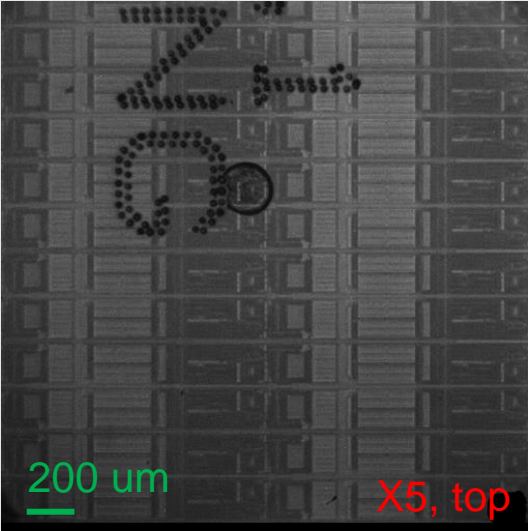
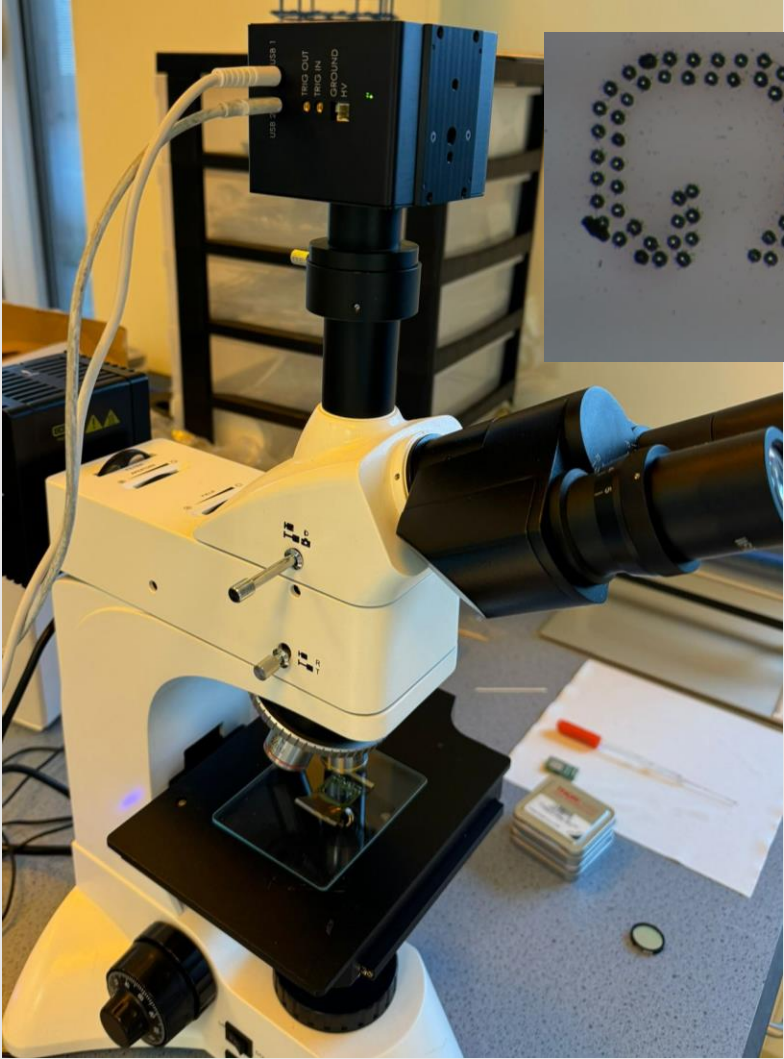
Smartphone:



QDI sensor, 1550 nm:



# SWIR microscope for Si wafer inspection (1550nm)





# Liquid filling

White light

Smartphone



SWIR, 1550 nm





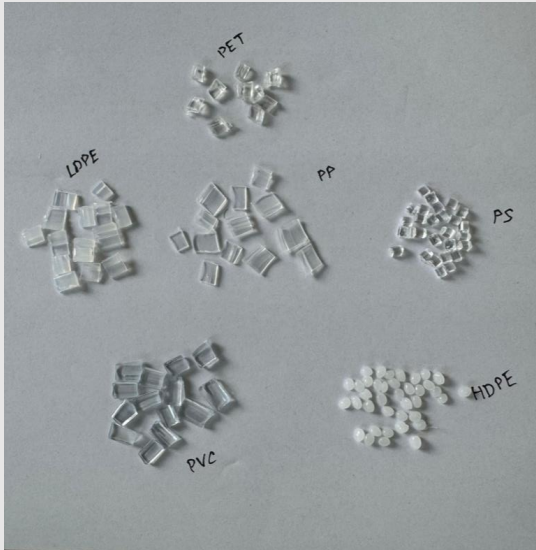
# Machine vision for food sorting



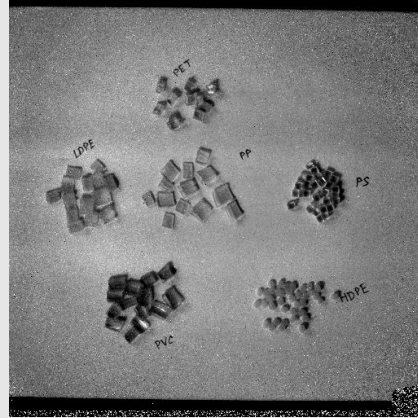
Using SWIR to sort coffee beans from stones.

# Plastic sorting

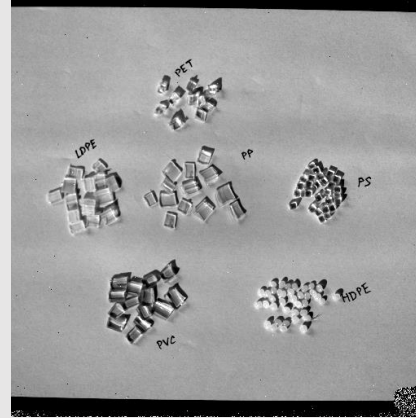
Smartphone



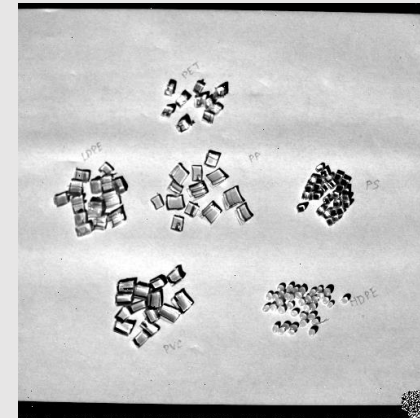
Cut-Off WL 450 nm



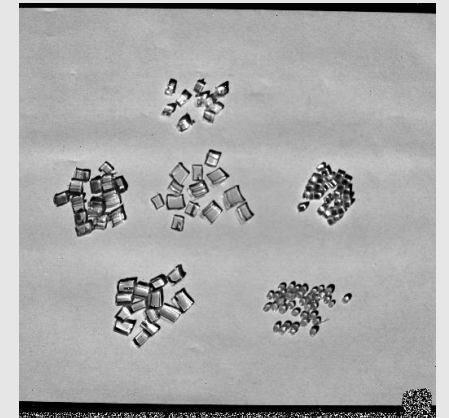
Cut-Off WL 700 nm



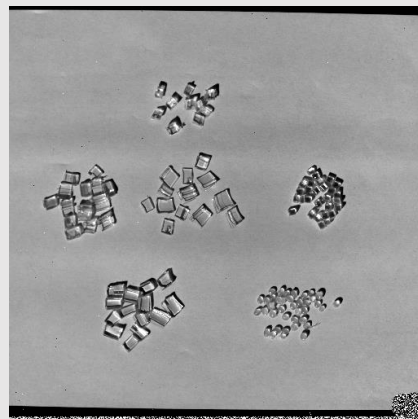
CWL 900 nm, FWHM 40 nm



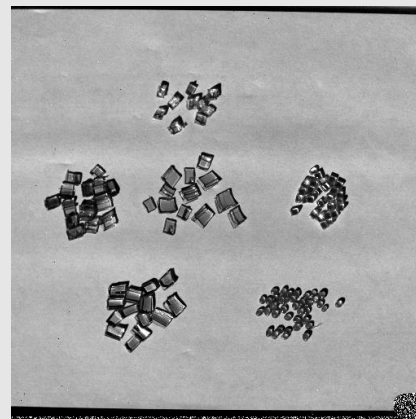
CWL 1250 nm, FWHM 10 nm



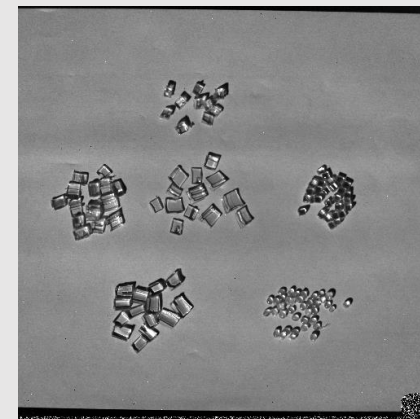
CWL 1300 nm, FWHM 30 nm



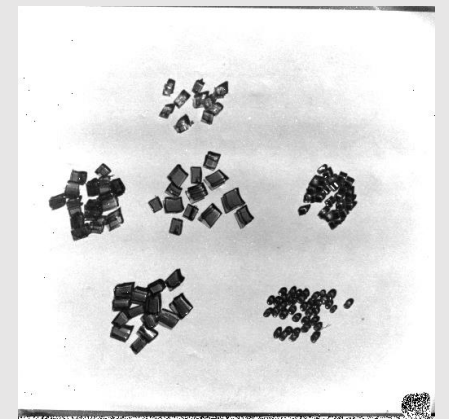
CWL 1400 nm, FWHM 12 nm



CWL 1600 nm, FWHM 12 nm



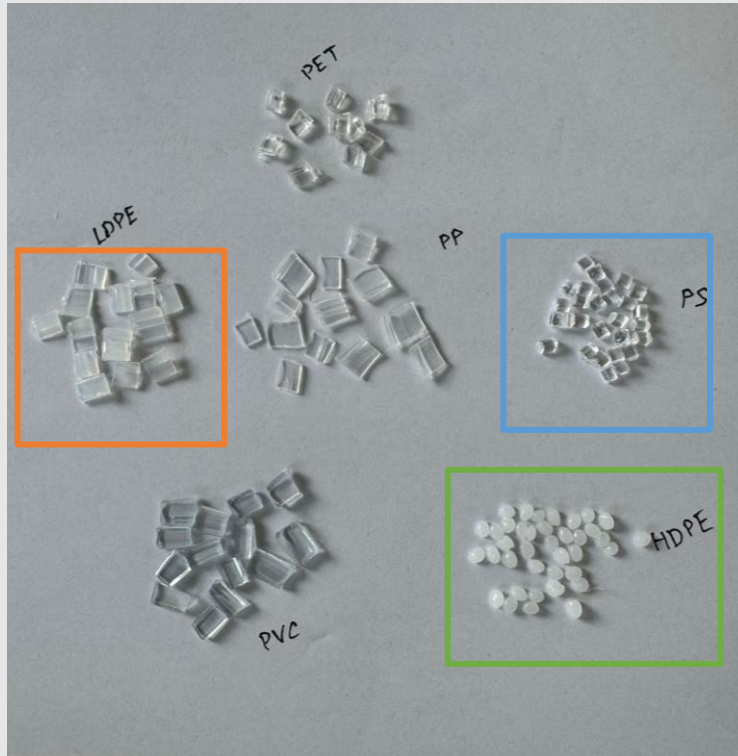
CWL 2000 nm, FWHM 500 nm



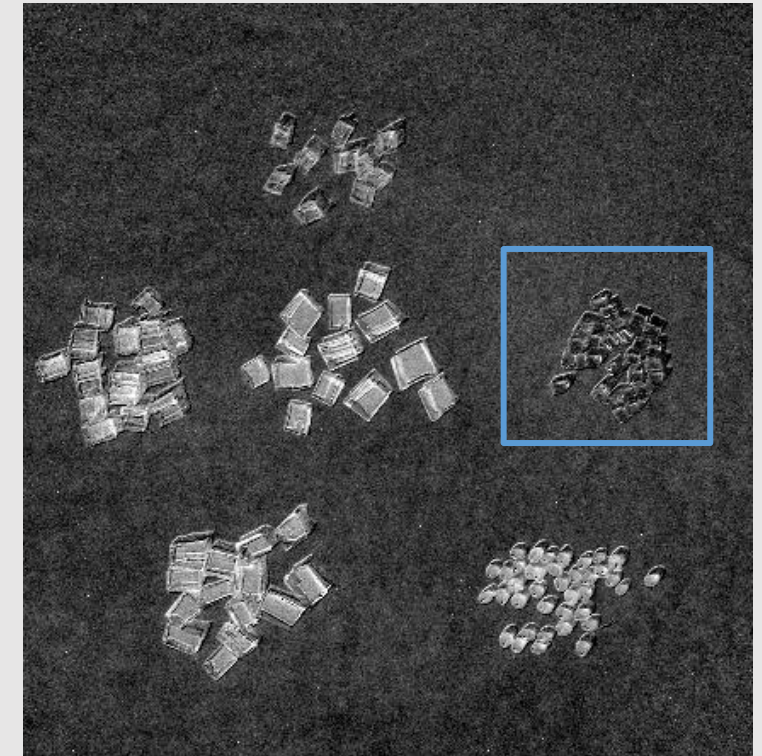
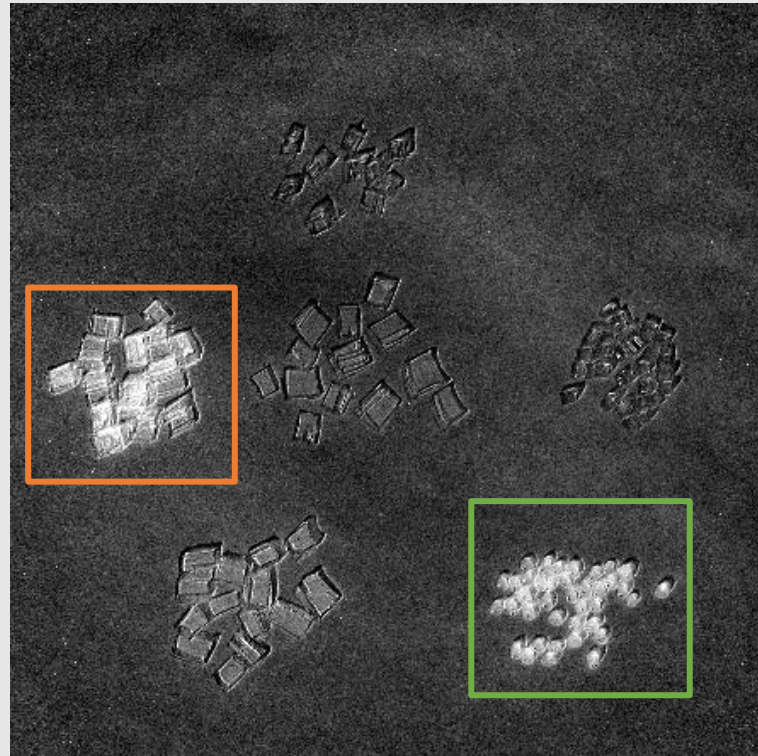


# Plastic sorting

Smartphone



Processed SWIR images

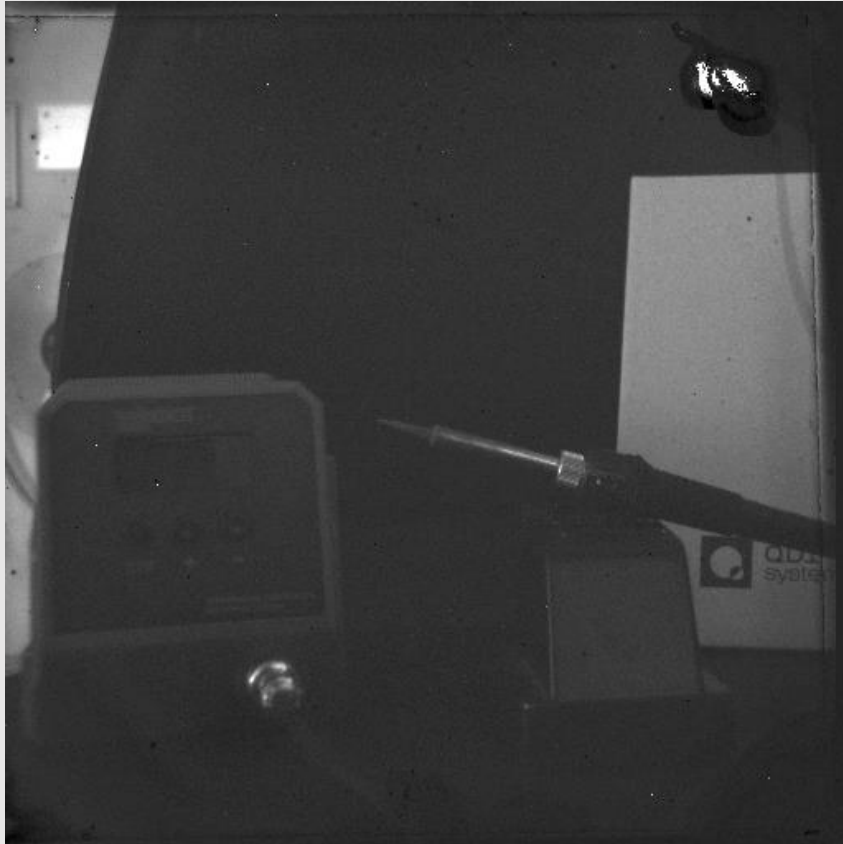




# Thermal pictures

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Cold



385 C



**Thermal emission of a soldering iron is visible in SWIR**

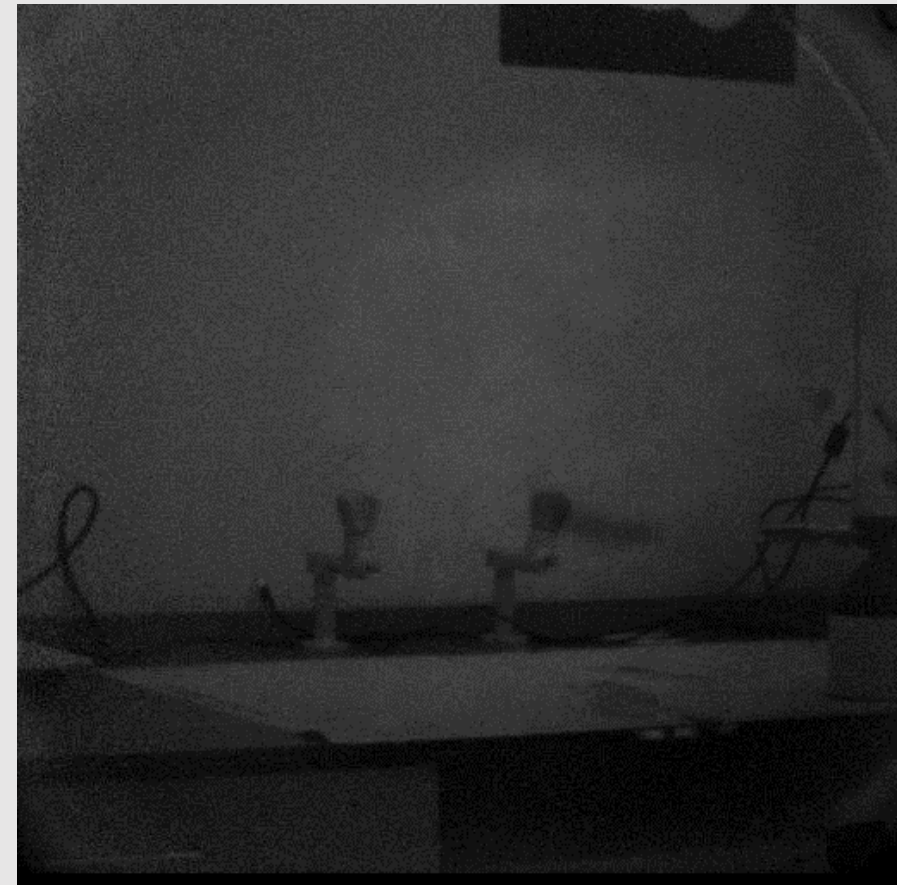
# Glass heat processing video

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Smartphone:



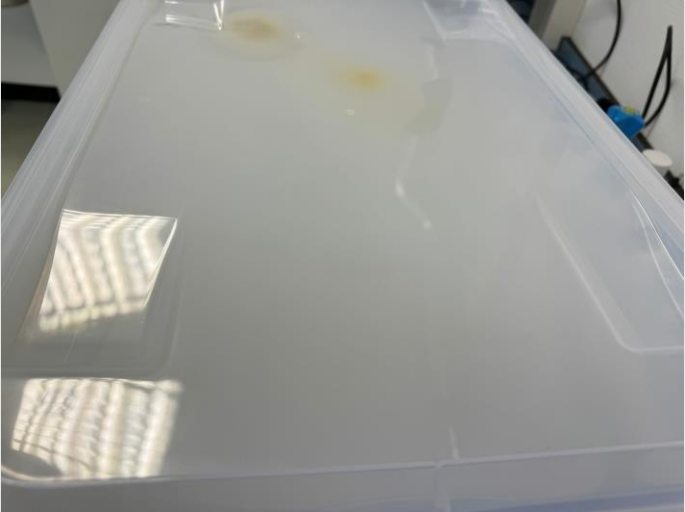
QDI sensor, 1550 nm:



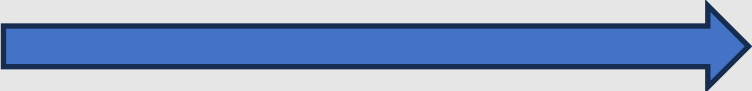
# Imaging through smoke (1550 nm)



No smoke



Picture through smoke





# Security application

Smartphone selfie



QD sensor, visible light



QD sensor, 1300 nm



QD sensor, 1550 nm



**Artificial skin and artificial hair are clearly distinguishable in SWIR**

# WHAT WE DO



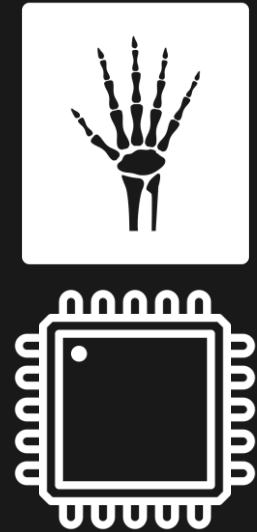
Quantum dot  
synthesis



Quantum dot Ink  
formulation



Quantum dot film  
deposition



TFT and CMOS  
Image Sensors

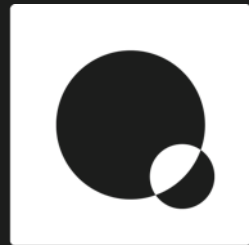


## ● QDI systems

# SWIR TECHNOLOGY SUMMARY

- Leader in SWIR QD technology
- 15 FTEs, 350/270 m<sup>2</sup> lab/cleanroom space
- Our goal is to increase the field of use of SWIR by making technology more accessible
- Technology is ready for production, assembling a manufacturing line in Groningen in 2025





QDI  
systems