MEMS Sensors for health and environmental monitoring

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Contents

The purpose of this presentation is to highlight some important enabling technologies which enable new devices & solutions & services for health and environmental monitoring

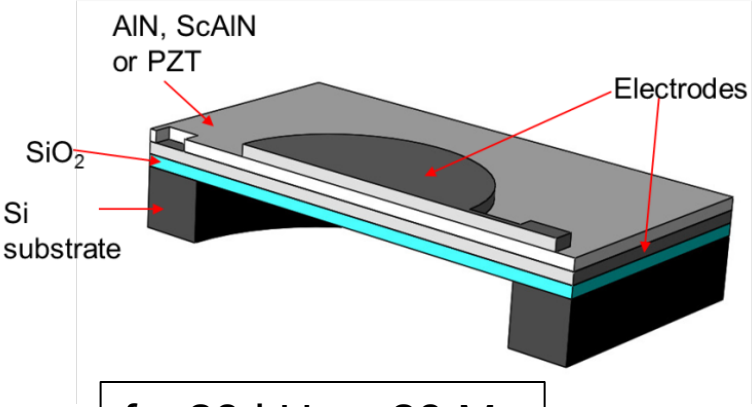
1. Ultrasonic health, wellness & therapeutic devices
2. Gas sensors for health and environment monitoring
3. Novel imaging devices

pMUT (piezoelectric ultrasonic micromachined transducers) and their applications

Imaging plaster

Proximity sensing

Gesture based user interface



f = 30 kHz – 30 Mz

Ultrasonic Near Field Communication

Smart plasters for ultrasonic imaging @ VTT

Value proposition: Wearable imaging device for continuous imaging of body functions and structures

Competitive edge: MEMS ultrasonic transducers offer the same performance as traditiotonal piezoceramic ultrasonic transducers used in professional medical imaging but in a wearable form factor. pMUT superior to cMUT technology in (i) sound power level (ii) no need for high bias voltage

Development phase: Transducers available for application development. Flexible integration platform available

IP status: Manufacturing and design know-how.

Offering: Custom and application specific designs, prototyping, production services, technology transfer.

R&D infrastructure: VTT´s Micronova Cleanroom

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Butterfly Network, a three-year-old tech startup owned by Rothberg, has just announced financing to the tune of $100 million, and hopes to build its first prototype of a handheld medical imaging device the size of a smartphone in the next 18 months. (22 Dec 2014)

Wide-area sensor arrays on flexible platforms @ VTT

Value proposition: A hybrid process for manufacturing wide-area flexible light sources and flexible sensor arrays.

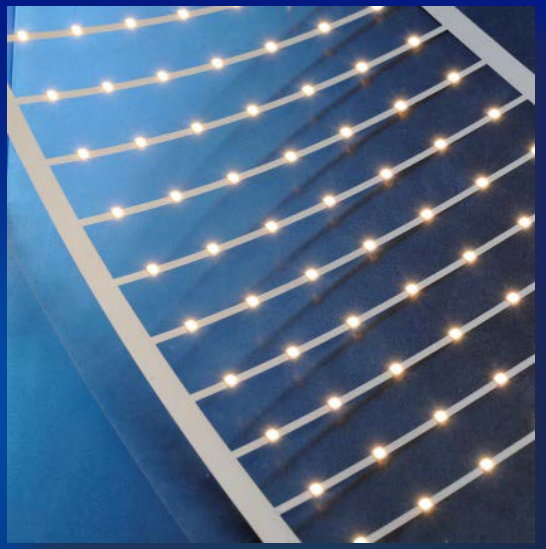
Competitive edge: Customer-specific lighting system design and pilot manufacturing.

Development phase: Proof of concept for the complete manufacturing process from printed electronics and hybrid integration to in-mould integration.

IP status: Proprietary know-how.

Offering: Feasibility studies, application demonstrators, pilot production.

R&D infrastructure: Design, simulation, prototyping, pilot production and testing facilities.



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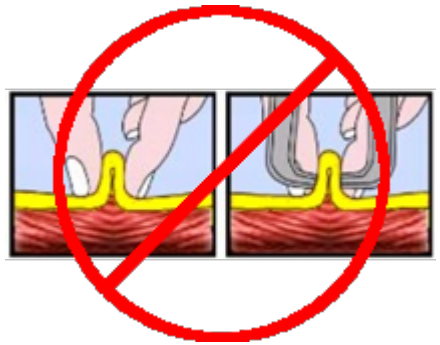
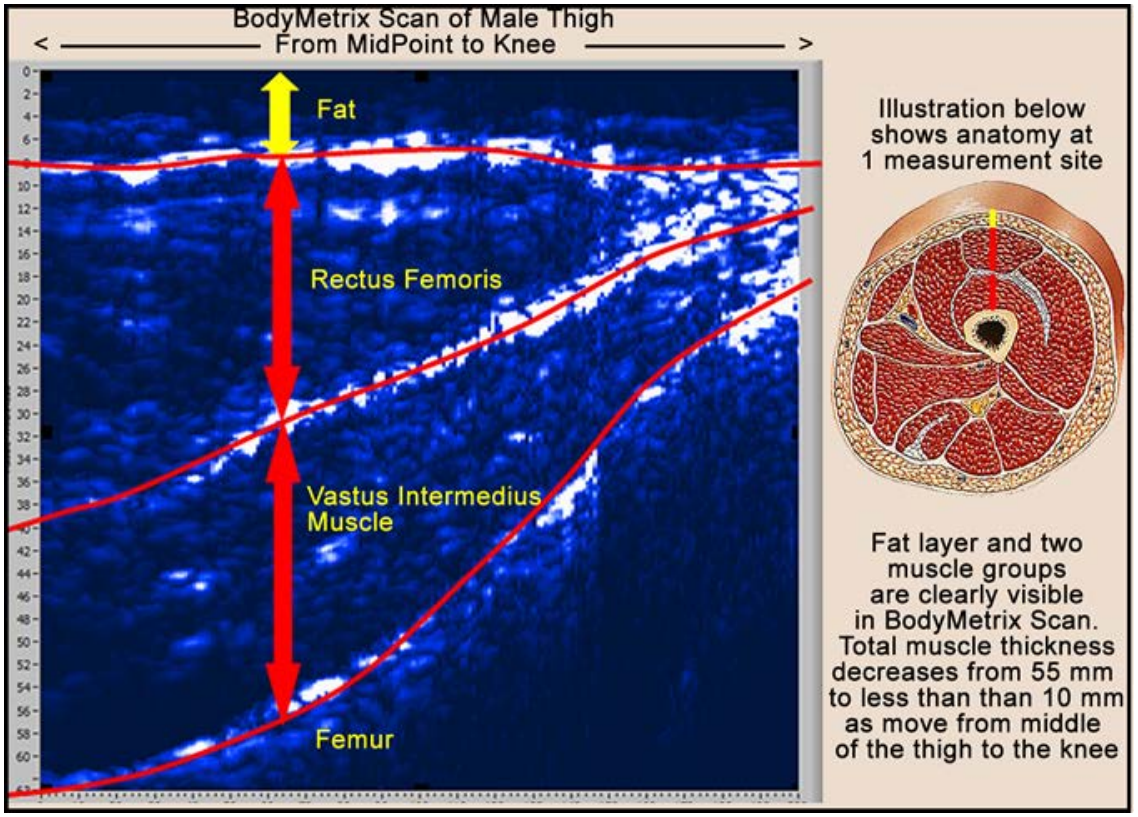
Bodymetrix

www.intelametrix.com

- Ultrasound 2.5MHz
- More convenient to use than other fat measurements





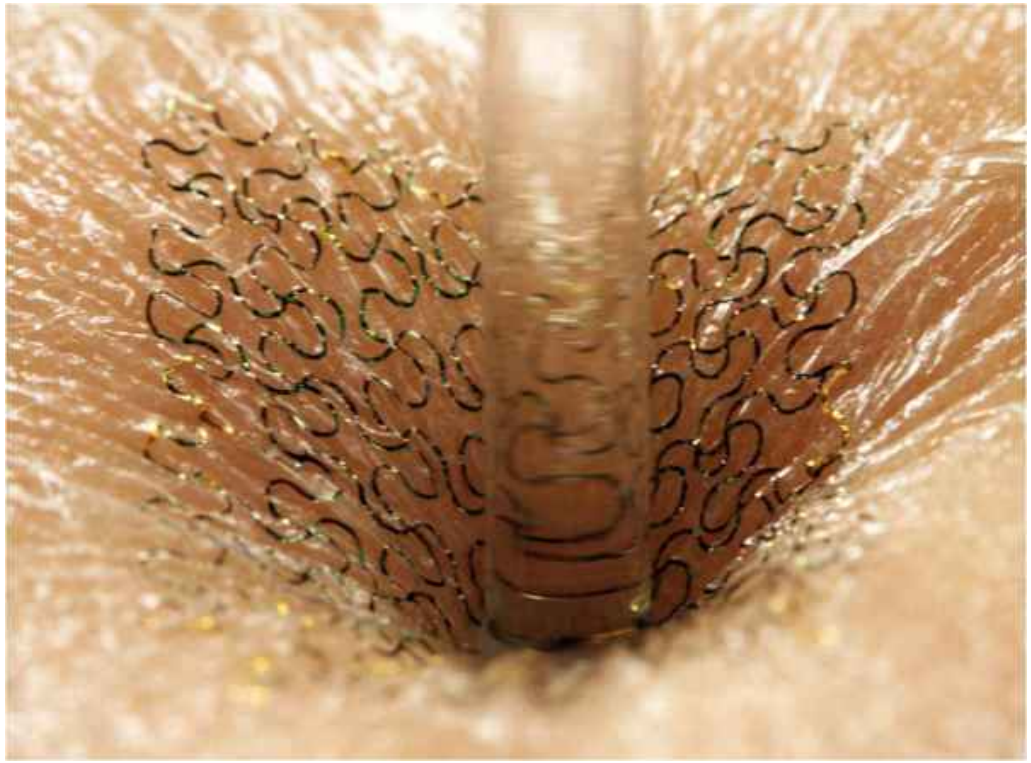
INCITE (Intelligent Catheters in Advanced Systems for Interventions) Project

INCITE technology platform that will enable advanced imaging, sensing (pressure, force, biomarker) and steering functions to be integrated into (sub)millimetre size in-body catheters and surgical instruments for emerging complex minimally invasive cardio-, neuro-, and peripheral vascular interventions.

Ultrasound Could Treat Alzheimer's Disease

http://www.iflscience.com/health-and-medicine/sound-waves-could-help-treat-alzheimers (ultrasound helps to pass blood-brain barrier by inducing vibrations of small bubless injected into the blood stream)

Injecting implantable sensors



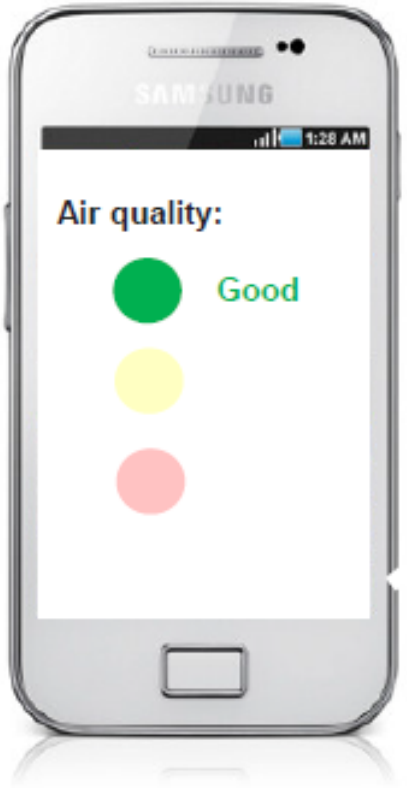
MEMS sensors can be made into a needle-like form factor so that they could be injected into the body (electrodes, pressure sensors, ultrasonic transducers, inertial sensors, ..)

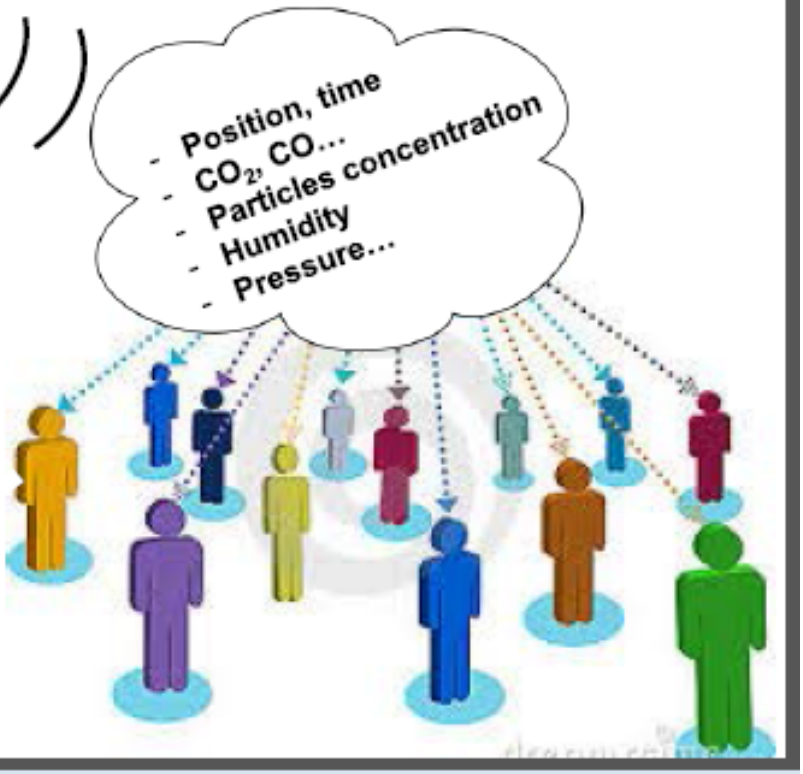
Star Trek scalpel-free surgery vs. Today's ultrasound surgery

http://www.socialphy.com/posts/computers-technology/20540/Star-trek-tech-we-use-today.html

ChipAir sensor

- On-chip air quality sensor for **ultrafine particles**
- Can be integrated with on-chip CO_2, humidity and pressure sensing
- Small footprint, low-power, integrable to a mobile device
- Personal monitoring and particle dosimetry
- Data can be transmitted to the cloud with the mobile device:
  - pollution maps
  - forecasting





VTT mobile phone CO2 demo

- CO_2, temperature and humidity sensors integrated in smart phone shield cover
- Measures CO_2 level with 1 second interval
- Averaging time 10 second

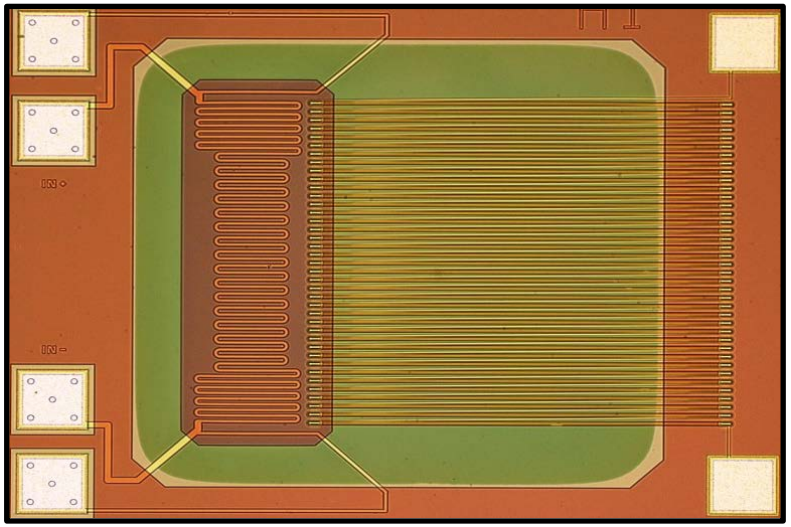
- Major use case: monitoring of indoor air quality (f.ex. in meeting rooms)
- Legistlation for air quality measurements in German schools

Wellness monitoring from breath

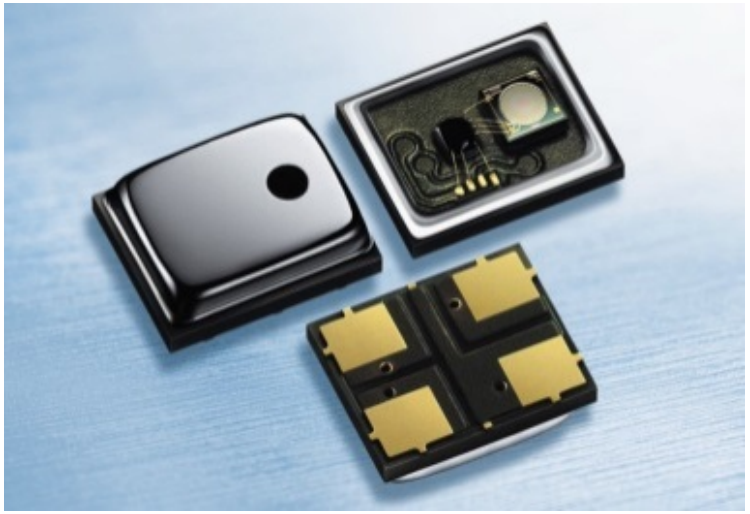
- Gases emerging from metaboly are useful diagnostic indicators
- Early sign of type-II diabetes: acetone at ppm levels
- Ketosis: when acetone above 1.8 ppm (fasting)

MEMS-based breath sensors

- Acetone & aldehyde sensor
  - resolution in the ppm range
- Low-cost MEMS technology available for commercialization

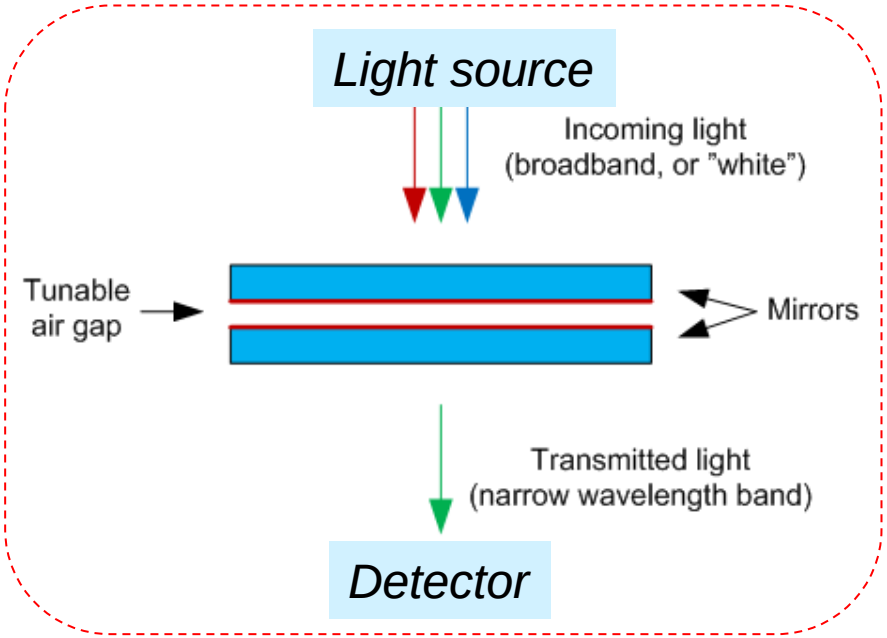


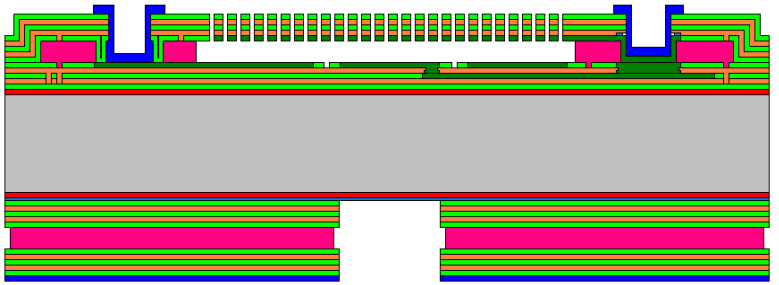
VTT MEMS micropellistor



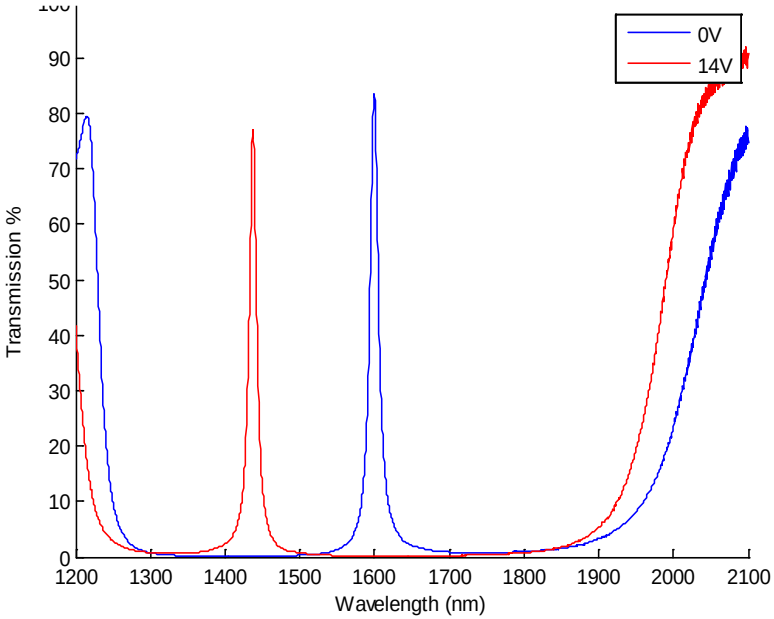
Packaging similar to that of the microphone of Infeon

Enabling MEMS technology for high resolution microspectrometers and imagers: MEMS based Fabry-Perot Interferometers @ VTT





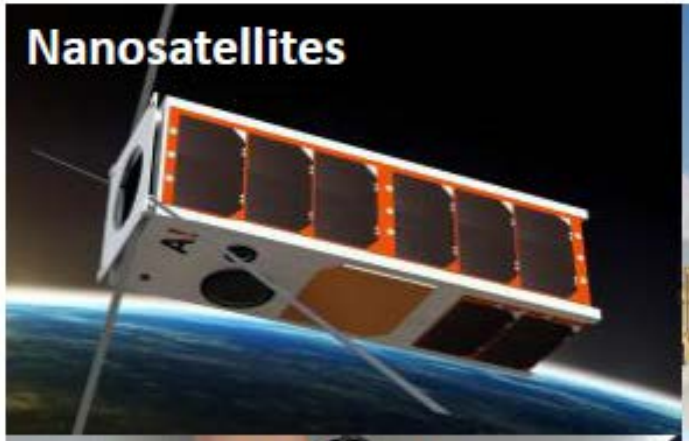
Packaged spectrometer



VTT's FPI technology in current applications

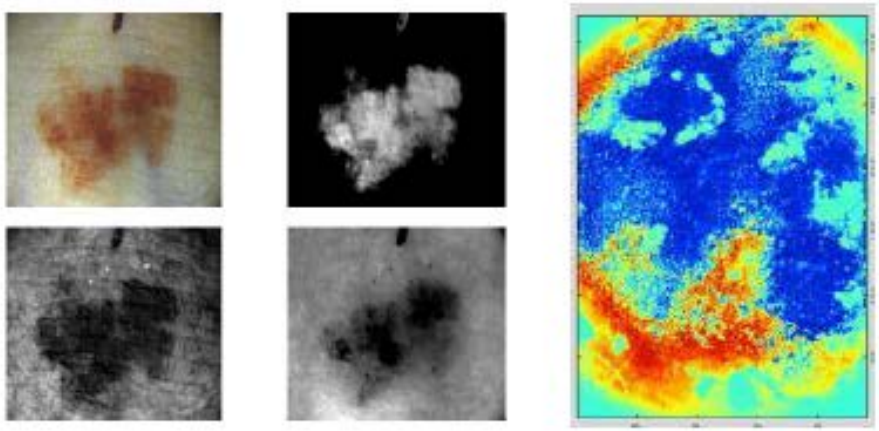
- Simple optical structure enables instrument customization for a variety of applications

Miniaturized Thermal-IR spectral imagers



Detection of skin cancer

- VTT's hyper spectral camera can detect skin cancer within seconds
- Easy-to-use hand held instrument
- Fast screening and early detection of skin cancer

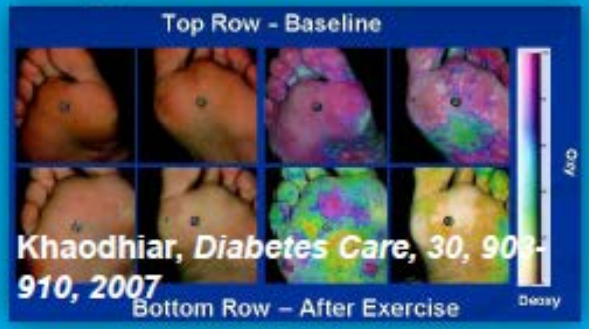


Hyperspectral imaging of cancerous tissue

Application being studied at the University of Jyväskylä, Päijät-Häme Central Hospital and Helsinki University Central Hospital

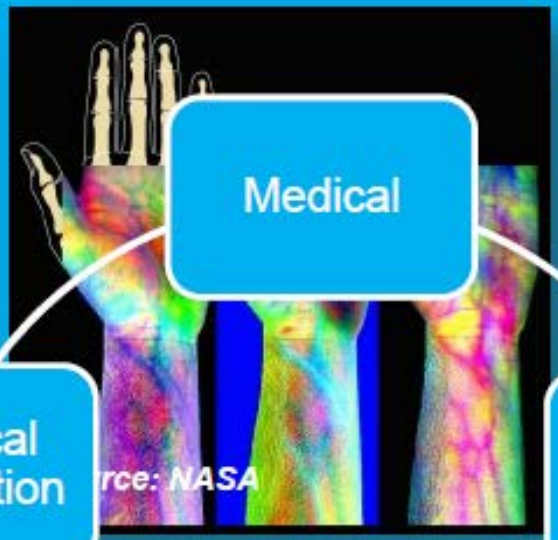
Application potential for spectral imaging

Oxygen saturation & diabetes



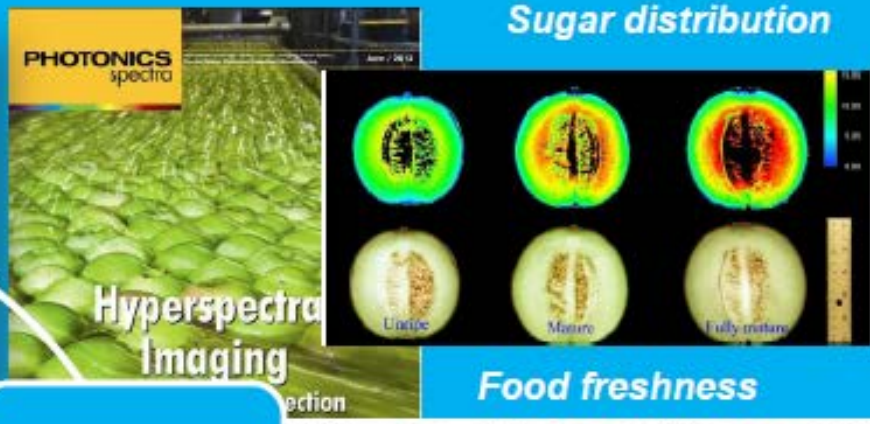
Khaodhiar, *Diabetes Care, 30, 90[illegible] 910, 2007*

Blood circulation



rce: NASA

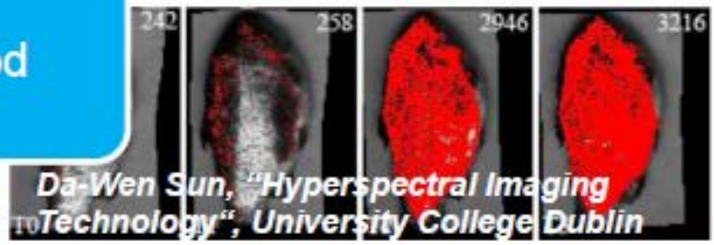
Sugar distribution



Pharaceuticals

Source: Resonon

Food freshness



Da-Wen Sun, "Hyperspectral Imaging Technology", University College Dublin

Medical

Chemical composition

Food

Environment

Security

Remote sensing

Applied Optics 45 (12)

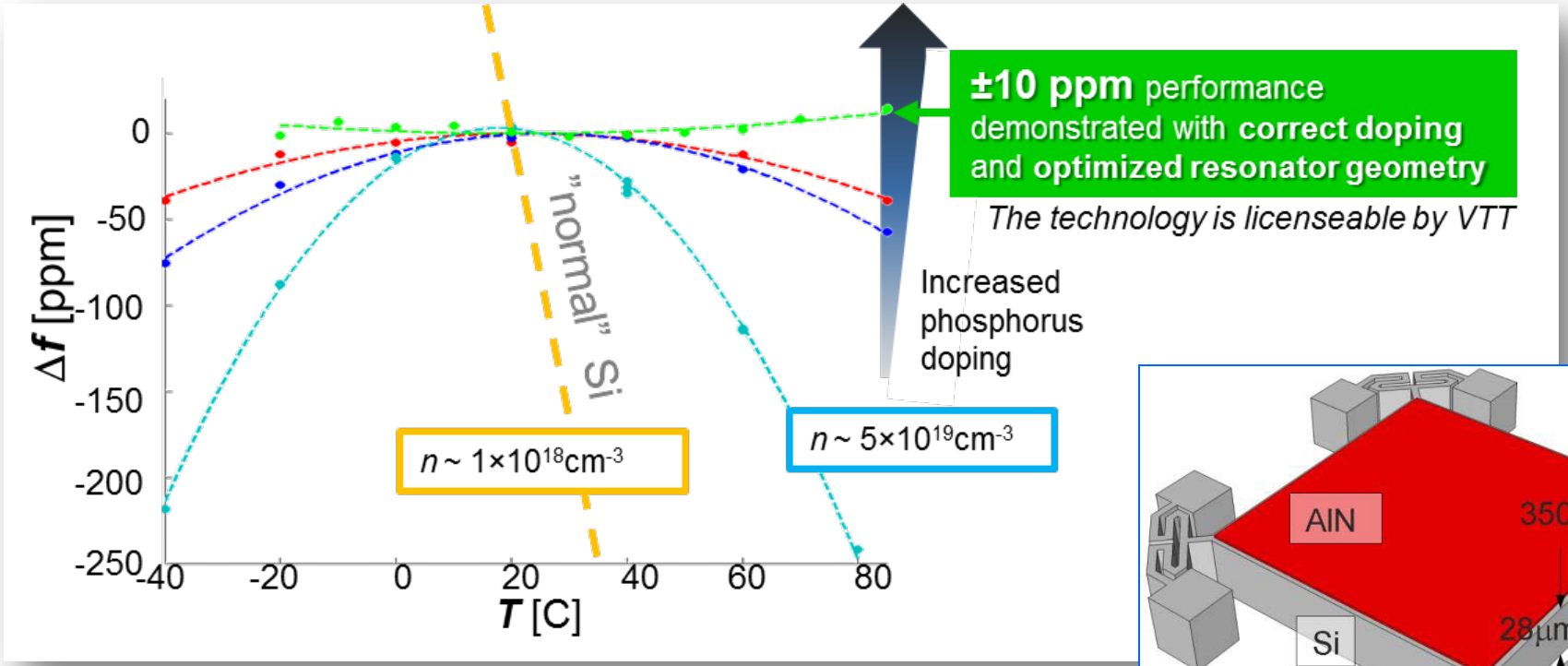
Source: ChemImage

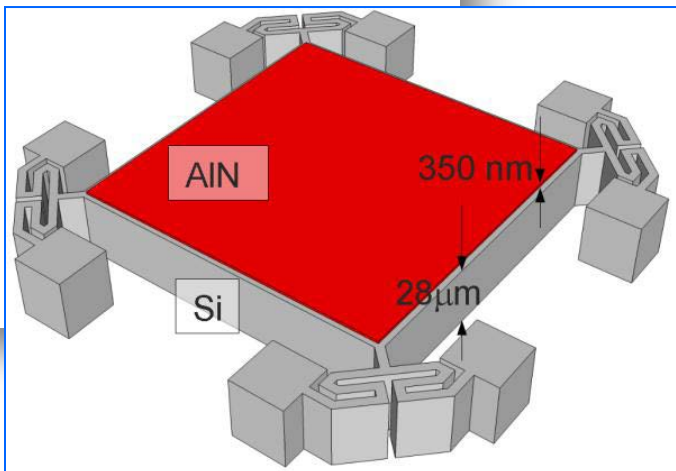
Crime scene investigation

Silicon MEMS resonators

with Quartz-class temperature stability

Optimized doping of silicon resonators dramatically enhances their temperature stability:





Conclusion

MEMS has a big yet-unexploited potential for new devices & solutions & services for health and environmental monitoring


TECHNOLOGY FOR BUSINESS