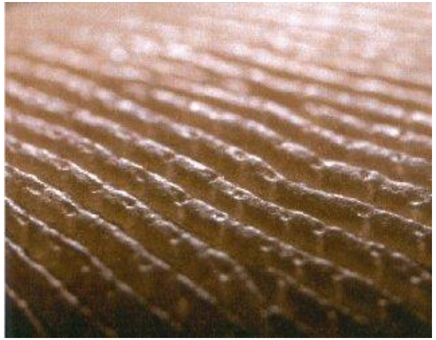
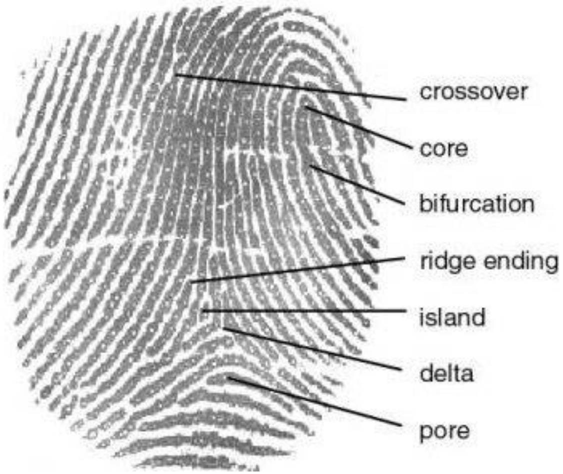
PYCSEL, un capteur d'empreinte digitale thermique actif et la détection du vivant

Jean-François MAINGUET

- Capture d’empreintes digitales: les principes physiques
- PYCSEL: un capteur d’empreintes thermique actif
- La détection du vivant

FINGERPRINT SENSING



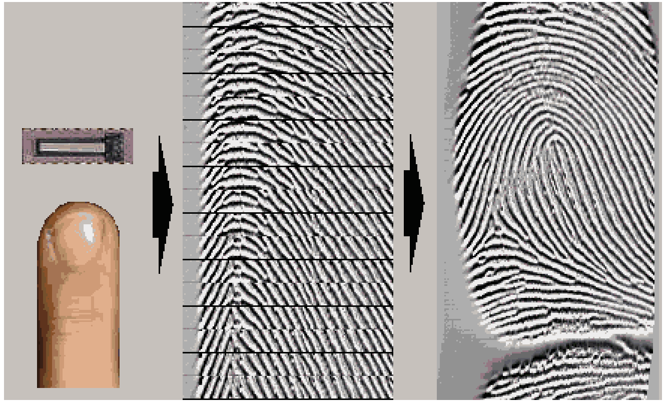


- Skin on finger consists of friction ridges with pores (sweat glands)

- Ridge discontinuities are minutiae points

- Static: the user just touches the sensing area

- Sweep: the user sweeps their finger across the sensing area
  - Advantage for silicon sensors: less area = less expensive



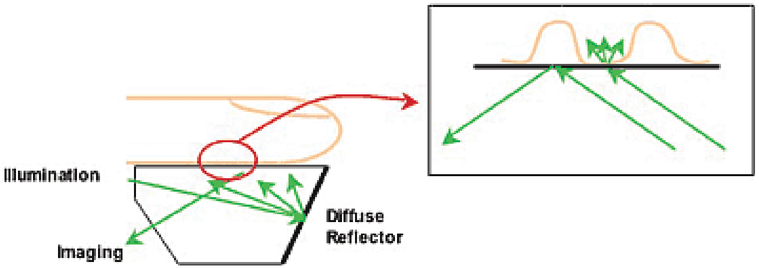
- **Optical**
  - Reflection FTIR
  - Direct image
    - Structured light
    - Pinhole
  - Transmission
  - OCT
- **Electro-Optical**
  - Piezo-led
  - Emissive polymer
- **Ultrasound**

- **Capacitance**
  - Passive
  - Active (RF field)
- **Pressure**
  - Piezo
  - Conductive membrane
  - Tactile (MEMS)
- **Thermal**
  - Passive
  - Active

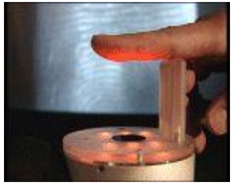
- **Combination (whenever possible)**
  - Silicon, TFT (glass)
  - Static, swipe
  - Contact, contactless

- Finger illuminated on one side of prism with a LED
- Light reflected by air (fingerprint valleys)
- Light absorbed/scattered by skin (fingerprint ridge)
- Other side of prism transmits the image through a lens to a camera

- Many clever variations on this theme

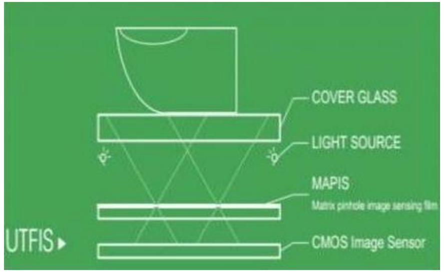


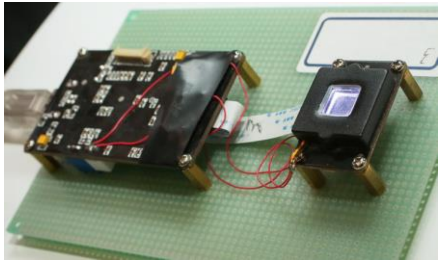
- Camera



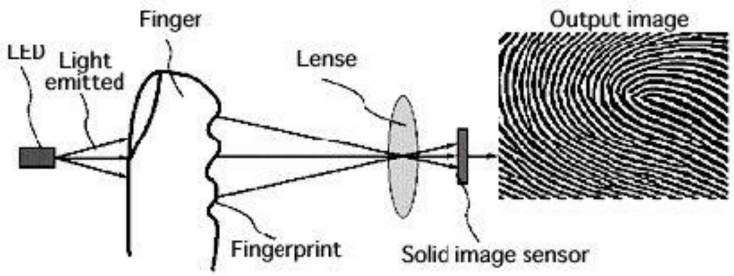
- Structured light illumination

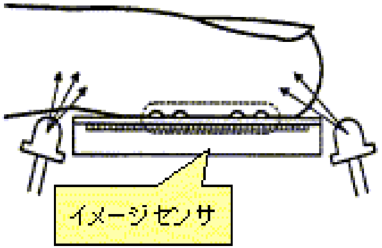
- Pinhole

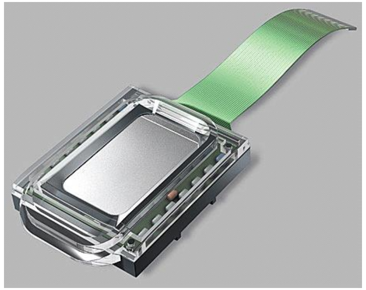




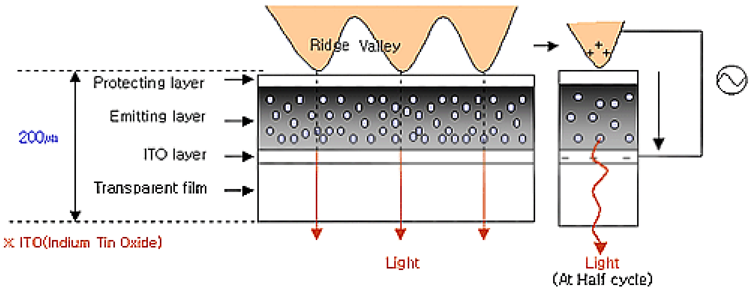
- Image light transmitted through the skin or finger

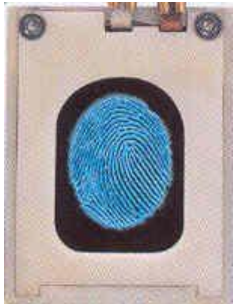


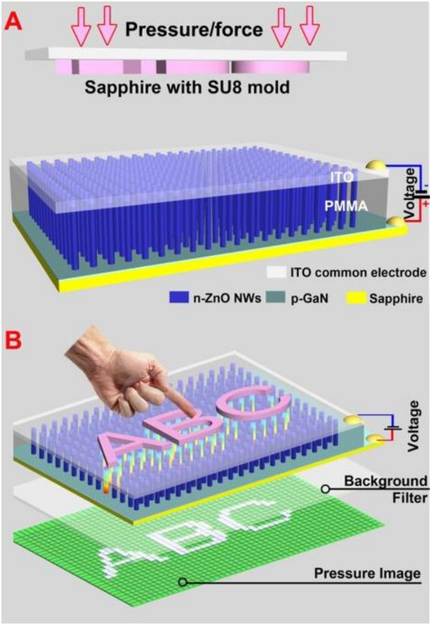




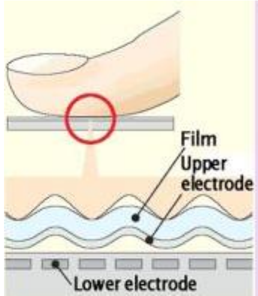
- A polymer emits light when properly powered
- A variation is proposed with a piezoelectric nanowire LED array

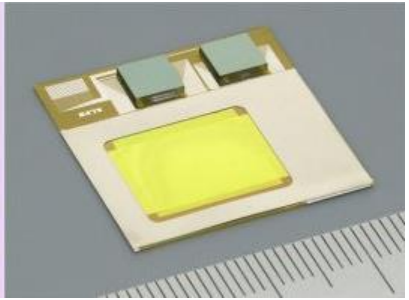


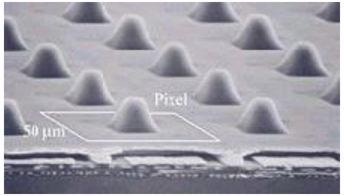


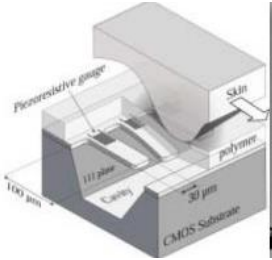


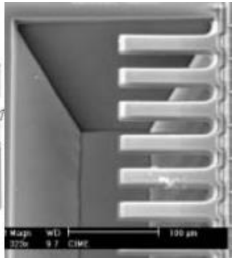
- Piezo
- Conductive membrane
- Tactile (MEMS)

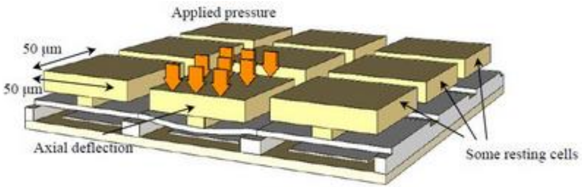


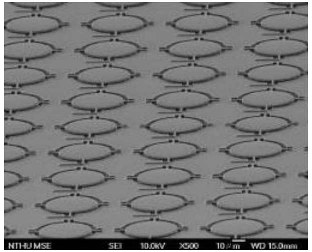




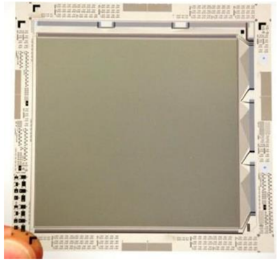


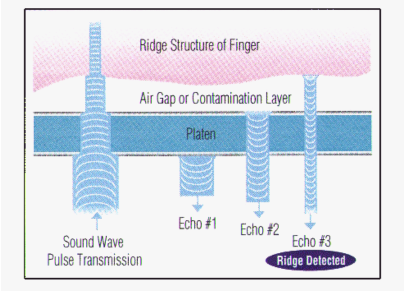


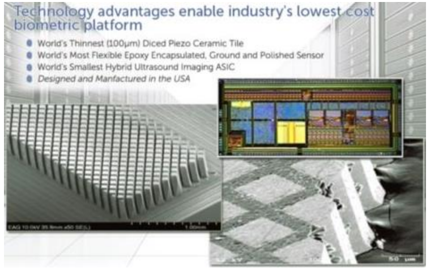




- Piezoelectric layer
  - Polymer
  - Ceramic







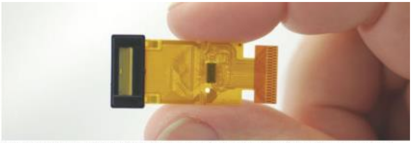
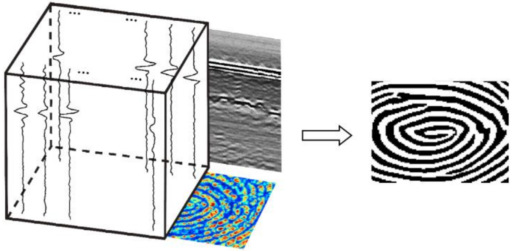
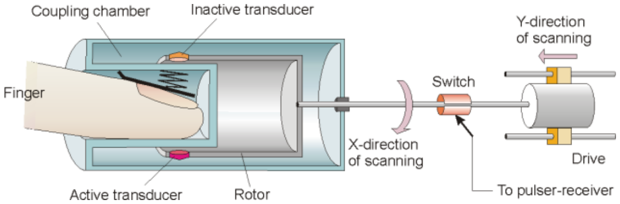


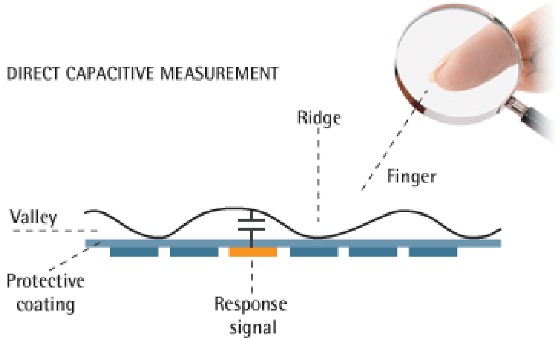
Figure 3. Sonovation's SonicSlide STS3000 3- by 14- by 0.1-mm fingerprint sensor consists of an array of ceramic piezoelectric transducers and advanced polymers combined in a silicon ASIC. Its components are integrated into a single 35- by 14.5- by 0.25-mm module with a single sensing element measuring just

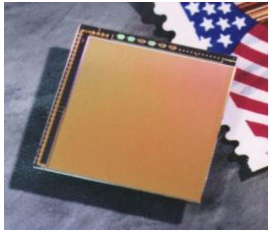




CAPACITANCE SENSOR, PASSIVE

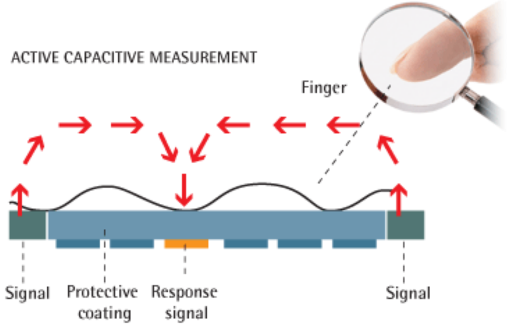
- Fingerprint valleys and ridges vary thickness of air dielectric layer, which modulates effective capacitance

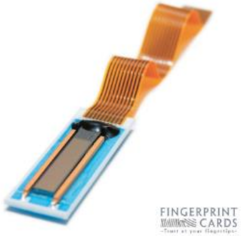


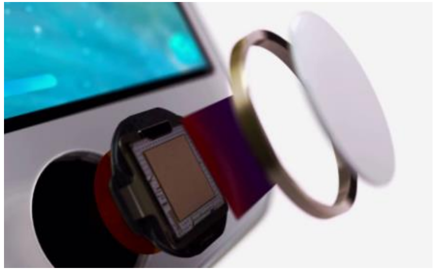


CAPACITANCE SENSOR, ACTIVE = RF FIELD

- RF signal sent into the skin and read at pixel level
- Signal crosses the coating via a capacitor

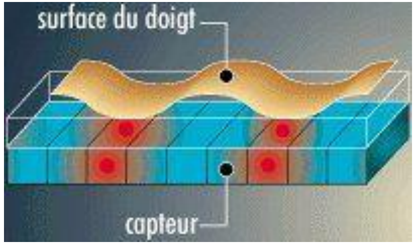






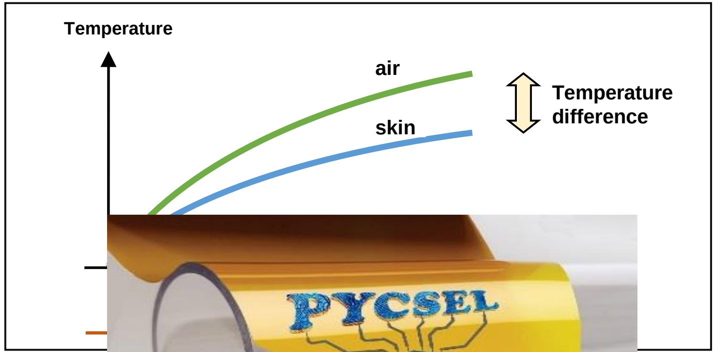
THERMAL PASSIVE

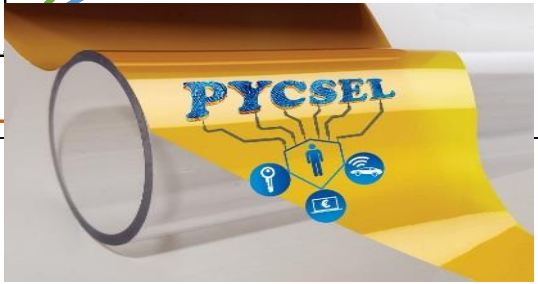
- Thermal exchange between the skin and the pixels



THERMAL ACTIVE

- A heat pulse is sent
- Skin will capture some heat, more than air: final temperature is lower





Horizon 2020

PYroelectric Conformable SEnsor matrix for Large area applications in security and safety

HORIZON 2020
GA N° 732423

THEMATIC PRIORITY:
ICT-02-2016 – RIA, ADVANCED THIN, ORGANIC AND LARGE AREA ELECTRONICS (TOLAE) TECHNOLOGIES

DURATION:
01/01/2017 – 31/12/2019

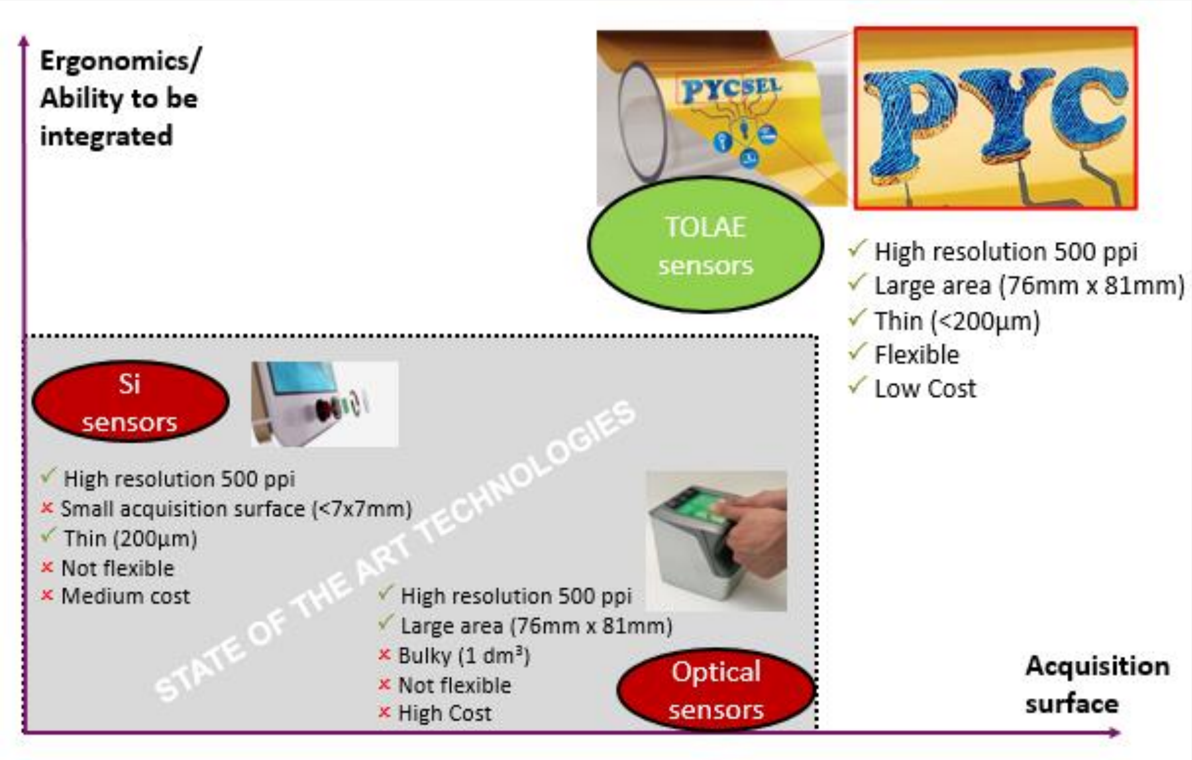
OBJECTIVES

- to develop and demonstrate very innovative fingerprint sensors enabled by TOLAE technology:
  - combining:
    - an innovative active thermal sensing frontplane, PVDF-based
    - an IGZO TFT backplane on a plastic flexible foil
  - offering high resolution and large surface compliant with standards (FBI) and multiple fingerprint capture / grip recognition
  - allowing easy integration and ergonomic use
  - targeting 2 applications:
    - Governmental
    - Automotive

Autoliv	BIOAGE	cea	imec
irlynx	IDEMIA augmented identity	Holst Centre	uc3m

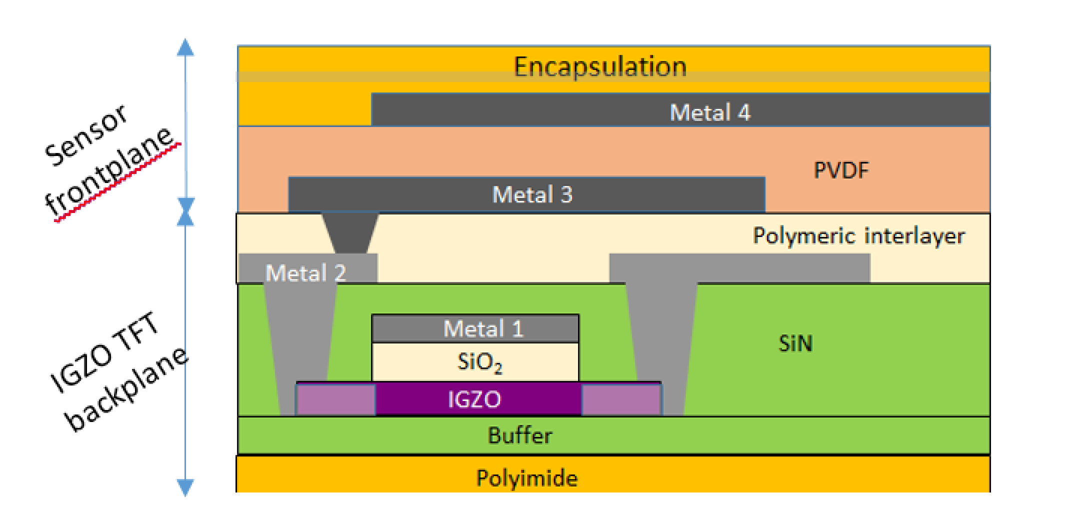
Horizon 2020

CONTEXT



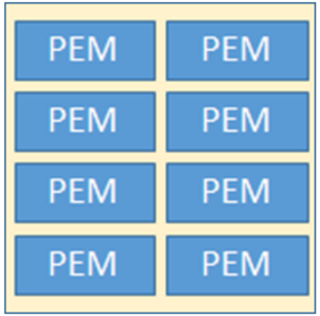
THE PYCSEL SENSOR

- Combination of
  - an innovative active thermal sensing frontplane, using PVDF-based pyroelectric material,
  - with an IGZO TFT backplane on plastic foil.



Horizon 2020

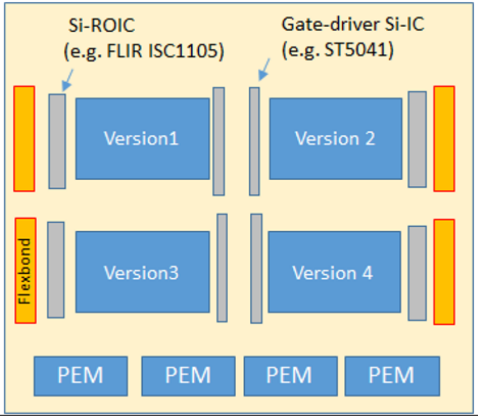
PYCSEL TEST VEHICLES



PYCSEL 1 lay-out structure

Non-functional device, PYCSEL1 is a Process Evaluation Module (PEM)

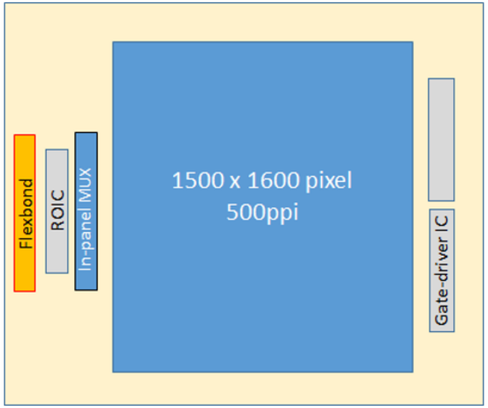
Polyimide foil, Gen1 substrate (320 x 352 mm)



PYCSEL 2 layout structure enabling 'single finger' imagers

4 versions per substrate / 256 x 256 pixels

Substrate: polyimide foil, 150 mm wafer



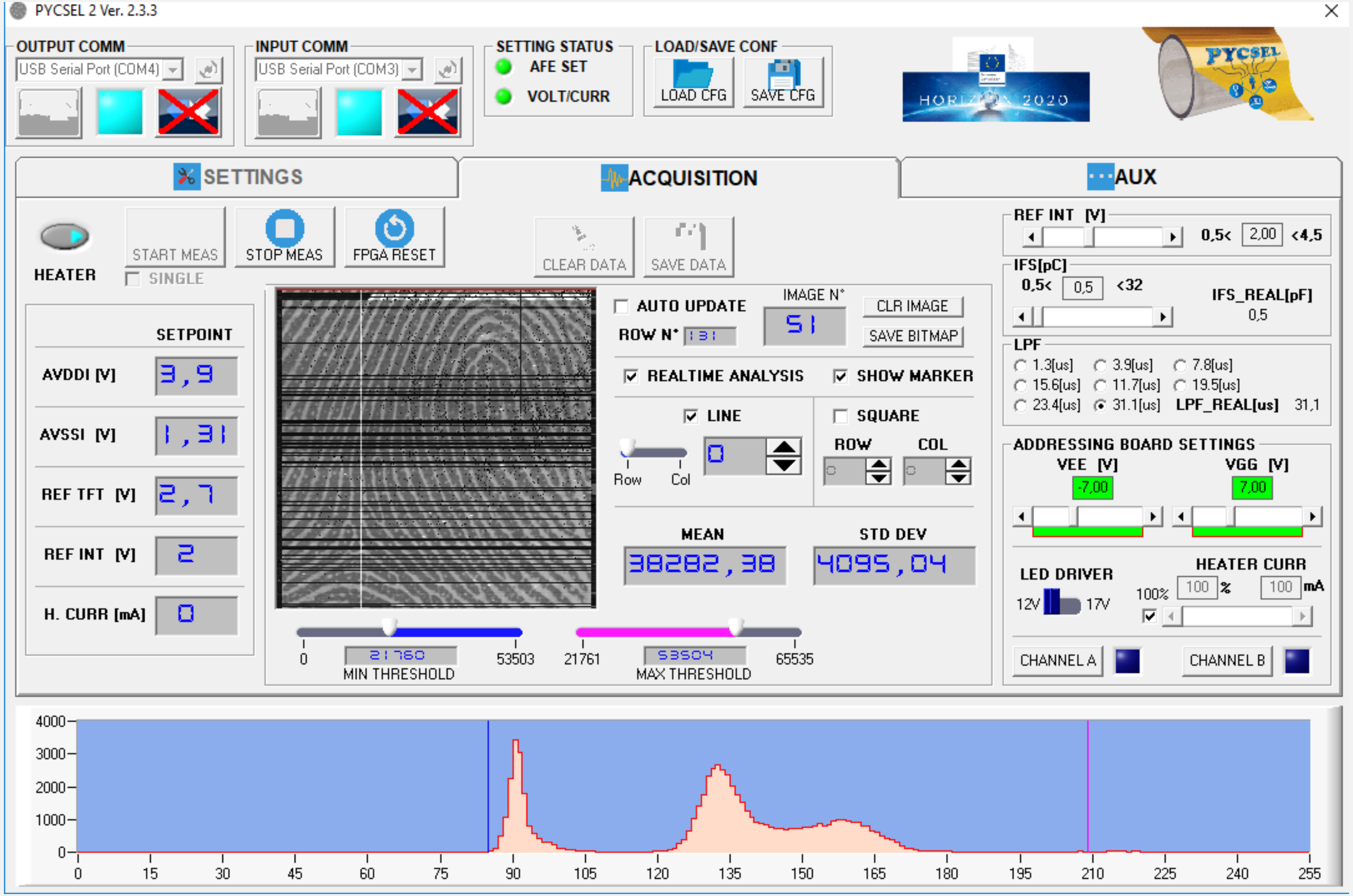
PYCSEL 3 layout structure enabling '4 fingers (4 SLAP)' imager

1 version per substrate / 1600 x 1500 pixels

Substrate: polyimide foil, 150 mm wafer

Horizon 2020

LOPEC DEMO



Horizon 2020

LOPEC

- PYCSEL remporte le Best Publicly Funded Project Demonstrator lors de la compétition OE-A à LOPEC 2019 / Munich (20 Mars)


OE-A Competition 2019 oe-a

CEA, Holst Centre/TNO, IMEC, et al.

successfully participated in the
OE-A Competition 2019 for Multifunctional Demonstrators
based on Organic and Printed Electronics
by submitting the demonstrator

PYCSEL H2020 - Thin Thermal
Fingerprint Sensor

and was awarded

Best Publicly Funded Project Demonstrator

On behalf of the jury

Dr. Martin Krebs
OE-A Competition Chair

Dr. Klaus Hecker
OE-A Managing Director

Stan Farnsworth
OE-A Board Chair

Munich, Germany, March 20, 2019

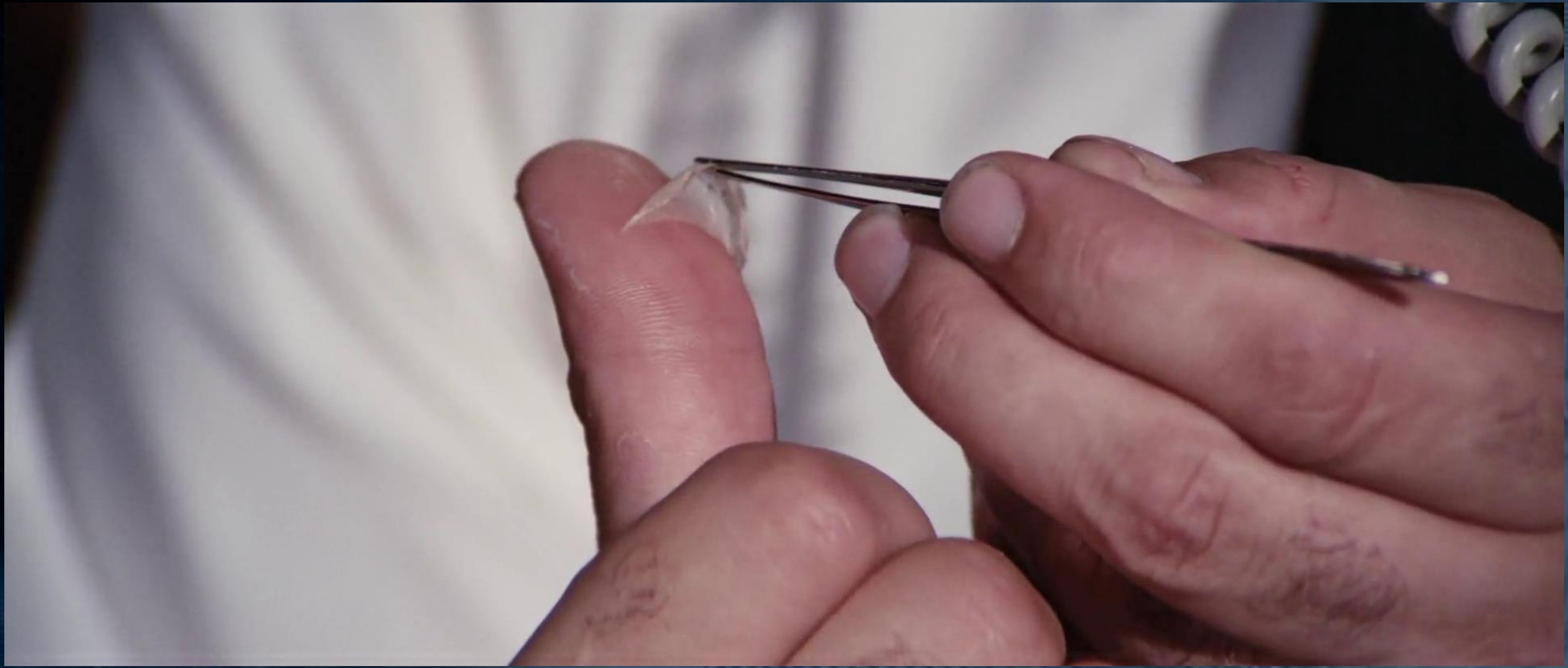
LA DETECTION DU VIVANT

“The 6th day”

The SIXTH DAY

The SIXTH DAY

BOND . . . JAMES BOND . . .

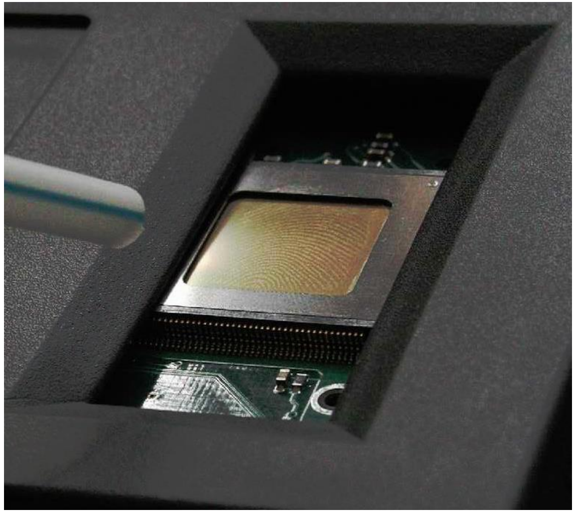


Diamonds are Forever (circa 1971)

- "I agree to the transaction"
  - Proving that you are living is not enough.
  - What is desired is to prove that:
    - ✓ I'm a living person not under threat, and I agree to make such and such action
  - This is impossible: you can't read a person's mind.
  - Once again, 100% security does not exist.

- Security of an (electronic) biometric system may be divided into two main areas:
  - Electronic security
    - ✓ Is it an authorized biometric system at the other end of the wires?
  - "Living" security
    - ✓ Is this finger alive, fake or dead?

- Aliveness: hard to detect
  - What is a dead finger?
    A surgeon is able to mend a cut finger (if kept in ice)!
  - Whole hands have already be transplanted from a deceased donor: also the fingerprints!



- Definition of levels:
  - Zero effort: a latent print left on the sensor
  - Fake/copies:
    - ✓ Fingerprint image
    - ✓ Fake made of gelatin, latex…
    - ✓ Thin layer of material glued to a real finger
  - Original finger:
    - ✓ Cut out
    - ✓ Belonging to a dead person

CUT FINGER?

Demolition Man 1994

- Biometric information is often public.
  - Think about face recognition!
  - You cannot rely on the biometric data secrecy!
- Donor cooperation helps but is not mandatory.
  - DNA: just pick up organic residues
  - Face: a simple photo
  - Iris: a good high resolution photo
  - Fingerprint: latent prints
  - Voice: a recorder
  - Hand: a mold
  - Vein: no visible trace
- Having the original sensor device helps.
  - You get a genuine electronic copy!
  - And so, you can create a fake to spoof this sensor…



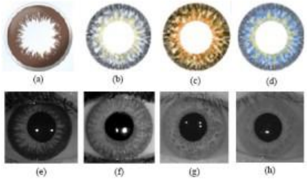


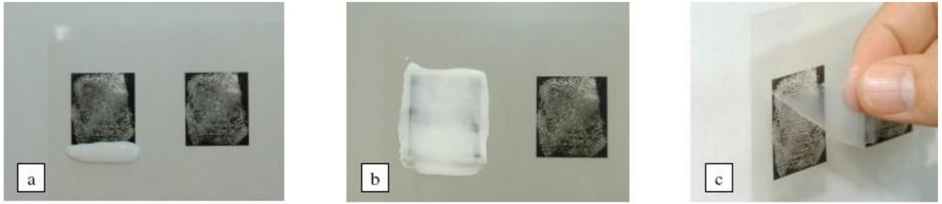
Figure 5. Samples of contact lenses((a)-(d)), fake iris((e),(f)) and live iris((g),(h)).




- How difficult is it to make a fake finger?
  - With cooperation
    - ✓ Making a mold is quite easy, and you can find information over the Internet.
    - ✓ Most articles dealing with this suppose cooperation.
  - From a latent print
    - ✓ Having the right latent print is not so obvious. (It is difficult to know which finger it is!)
    - ✓ Identifying the latent print is very often difficult, even for a forensic professional.
    - ✓ From a good picture, making a mold is not too hard; like a rubber stamp or a printed board.

FAKE FINGERPRINTS

- Many different materials have been tried
  - Gelatin
  - Silicone
  - Rubber
  - Wood glue
  - Hot glue
  - Soft plastic
  - Latex
  - Alginate
  - Clay
  - Glycerin
  - …
- Material to adapt to the sensor!
- We consider that making a latex copy is difficult, but far from being impossible.



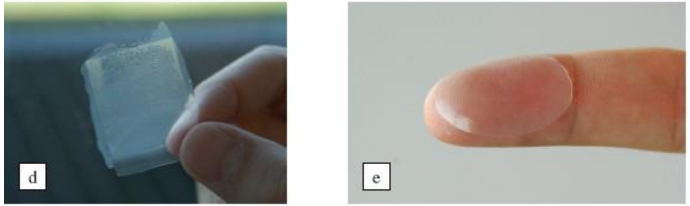


Figure 5-19: Making the wood glue fingerprint spoof:

a) Inverted binarised fingerprint image printed on sheet with laser printer

b) Glue smeared out in thin layer

c) Peeling off the dried glue

d) The peeled off spoof

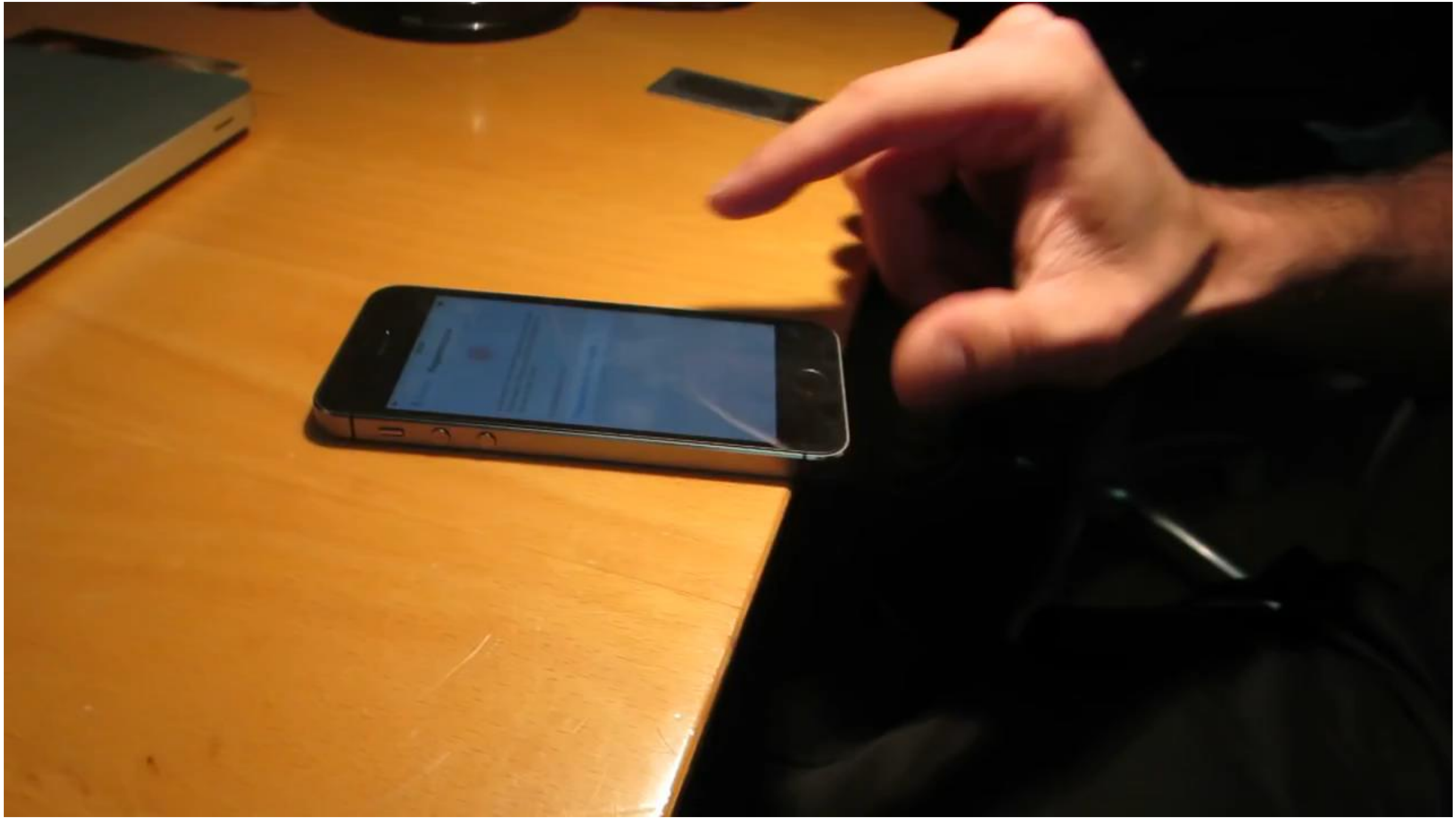
e) The spoof cut to proper size and stuck on fingertip

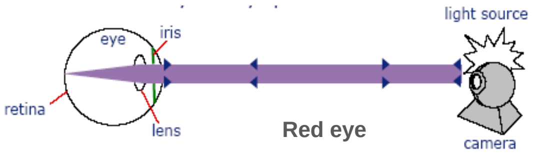
Fig. 5. Glycerin - left: thin layer - center: thick layer - right: 3D models

iPhone 5 & 6

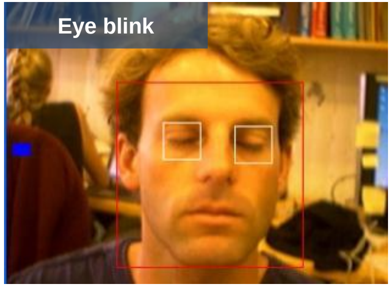
- Touch ID : no aliveness detection

- Authentec said their sensor is working with a live finger…. But never said that fakes are also working!



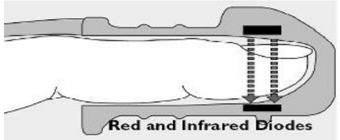


pupillary light reflex / hippus

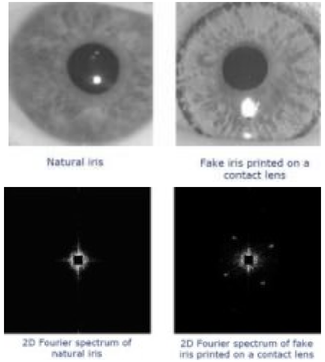


Skin distorsion (Maltoni)

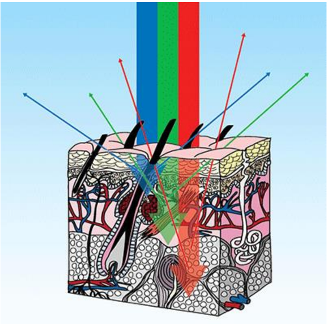
Skin impedance (Guardware)



Pulse oximetry



Fourier analysis



Skin spectrum (Lumidigm)

3M Biosentry ultimate (1996)
pulse detection + EKG

Perspiration (Schuckers)

First real known case

- Malaysia end of March 2005, where a team of carjackers on the prowl in Subang Jaya chopped off part of the left index finger when they realized that the S-Class Mercedes Benz had a security feature which would immobilize the car without his fingerprint.

- ## Graft

  - George attempted to enter the U.S. illegally on September 24, 2005 through the Nogales, Ariz. Port of Entry during which time U.S. Customs and Border Protection officers noted that his fingerprints had been surgically replaced with skin from his feet.

  - George stated that this procedure had been done to "clean" his identity by a doctor in Phoenix.

- Angry wife gets Doha-Bali flight diverted to Chennai (2017 Nov, 5th)
  - The Iranian woman, who was with her husband and their young child on a Qatar Airways flight from Doha to Bali on Sunday, unlocked her sleeping hubby's phone by putting his finger on the home button and found evidence he was cheating on her.

QUESTIONS ?

"This new Apple iPhone is great. It takes high quality pictures and recognizes my fingerprint. It's just like when I get arrested."