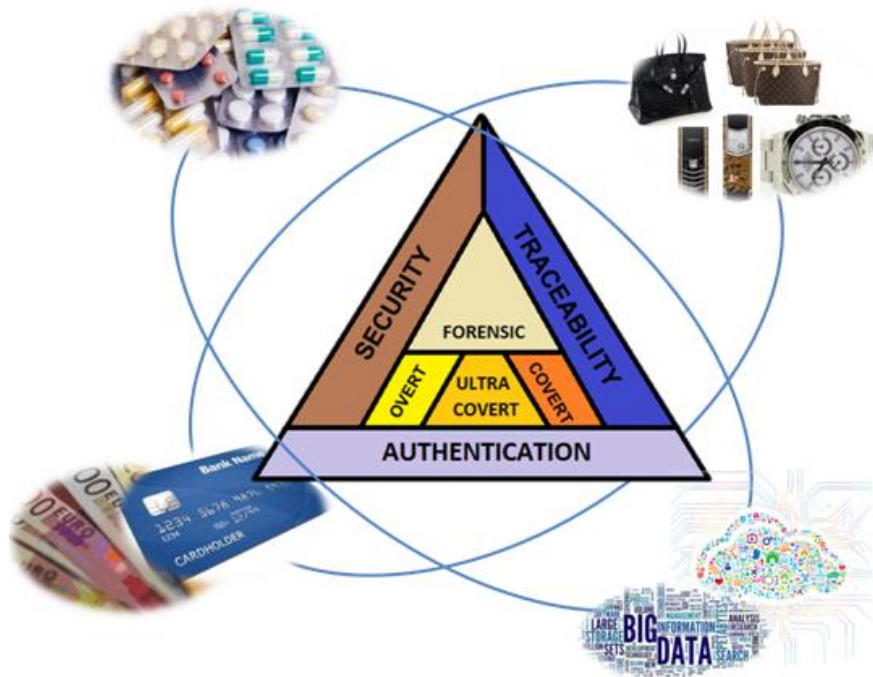


# Security fingerprints for smart physical and digital identities



**3D-OXIDES**  
MULTI-FUNCTIONAL THIN FILMS

Giacomo BENVENUTI, PhD

**CERN Workshop, 07/11/2017**

# Challenge: towards a smart 4.0 era

The 4<sup>th</sup> industrial revolution is here!

SUPPLY CHAINS

FINTECH

INSURETECH

MANUFACTURING 4.0

SMART GRIDS

MOBILITY 4.0

IoT & IIoT

SMART CITIES

SMART SERVICES

3D-PRINTING

BLOCKCHAIN + AI

**Smart, Reliable & Intelligent objects.**

# Pains and hopes...

## Strong issues:

Growing counterfeiting

Weak cyber-security

Poor traceability of objects and data

Lack of trust and value management

## Blockchains approach

Reinforced trust

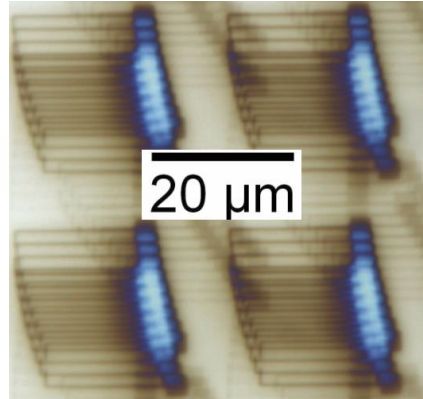
Improved interactions between:

≠ verticals

≠ partners

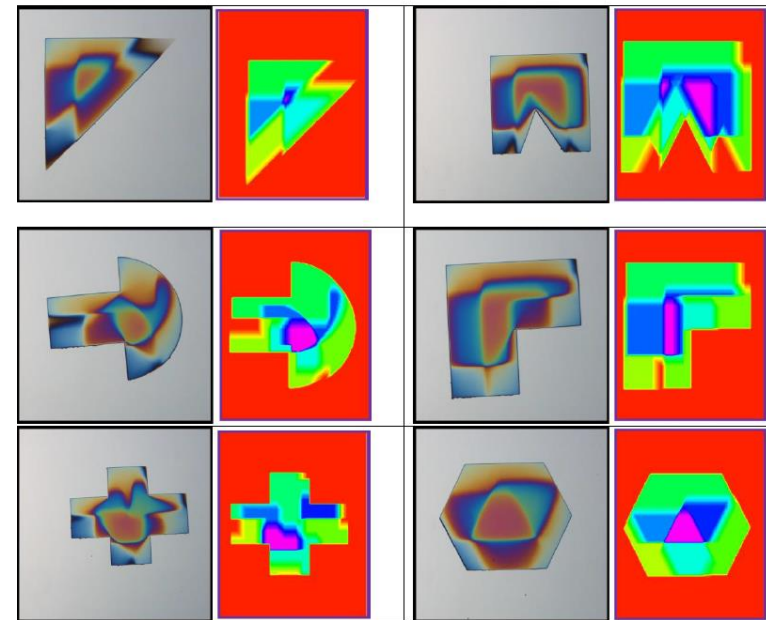
But still too many technical intrinsic limits...

# Physical and digital FINGERPRINTS



**Identities to make  
object SMART!**

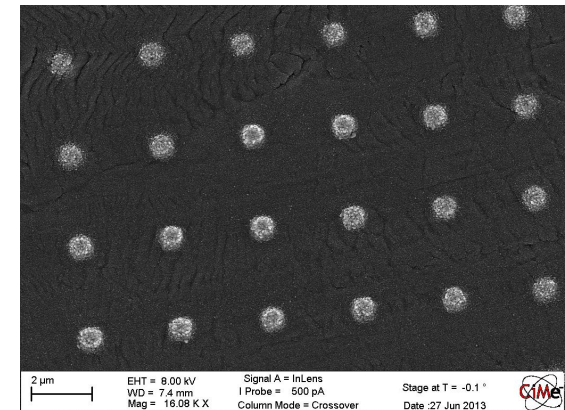
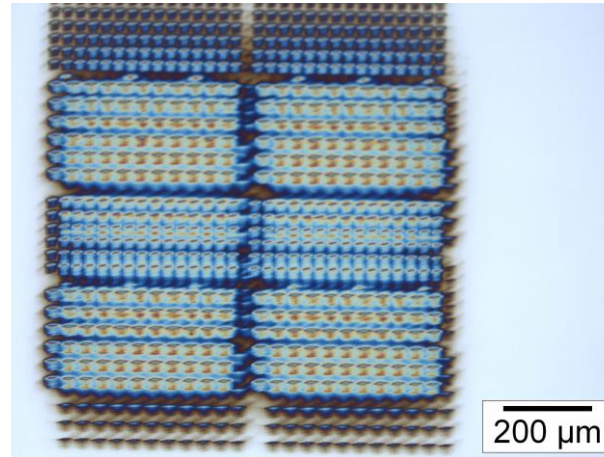
- Single object identities
- Mass Production
- Physical + Digital solution
- Strong miniaturization
- Affordable costs



*Experimental vs model*

# Our expertise.

## Micro and nano 3D and 4D-printing of multifunctional thin films materials

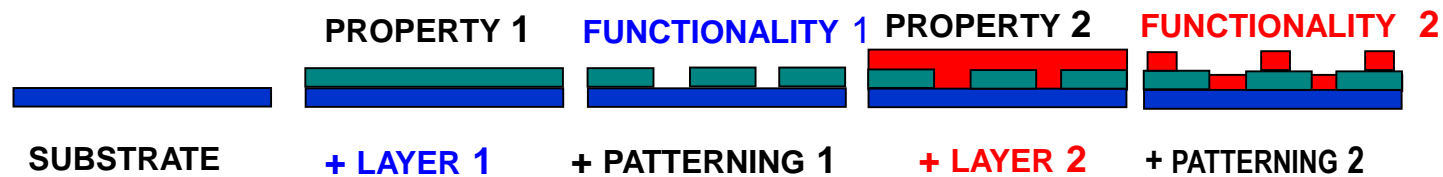




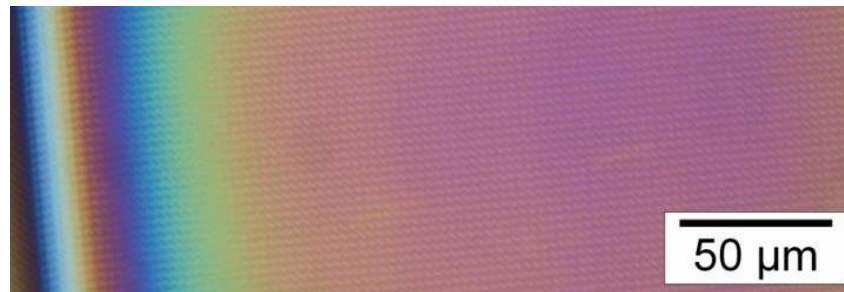
# Thin films

A high-tech paint with dimensions of 10 nm to 10  $\mu\text{m}$  allowing:

- ✓ Miniaturization of devices
- ✓ Development of new material properties due to nano-size effects
- ✓ Integration of new functionalities (value) onto a substrate



**HIGH ADDED VALUE**

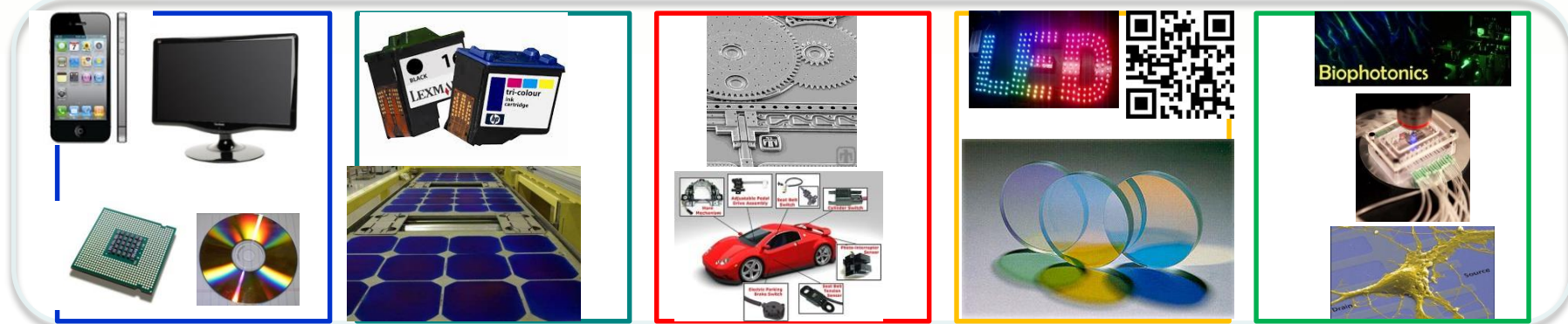


More (functionalities / value / quality of life)  
with less (resources / eco-impact) = Sustainability

# Markets & Applications of thin films

## PERVASIVE COST EFFECTIVE MASS PRODUCTION

Less Resources, Robust devices, Transportability



Micro-  
electronic  
s

Memories  
Power  
electronic  
s  
Chips

Clean-  
Tech

Photovoltaic  
H<sub>2</sub> generation  
Catalysis  
Fuel cells

MEMS

Inkjet  
heads  
Actuators  
Sensors

Optics

Integrated  
optics  
Photonics  
Sensors  
Security

Biotech

Bio-  
interfaces  
Bio-  
photonics  
Lab-on-chip



**ABCO**  
TECHNOLOGY  
THIN FILM EQUIPMENT

[www.3d-oxides.com](http://www.3d-oxides.com)

**Disruptive nano-materials**

**3D-OXIDES**  
MULTI-FUNCTIONAL THIN FILMS

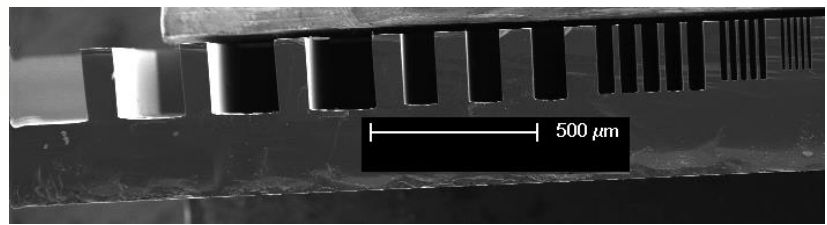
# R&D Network



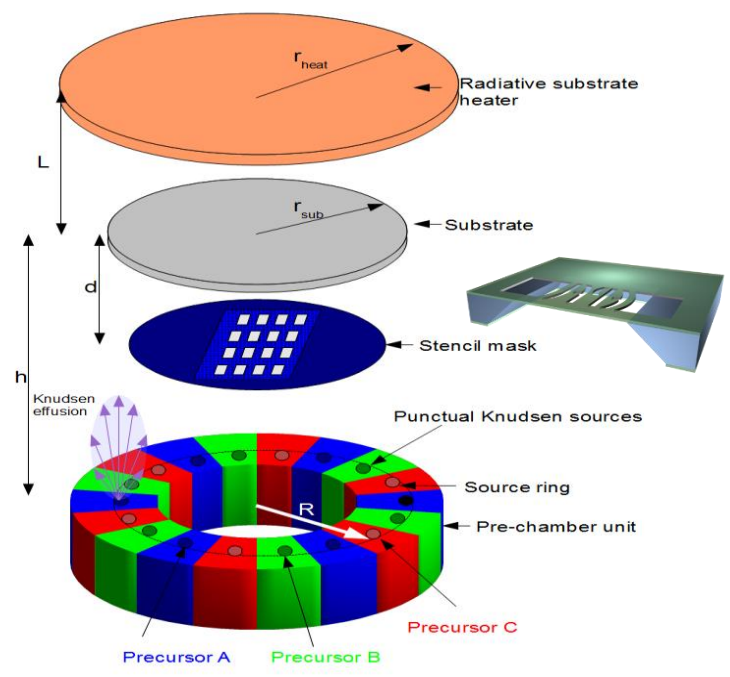


# Our additive growth set-ups

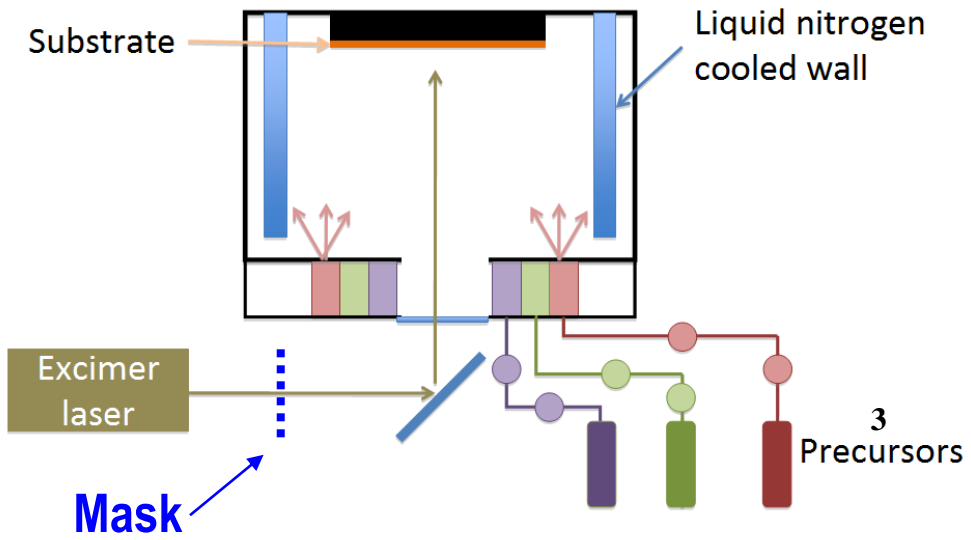
## Deposition on patterned substrates



## Stencil-mask assisted deposition

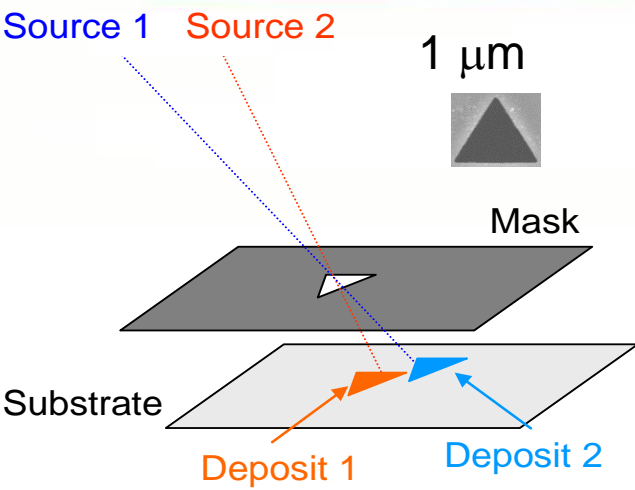


## Laser-assisted deposition

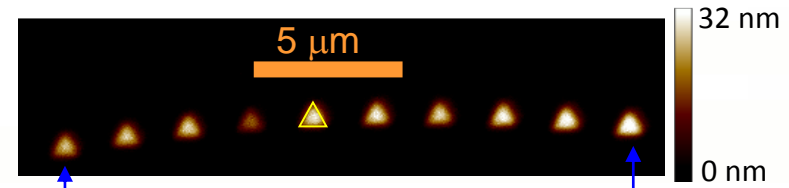


Chemicals under vacuum

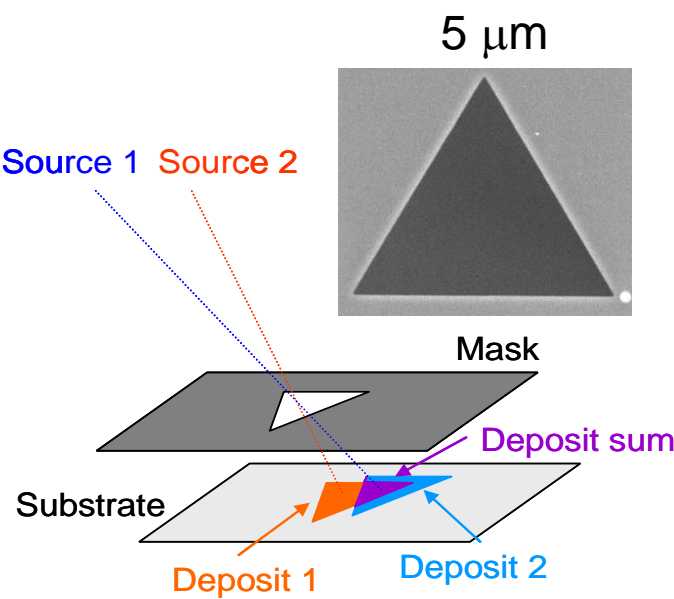
# Mask Deposition



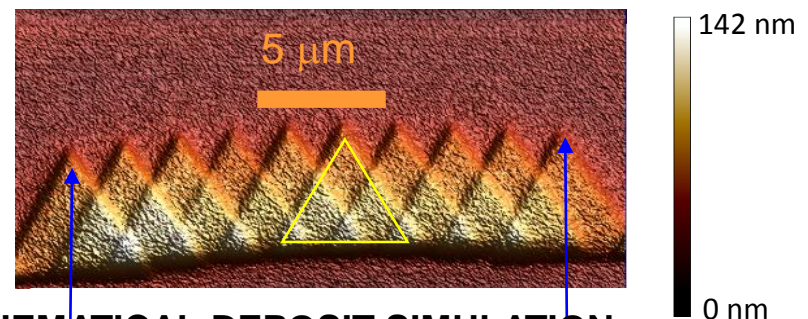
DEPOSIT AFM MEASUREMENT:



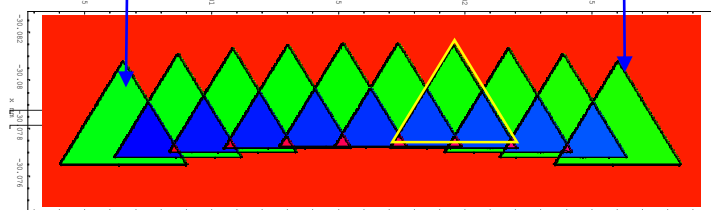
MATHEMATICAL DEPOSIT SIMULATION:



DEPOSIT AFM MEASUREMENT:

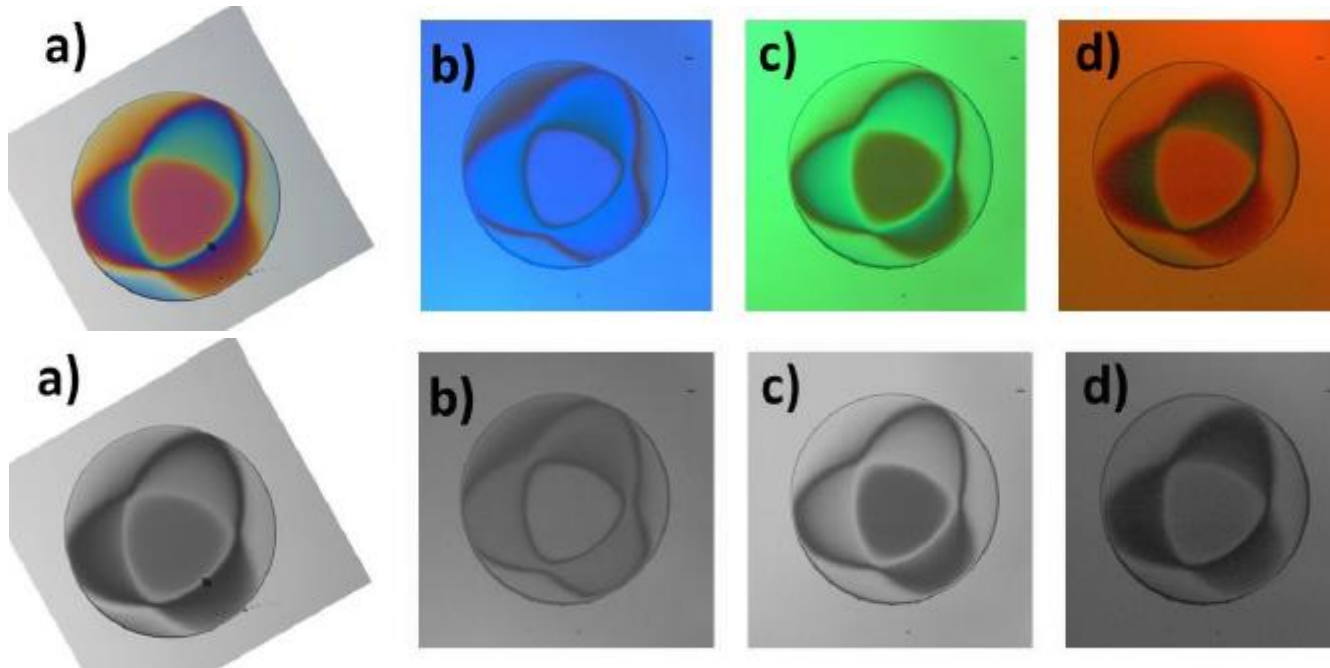


MATHEMATICAL DEPOSIT SIMULATION:



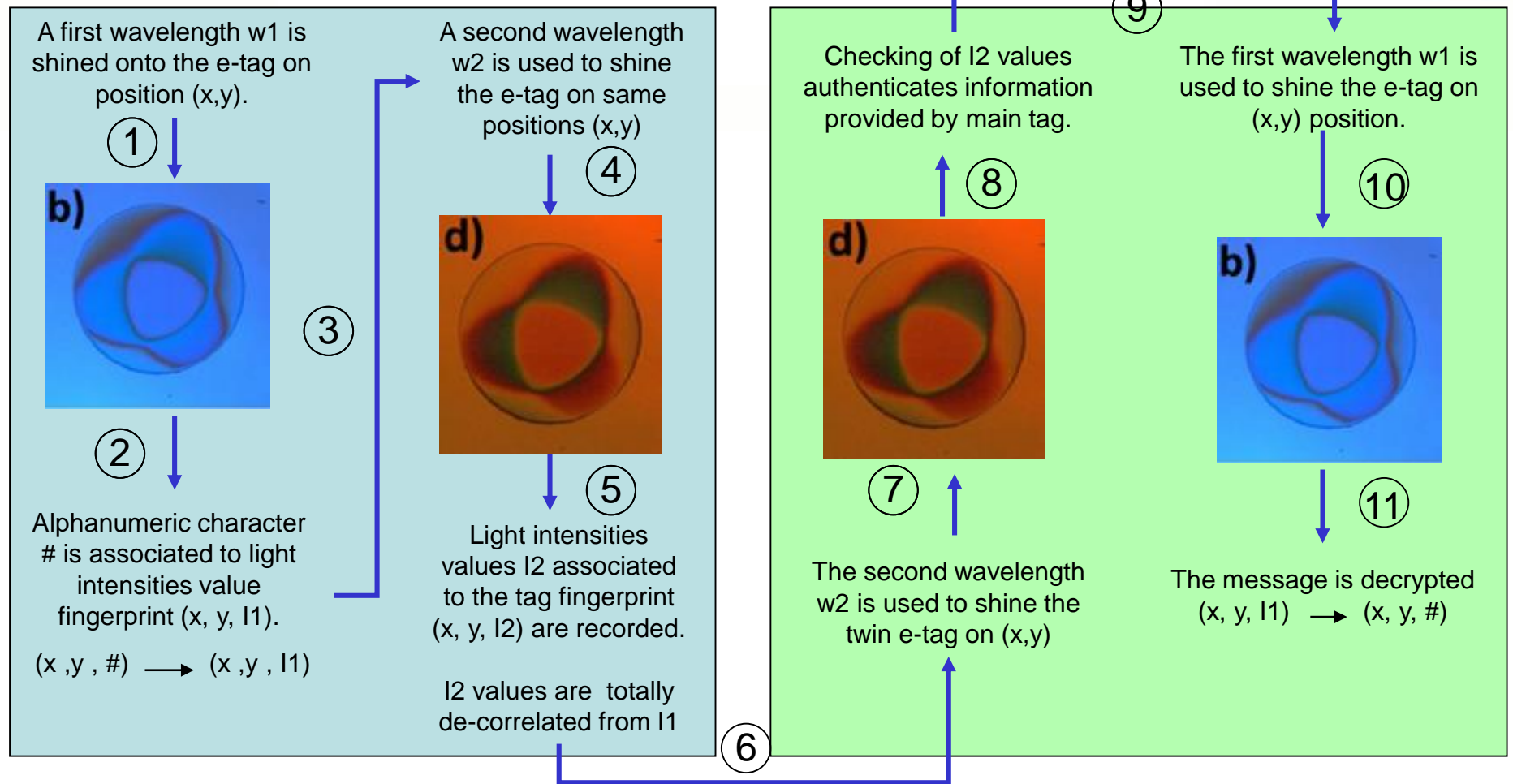
# The 4th dimension...

≠ fingerprints vs external conditions.



A cryptographic key...

# Cryptography functionality



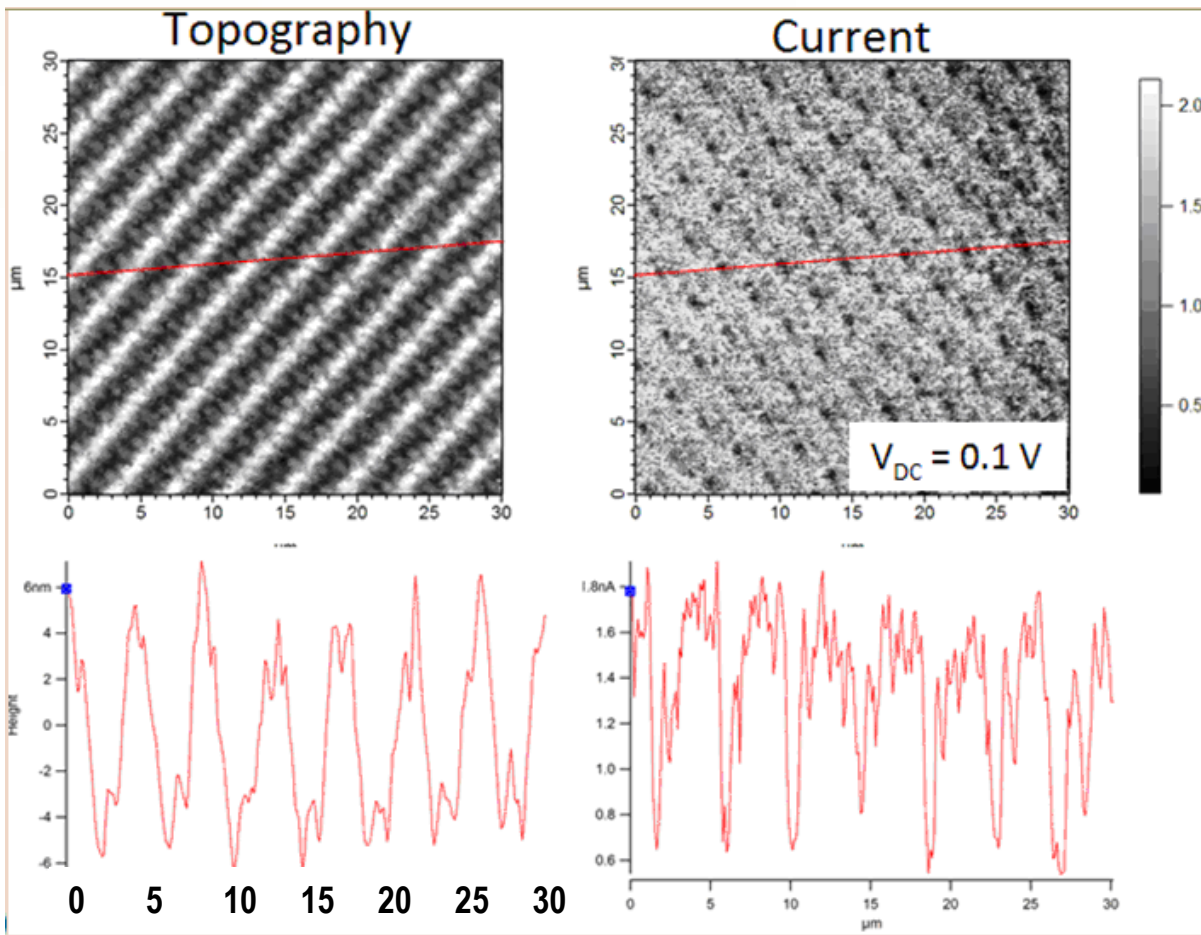
**MAIN TAG**

Encrypted information  $(x, y, I_2)$  is transferred

**TWIN TAG**



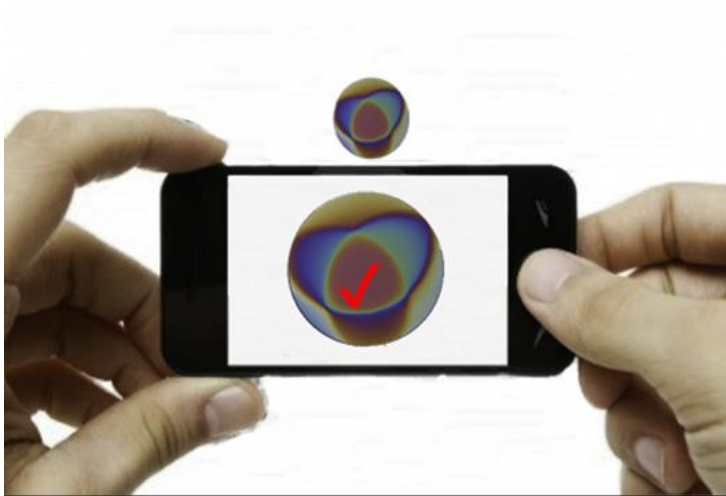
# Other properties available...



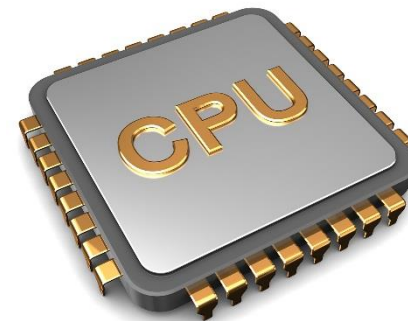
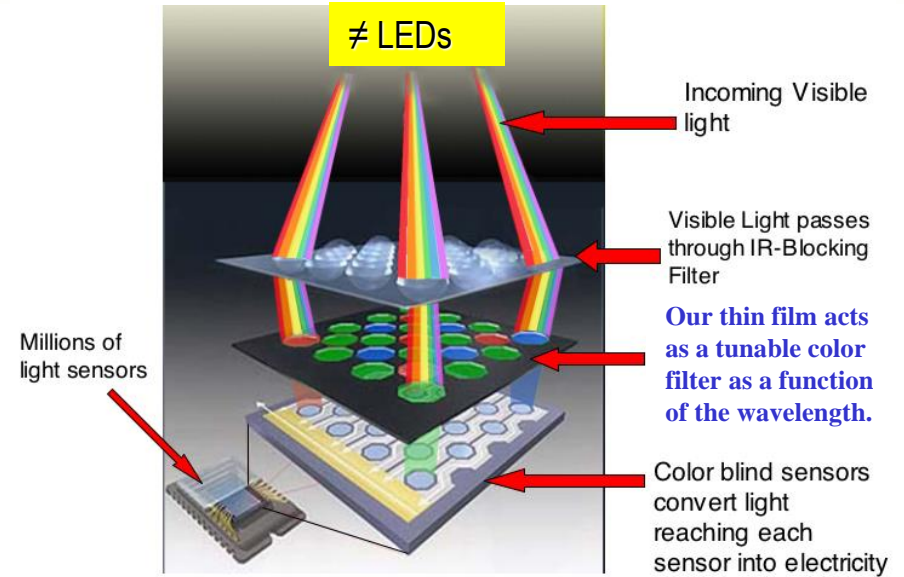
Most material properties can be modulated and patterned.

# Readers

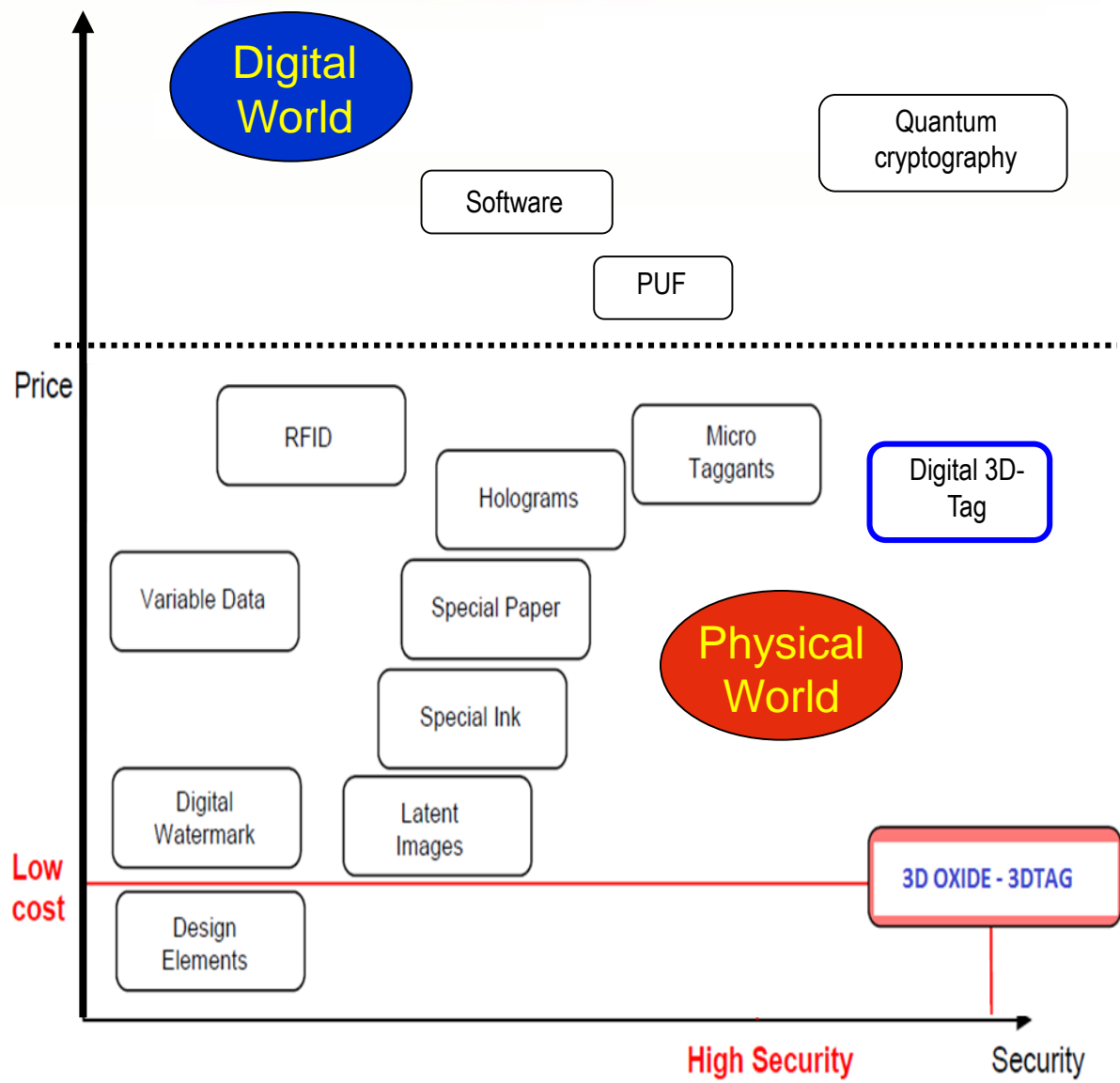
## External reader



## Integrated reader



# Benchmarking



**Better and cheaper than competitors solutions**

# TRL Roadmap

- *Equipments* Available for small series
- *Physical ID* Addressing industrial PoC
- *Digital ID* Addressing Lab PoC
- *Mass Production* Easy equipment upgrading

**Most experimental incertitude addressed**

**Need to optimize the production process**



# Conclusions

## All competitors functionalities

### Physical

*Overt*

*Covert*

*Forensic*

*Ultra-covert*

### Digital

*Firewall*

*PW generators*

*Physical Unclonable Functions*

*Cryptography*

**Monolithically Integrated  
CMOS compatible production  
New Blockchain and AI models enabled**

## Looking for partners:

- **Industries / R&D Labs**

  - Co-developers*

  - Integrators*

  - Early adopters*

- **(Industrial) Venture funds**

  - Production (2 M€)*

  - Marketing + sales (3M €)*

A man with dark hair, wearing a dark suit jacket, a dark shirt, and a patterned tie, stands with his arms crossed. He is smiling slightly. The background is a blurred office or cityscape.

Thank you for your attention.

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+33-(0)7 777 54 397

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