



# PiezoMAT Introduction



Alain GRAILLOT  
**SPECIFIC POLYMERS**

**Research and Development  
Functional Monomers, Polymers and Materials**



EU Project No. 611019



## PRESENTATION OUTLINE



### COMPANY PRESENTATION

- Company Profile - Partners
- R&D Activities

### SP & PIEZOMAT

- NWs Encapsulation
- Polymer/Silver hybrid materials

### OPTO-ELECTRONIC DEVICES

- Functional dielectric materials
- Optical layers
- $e^-$  and  $h^+$  transporting layers

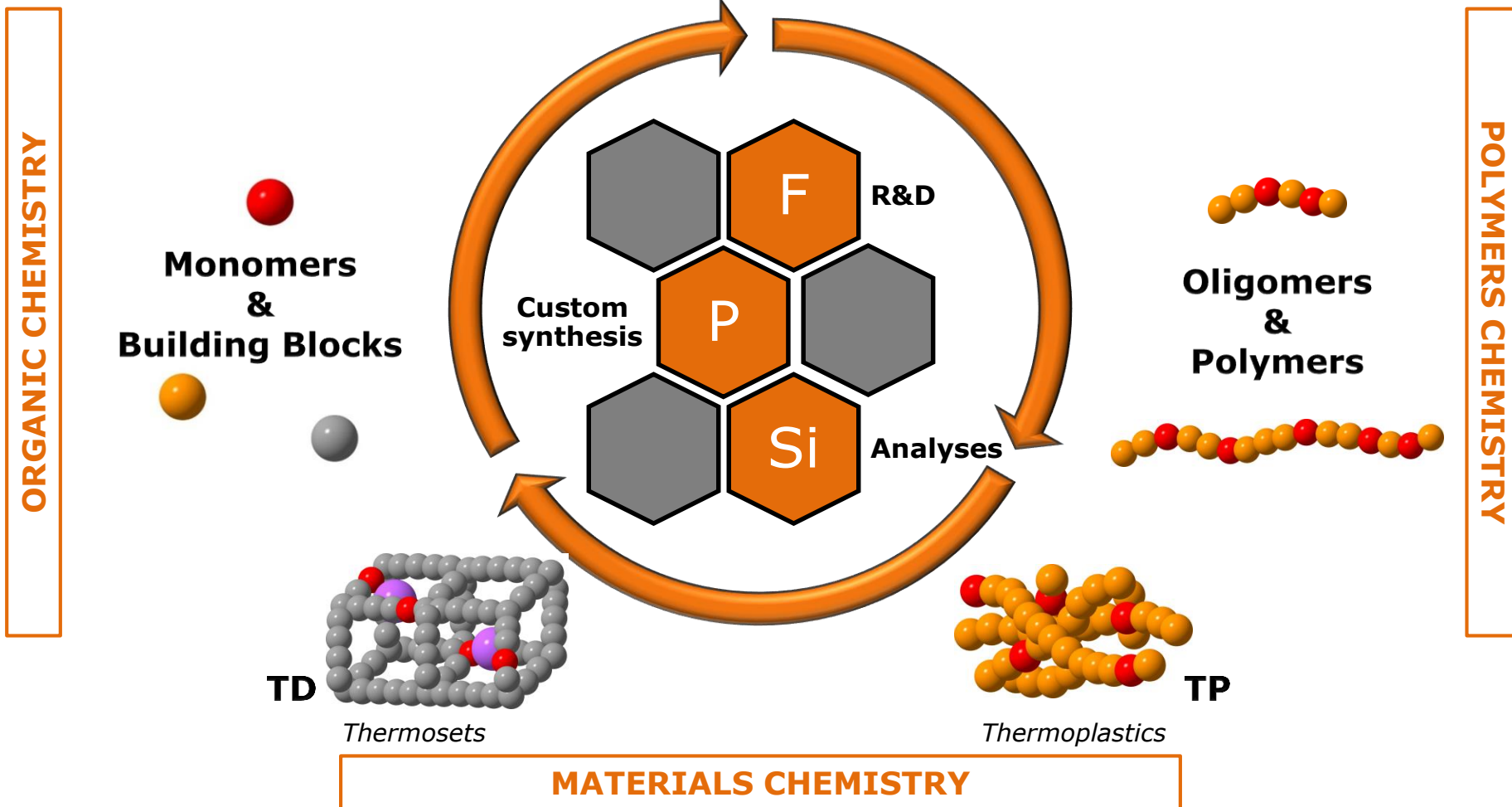
# SPECIFIC POLYMERS – COMPANY PROFILE

- ❑ SME created in 2003
- ❑ Headquarters: CASTRIES (MONTPELLIER - FRANCE)
- ❑ 11 employees : 3 PhDs, 5 Engineers, 2 Technicians, 1 Adm
- ❑ Annual turnover : 2015 – 620 K€ / 2016 – 800 K€
  - ✓ 50 % : R&D services
  - ✓ 30 % : Catalog product sells
  - ✓ 20 % : Custom synthesis
- ❑ 400 customers in more than 30 countries



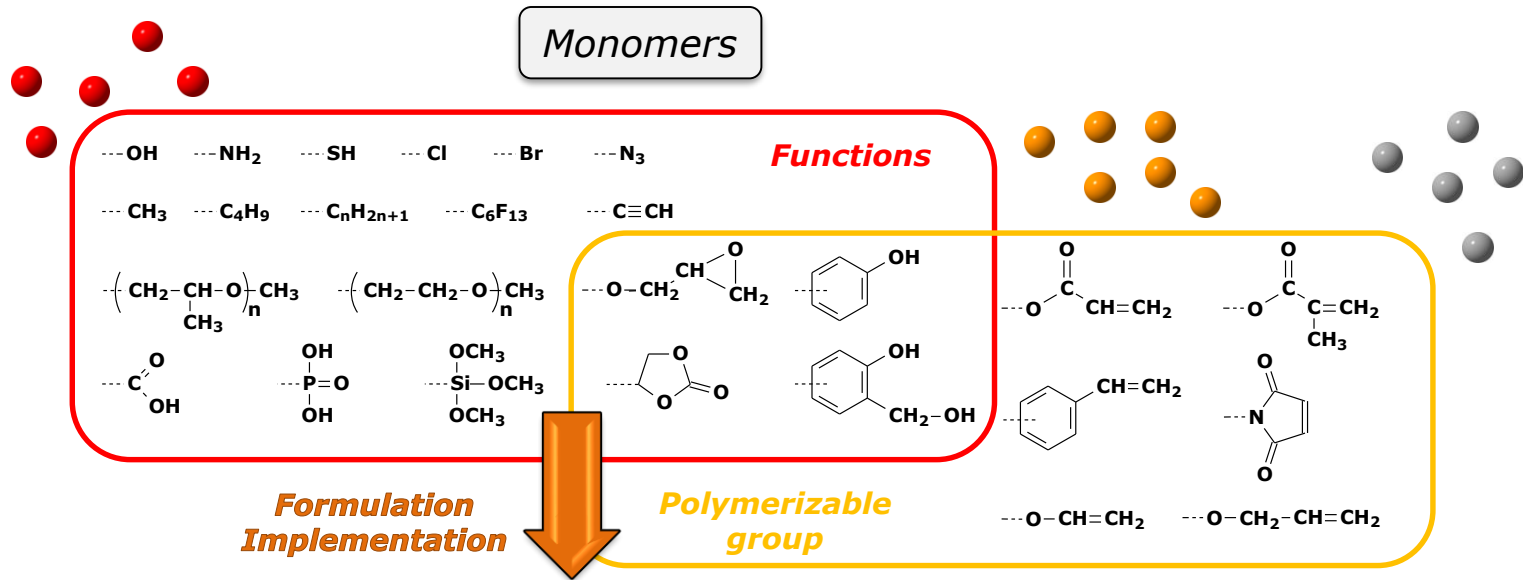
# SPECIFIC POLYMERS – ACTIVITIES

Synthesis of functional monomers, polymers and materials

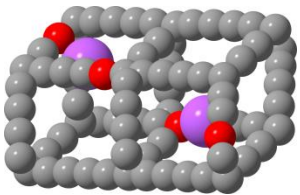


## SPECIFIC POLYMERS – ACTIVITIES

### Synthesis of functional monomers, polymers and materials



☐ Epoxy

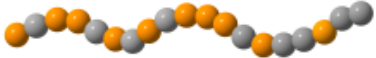


Thermosets

☐ Phenolics

☐ Polyuréthane

☐ Acrylics

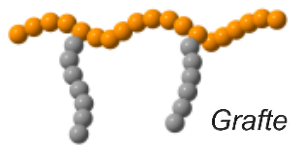


Statistical



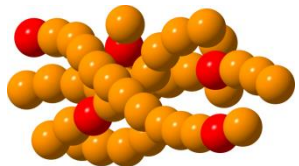
Block

☐ Styrenics



Grafted

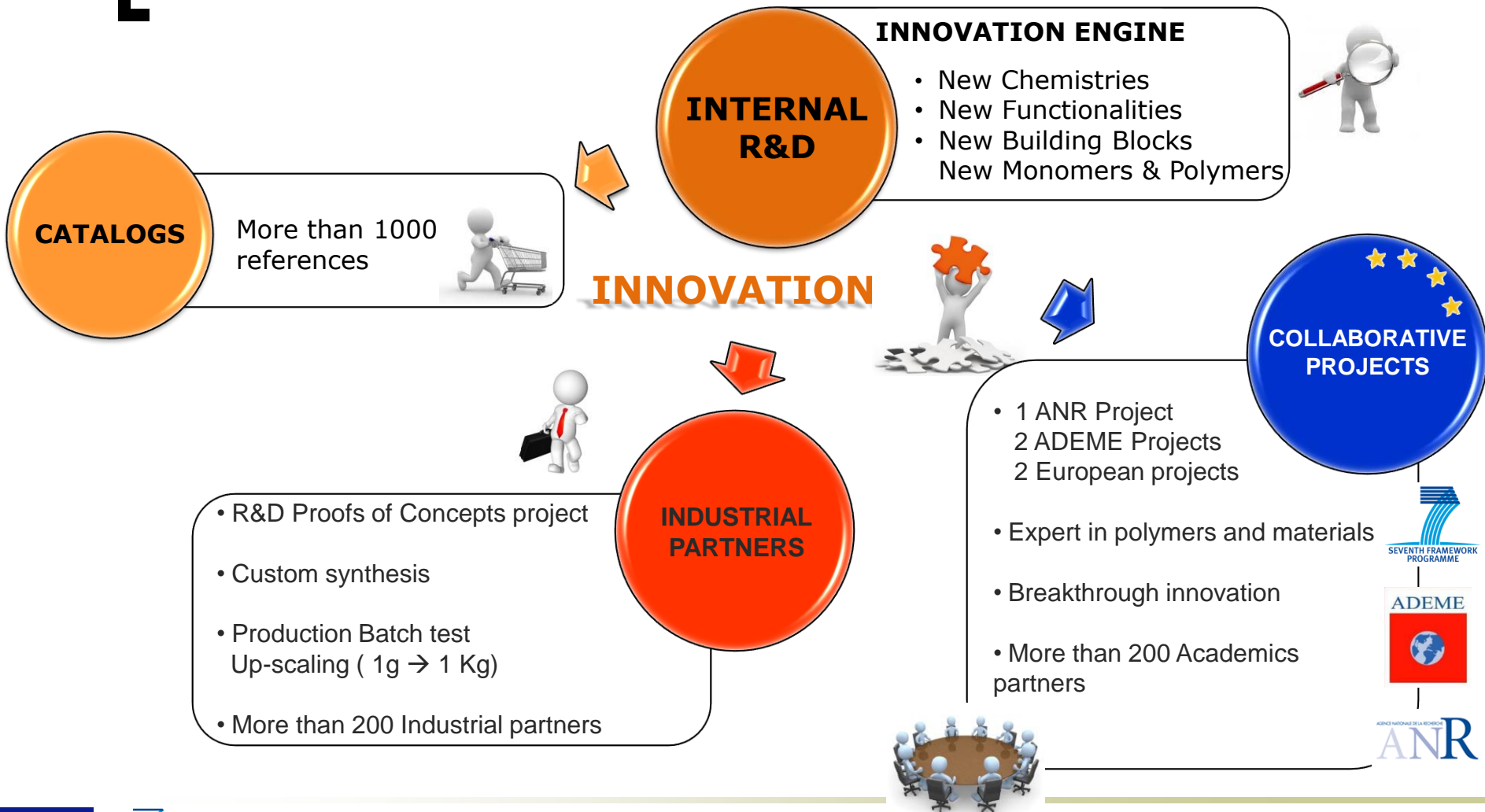
☐ Hybrid materials



Thermoplastics



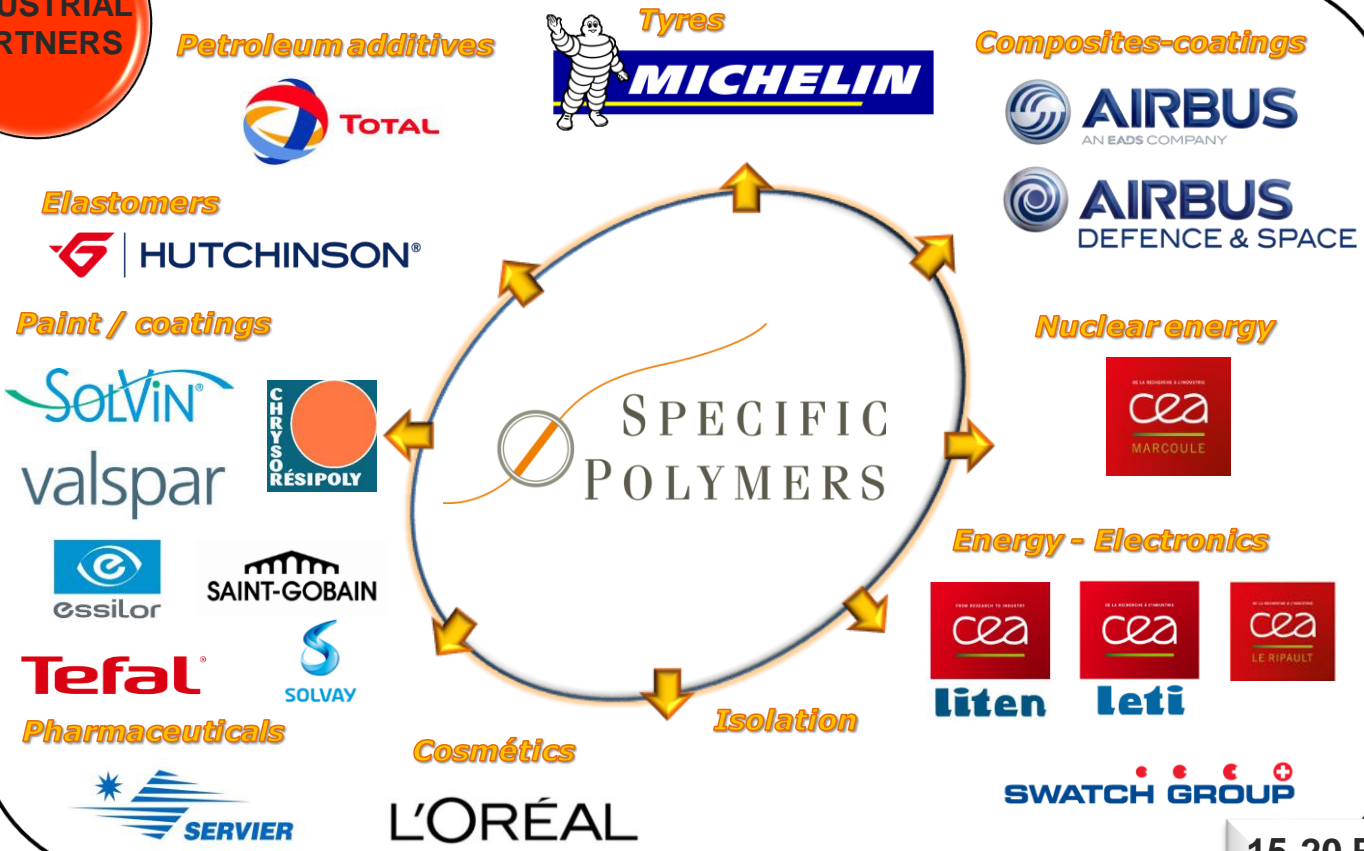
## SPECIFIC POLYMERS – COMPANY PROFILE



## SPECIFIC POLYMERS – PARTNERS

R&D Research Programs & Collaboratives Projects

INDUSTRIAL  
PARTNERS



15-20 Research Program / year

## SPECIFIC POLYMERS – PARTNERS

### Catalog Products and Custom-synthesis – Academic Partners

ACADEMIC PARTNERS

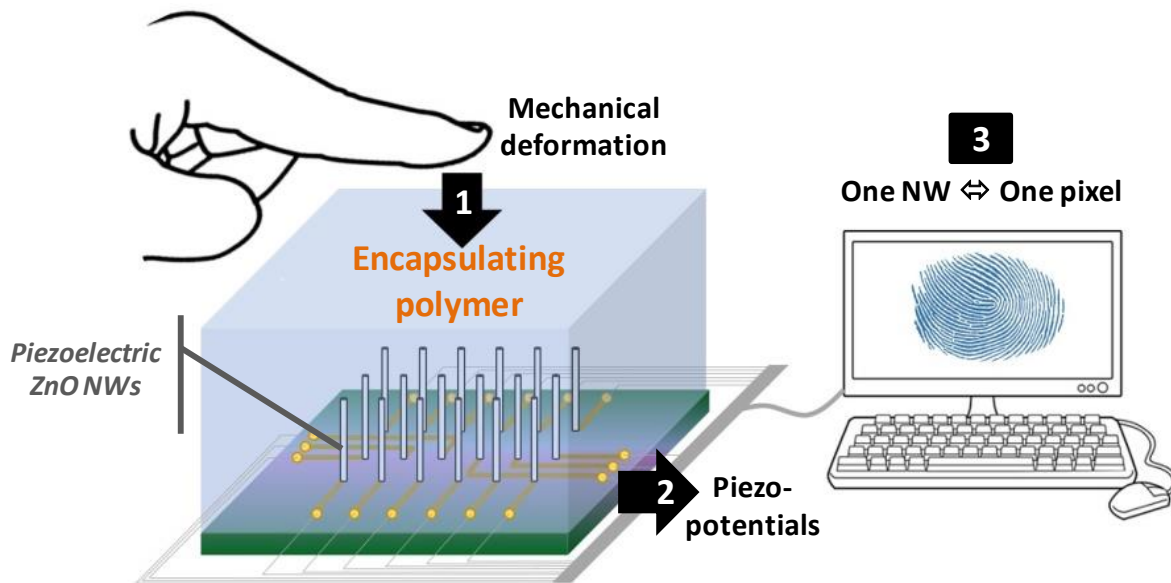


200-250 Catalog Products / year  
30-50 Custom Synthesis / year

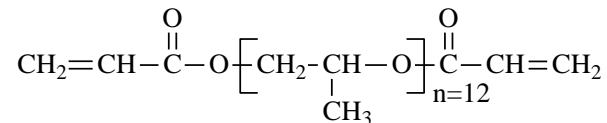
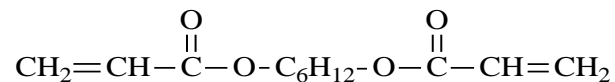


## SPECIFIC POLYMERS & PIEZOMAT

Encapsulation polymeric materials in multi-NWs pressure based fingerprint sensors



### Acrylate based UV crosslinked materials



Spin-coating



UV curing

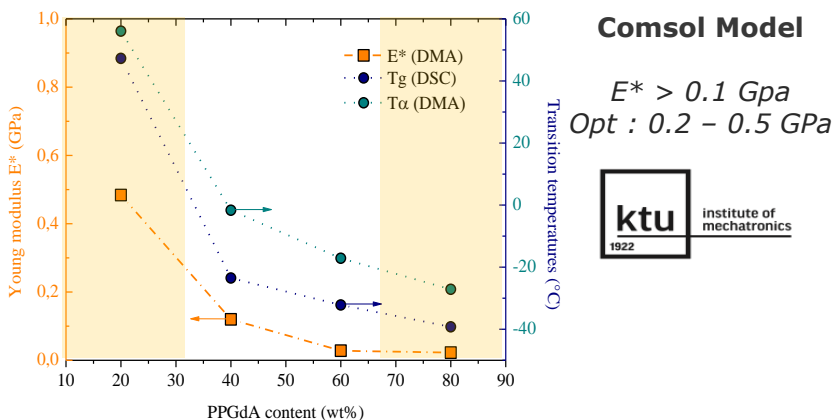
### Required properties

- Adjustable mechanical properties: soft to tough materials
- Accurately and easily processable: liquid formulation
- Compatibility with NWs and seed layers : liquid and solvent free
- Chemical and Thermal resistant : Crosslinked thermoset materials

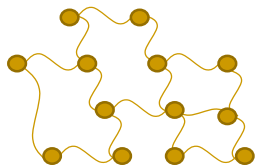
## SPECIFIC POLYMERS & PIEZOMAT

Encapsulation polymeric materials in multi-NWs pressure based fingerprint sensors

### Mastering mechanical properties

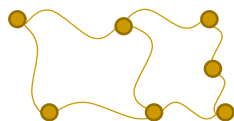


#### Low PPGA content



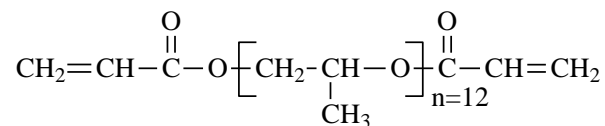
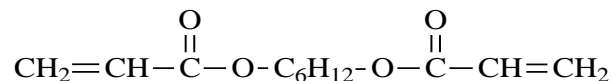
High crosslinking degree  
 ↓  
 High Young Modulus ( $E^*$ )

#### High PPGA content



Low crosslinking degree  
 ↓  
 Low Young Modulus ( $E^*$ )

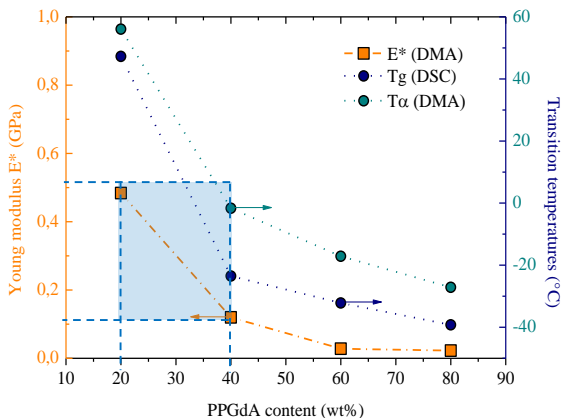
### Acrylate based UV crosslinked materials



## SPECIFIC POLYMERS & PIEZOMAT

Encapsulation polymeric materials in multi-NWs pressure based fingerprint sensors

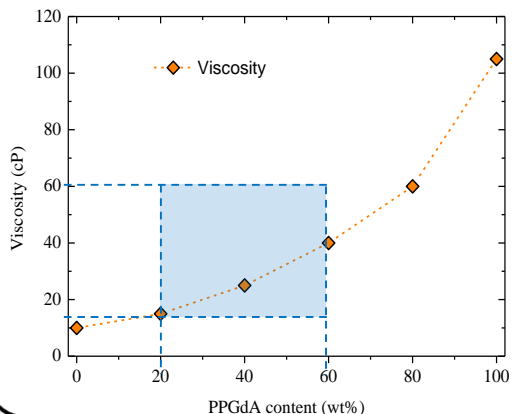
### Mastering mechanical properties



**Comsol Model**  
 $E^* > 0.1$  Gpa  
 Opt : 0.2 - 0.5 GPa



**PPGA content**  
 20-40 wt%



**Formulation**  
 Viscosity  
 $\updownarrow$   
 Processability

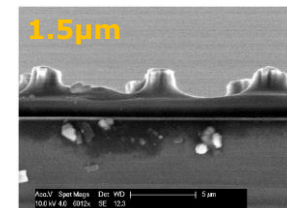
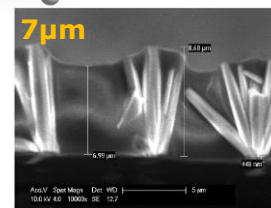
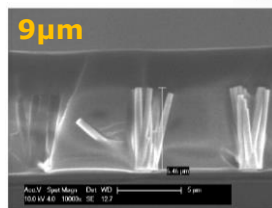
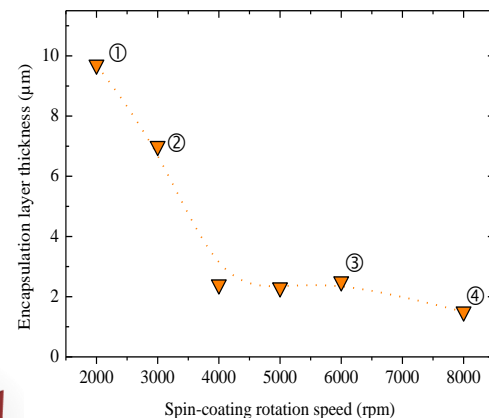
**Best Compromise**  
 40 wt% PPGdA

### Mastering thin layer thicknesses

Formulation : 60%wt HdA / 40%wt PPGdA



*Influence of spin-coating rotation speed*



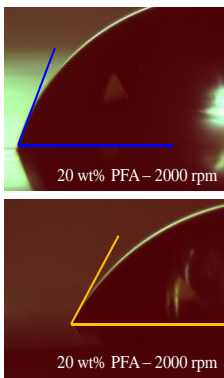
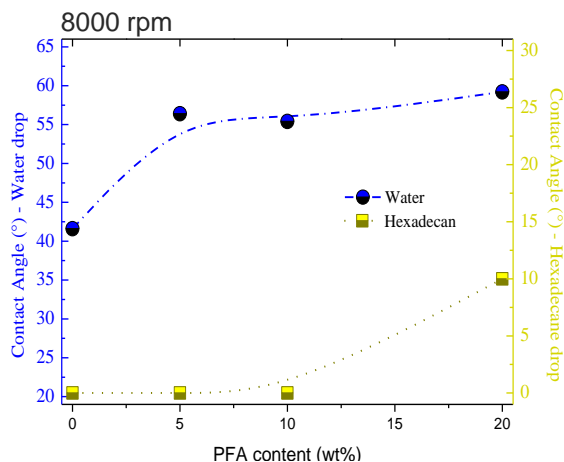
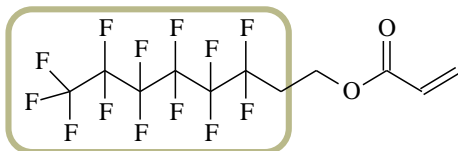
**Polymer layer thickness from 1 to 9  $\mu\text{m}$**   
 Suitable process for both options

## SPECIFIC POLYMERS & PIEZOMAT

Encapsulation polymeric materials in multi-NWs pressure based fingerprint sensors

### Improving surface properties

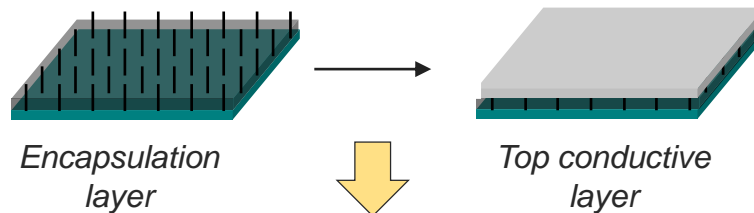
Perfluoro octyl acrylate (PFA)  $\Rightarrow$  hydrophoby / oleophoby



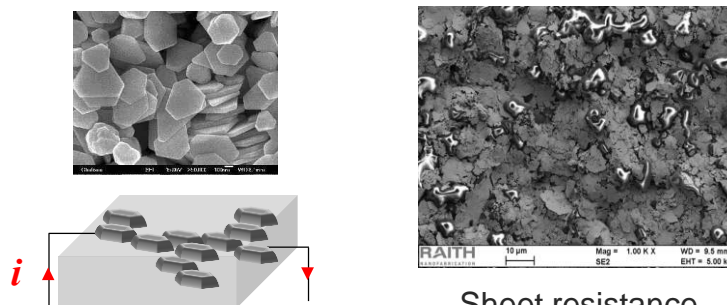
Further improvements of hydrophoby and oleophoby are on going

### Conductive polymer layer as top electrode

Compression option



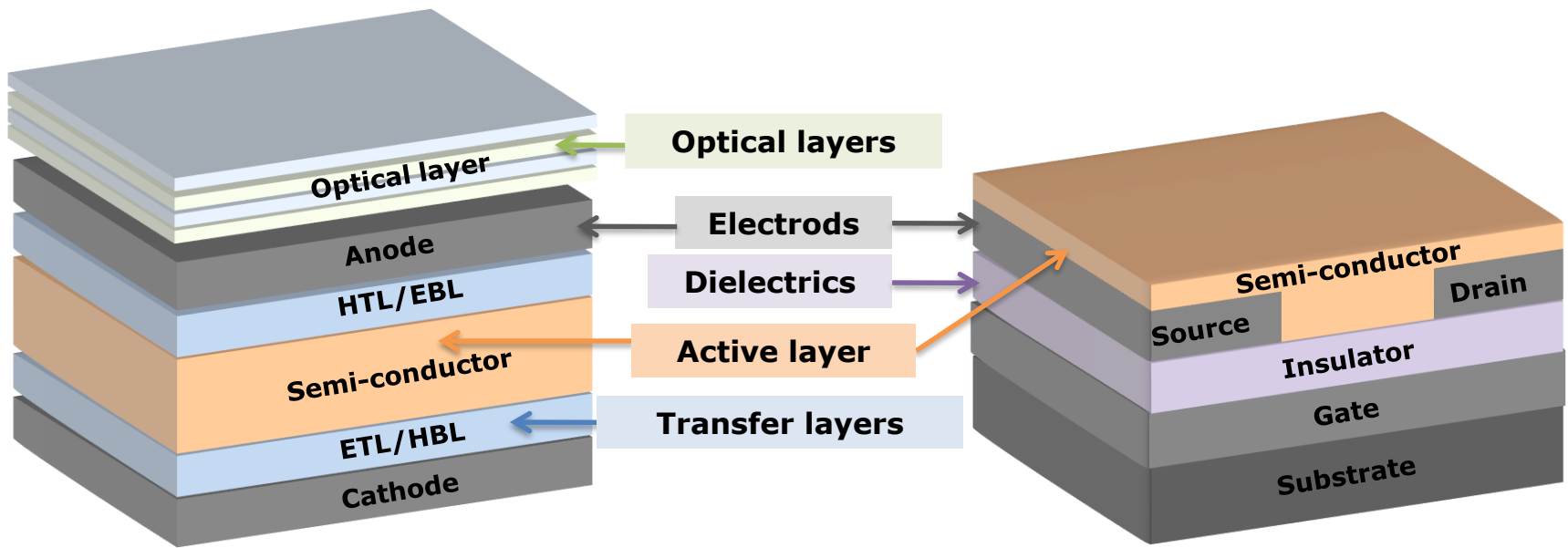
### Polymer – silver flakes hybrid material



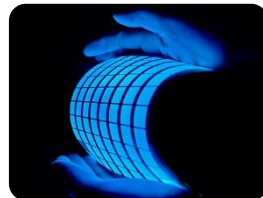
Sheet resistance  
1 and 60  $\Omega$ /sq

## OPTO-ELECTRONIC DEVICES

One polymer for every layers



Organic  
Photovoltaics



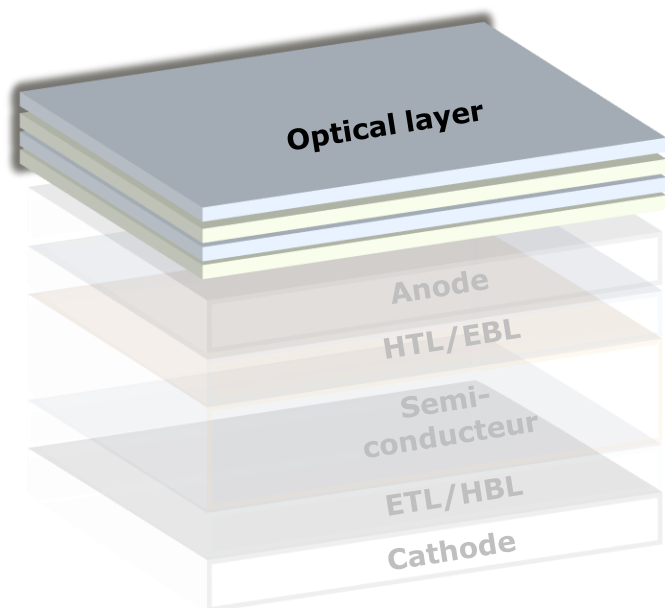
Organic Light  
Emitting Diodes



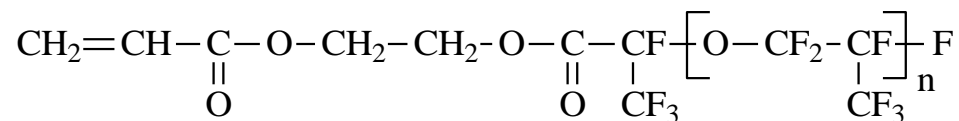
Organic Field-Effect  
Transistor

# OPTO-ELECTRONIC DEVICES

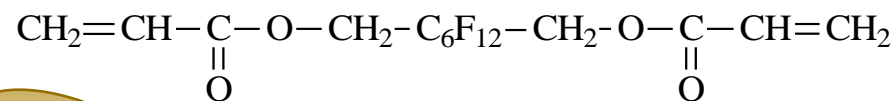
Optical layer : Low refractive index layer



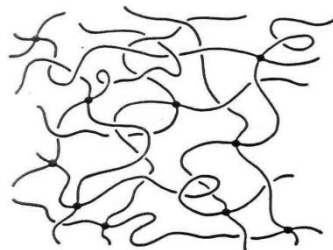
**Poly(HFPO) acrylate (SP-0P4-7-002)**



**Fluorinated diacrylate crosslinker**



**UV-Crosslinked  
Low Refractive index material**

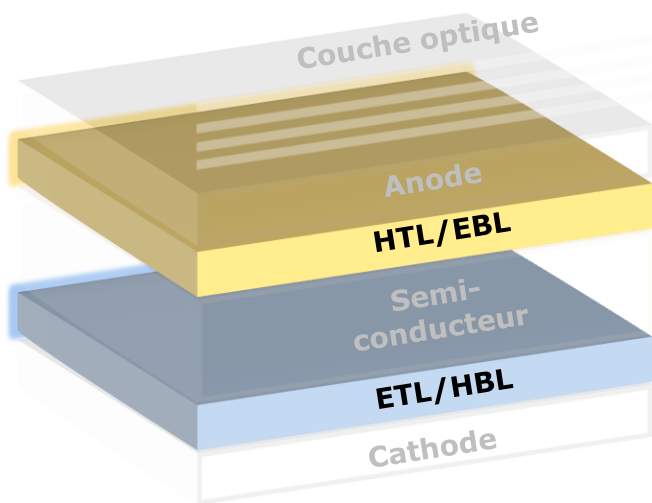


**RI = 1.4**

Hybrid thin layer under study  
(SrTiO<sub>3</sub>, BaTiO<sub>3</sub>, NaF, LiF, CaF<sub>2</sub>)

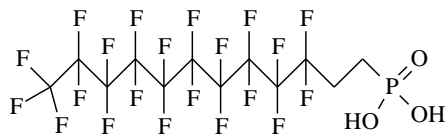
# OPTO-ELECTRONIC DEVICES

e<sup>-</sup>/h<sup>+</sup> transporting and blocking layers



- Hole transporting layers**

Fluorophosphonic acids on PEDOT:PSS layer



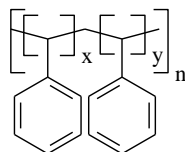
Hole injection

ITO  
Adhesion

⇒ **Better hole transport**

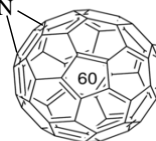
⇒ **Enhanced luminous efficacy**

- Electron transporting layers**



C60 grafted polystyrene

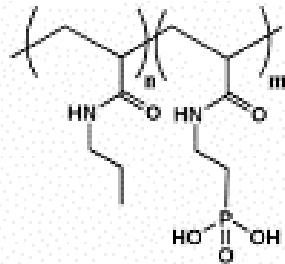
⇒ **Avoid recombination of excitons**



# SP & EUROSENSORS

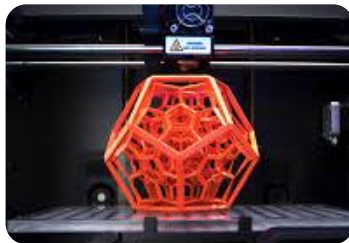
Innovative polymers and materials in the fields of sensors

## Smart Stimuli Responsive Polymers



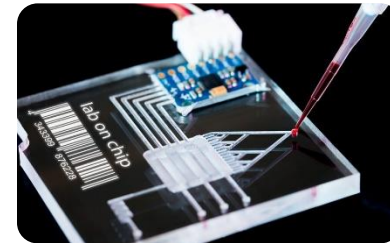
- *Thermal and pH sensitive polymers*

## 3D-printing

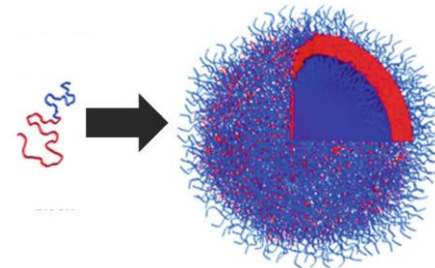


- *Functional materials for 3D printing applications*

## Materials for Microfluidic



- *Sol-Gel materials – Functional alcoxysilane*
- *Functional PDMS, poly(methacrylate), etc.*



- *Amphiphilic block copolymers*





# CONCLUSIONS

## ❑ SPECIFIC POLYMERS

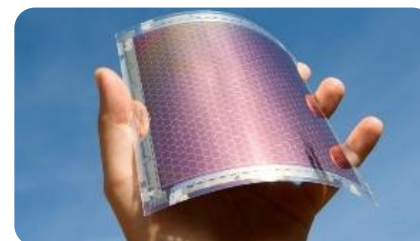
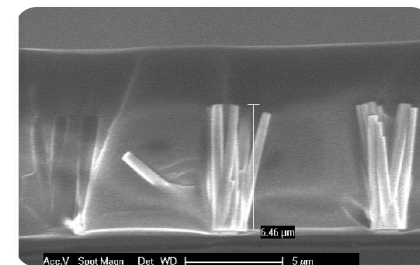
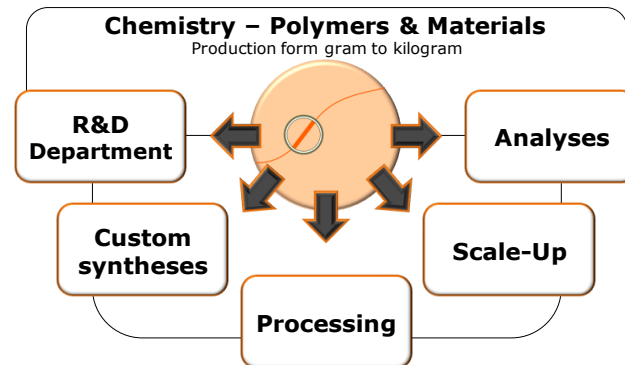
R&D services provider  
Polymers and materials science

## ❑ PiezoMAT European Project

Innovative UV-crosslinked encapsulation  
layers for multi-NWs based sensors

## ❑ Opto-Electronic devices and sensors

SP is involved in optoelectronics  
Looking for collaborations in Sensors



# PiezoMAT



# THANKS

