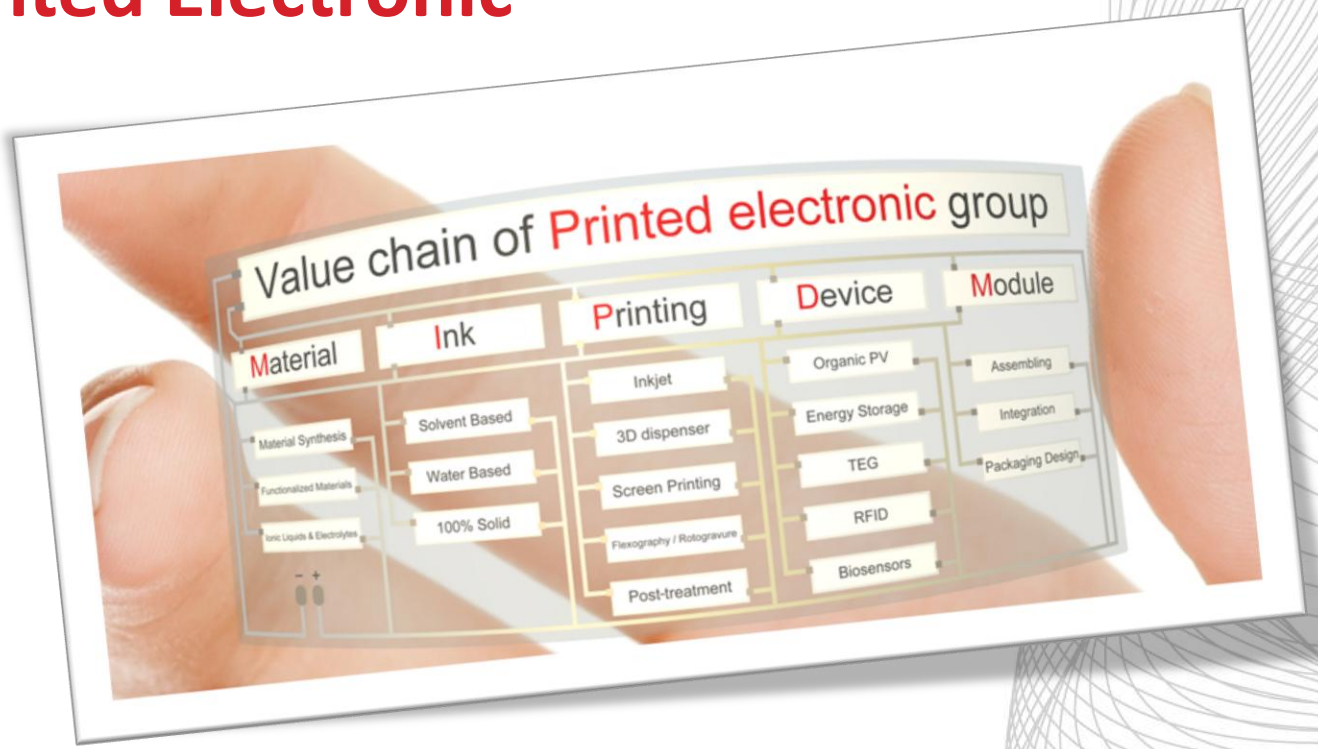
LEITAT Technological Center
managing your technologies
member of TECNIO Be tech. Be competitive

Printed Electronic



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Content list

- General overview on Printed electrinc in Europe
- Leitat Introduction
- Printed electronic at Leitat
- BASMATI project
- Similar EU project
- Equipments and facilities
- Other printed devices
- Other project on printed electronic

Competitive landscape

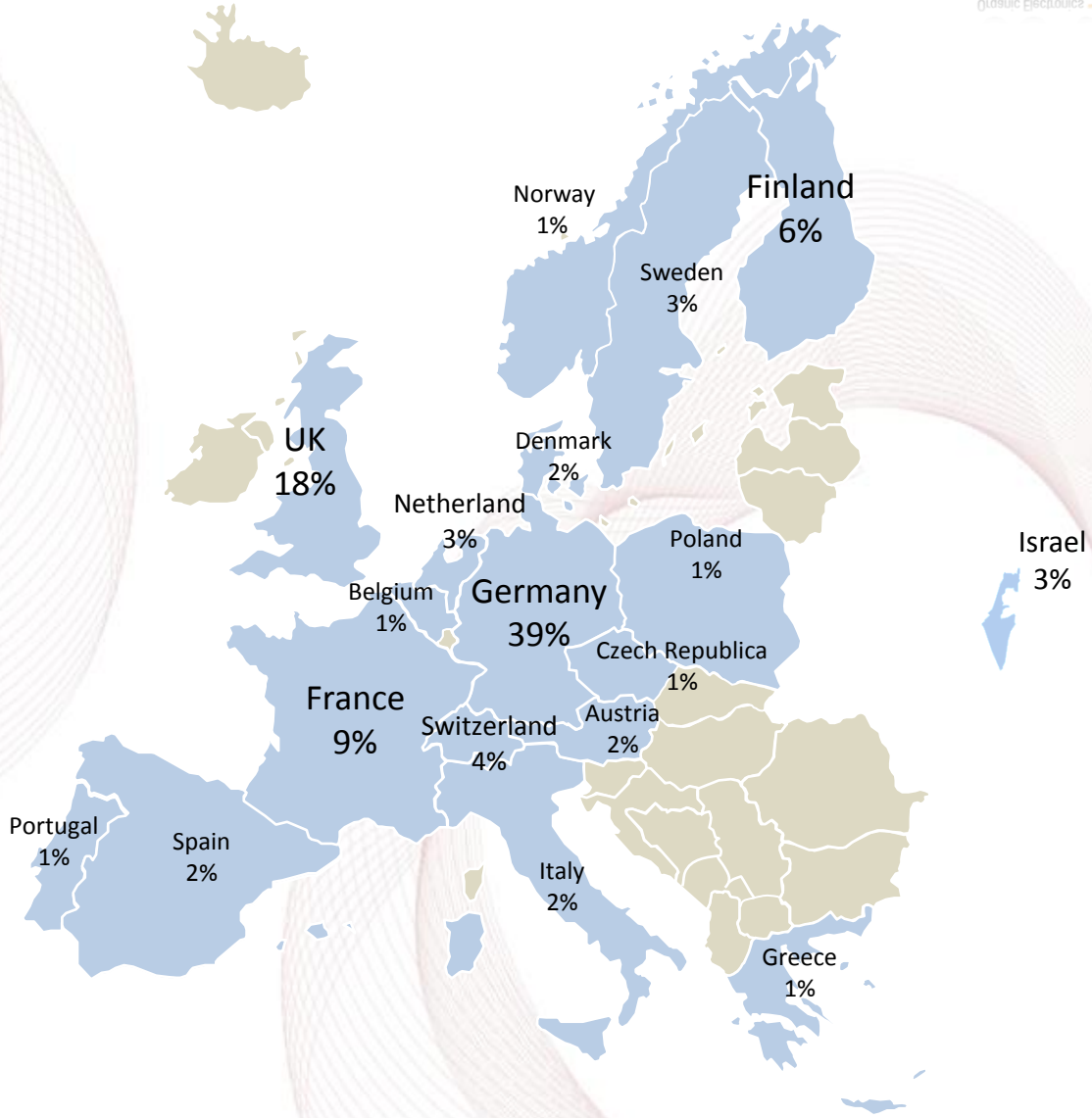
✓**Advancements in printing electronics technologies** are primarily being witnessed in the Asia Pacific region due to the presence of various consumer electronics OEMs (original equipment manufacturers) in these regions.

✓**The European and North American regions** are witnessing a number of research actives focusing on the development of printed and flexible electronics.

✓**Government bodies** across the globe are supporting research and development of printed and flexible electronics by granting funds

Distribution of entities in Europe involve printed electronic

Country	Num. Involved entity
Germany	67
United Kingdom	32
France	15
Finland	11
Switzerland	7
Netherland	6
Israel	5
Sweden	5
Spain	4
Austria	4
Italy	4
Denmark	3
Belgium	2
Norway	2
Poland	2
Portugal	2
Czech Republic	1
Greece	1



Printed Electronics technologies enabling the development of flexible and conductive electronics

Key Trending Markets

Energy

Healthcare

Sport Leisure

Food & Packaging

Security

Communication

Home automation

Aeronautic & Transportation

Benefits and Restraints

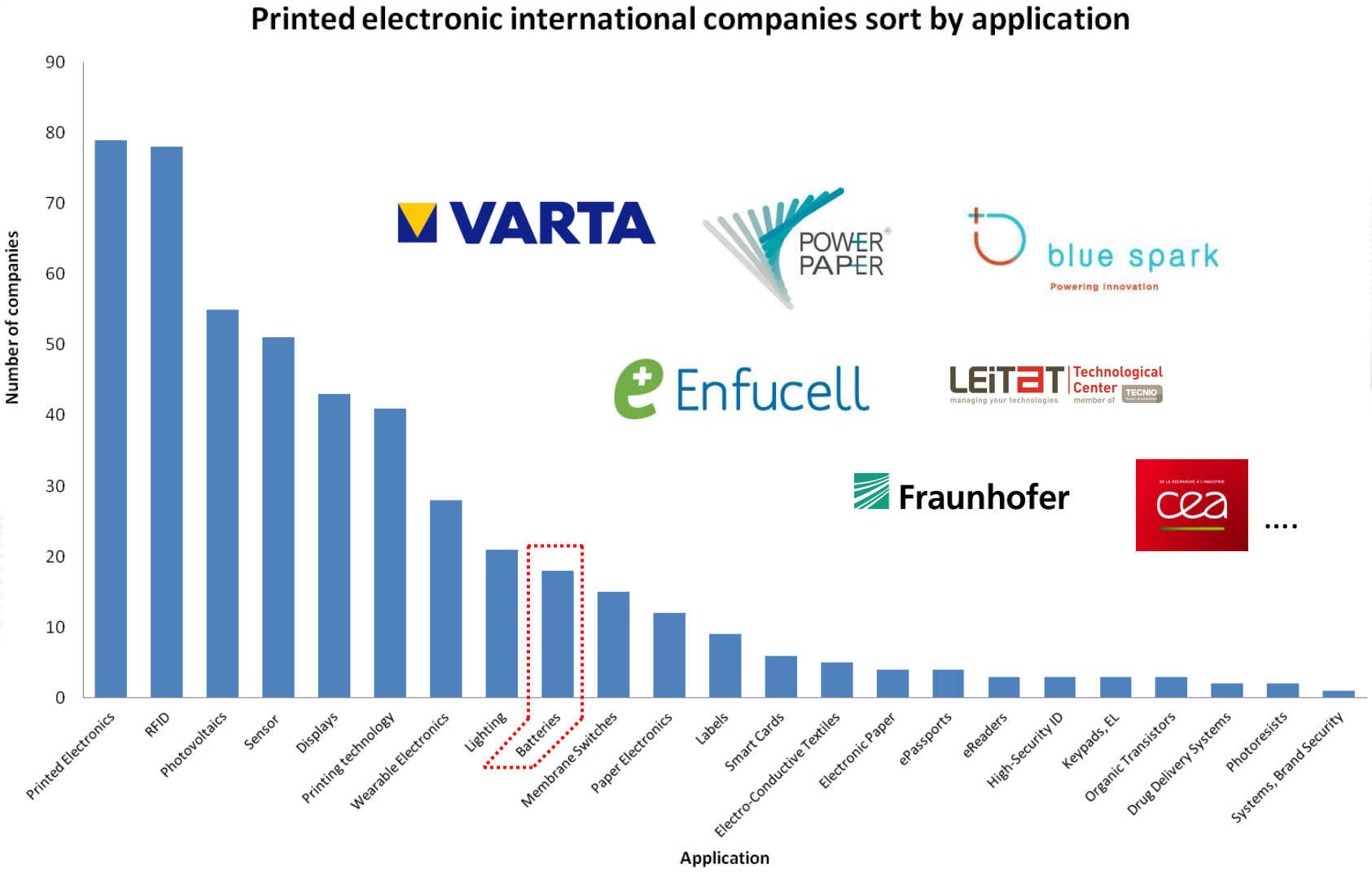
✓Reduction in cost of manufacturing electronics
✓Large scale production
✓Ease of integration
✓Environmental friendly

✓High initial cost
✓Lack of standardization
✓Instability of materials used in printed and flexible electronics

Entry Barriers

With continuous advancements in enabling technologies such as inkjet materials, transparent films and many others, printing electronics technology developers are expected to incorporate the latest technologies. This in turn leads to increase in the initial cost involved.

Number of companies in different application sector



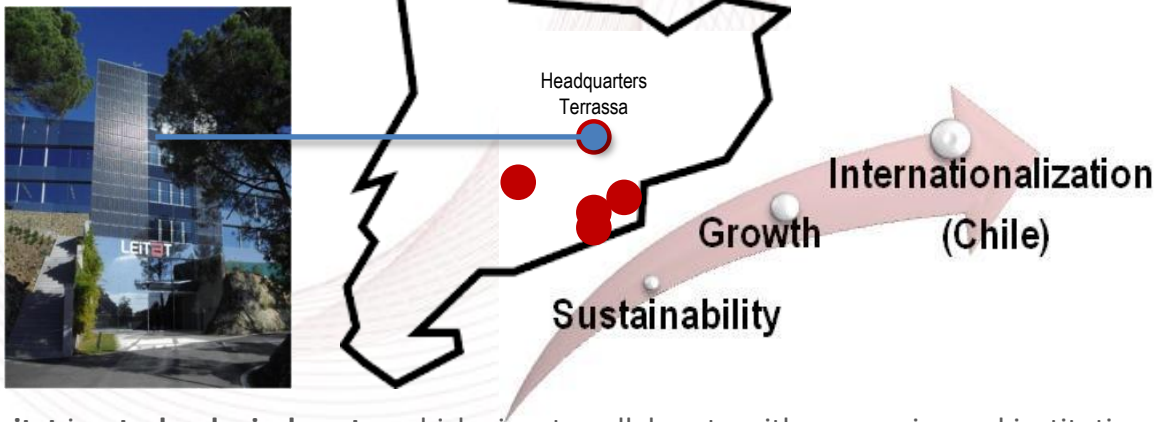
LEITAT

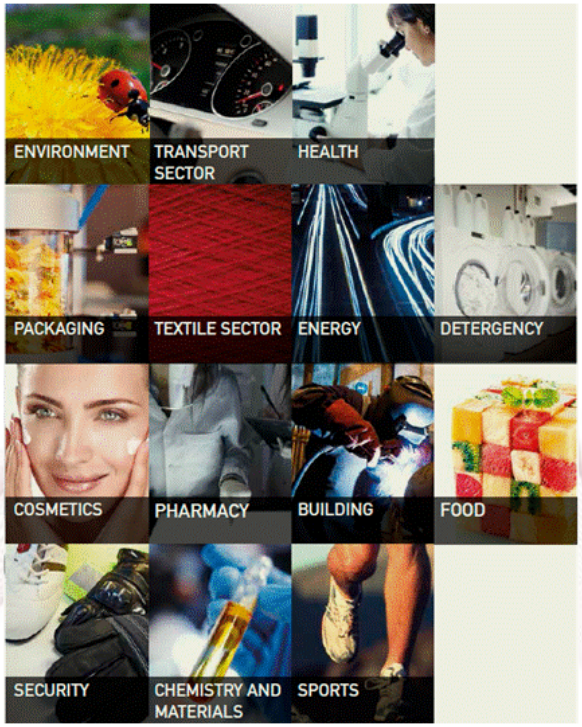
MISSION

Create and transfer **value** with research and technological projects.

VISION

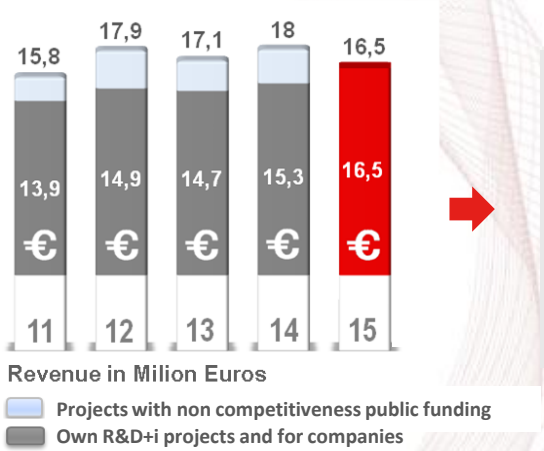
Be an acknowledged **technological partner** for companies and administration; create a co-operative culture that enables sustainable growth and efficiency of actions.

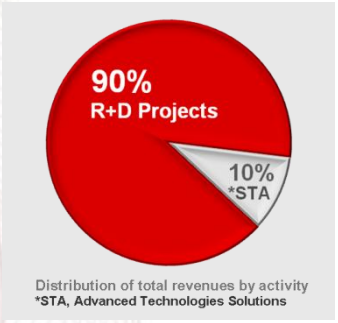


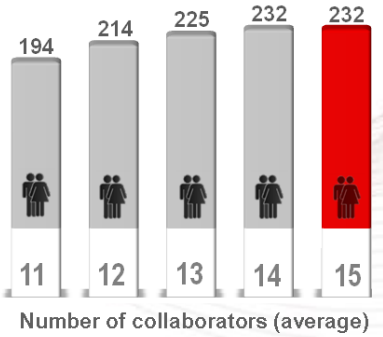


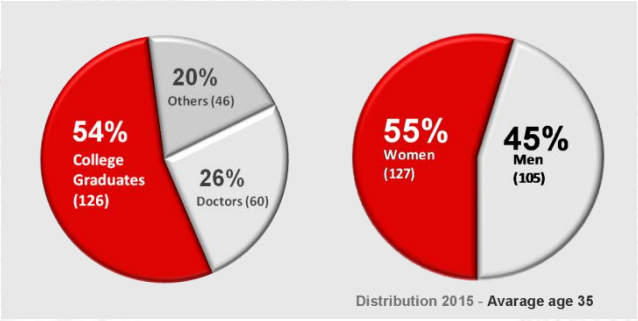
- **Leitat** is a **technological center** which aims to collaborate with companies and institutions to create economic, social and sustainable value.
- Leitat is the trademark of Acondicionamiento Tarrasense, an Spanish **non-profit private institution** constituted in 1906.
- Leitat **performs R&D projects** in collaboration with companies and institutions both nationally and internationally

Results









Our customers' value: ***Quality, personal contact, technology solvency***
Level of loyalty (future collaboration and recommendation) **> 90%**

Figures 2015

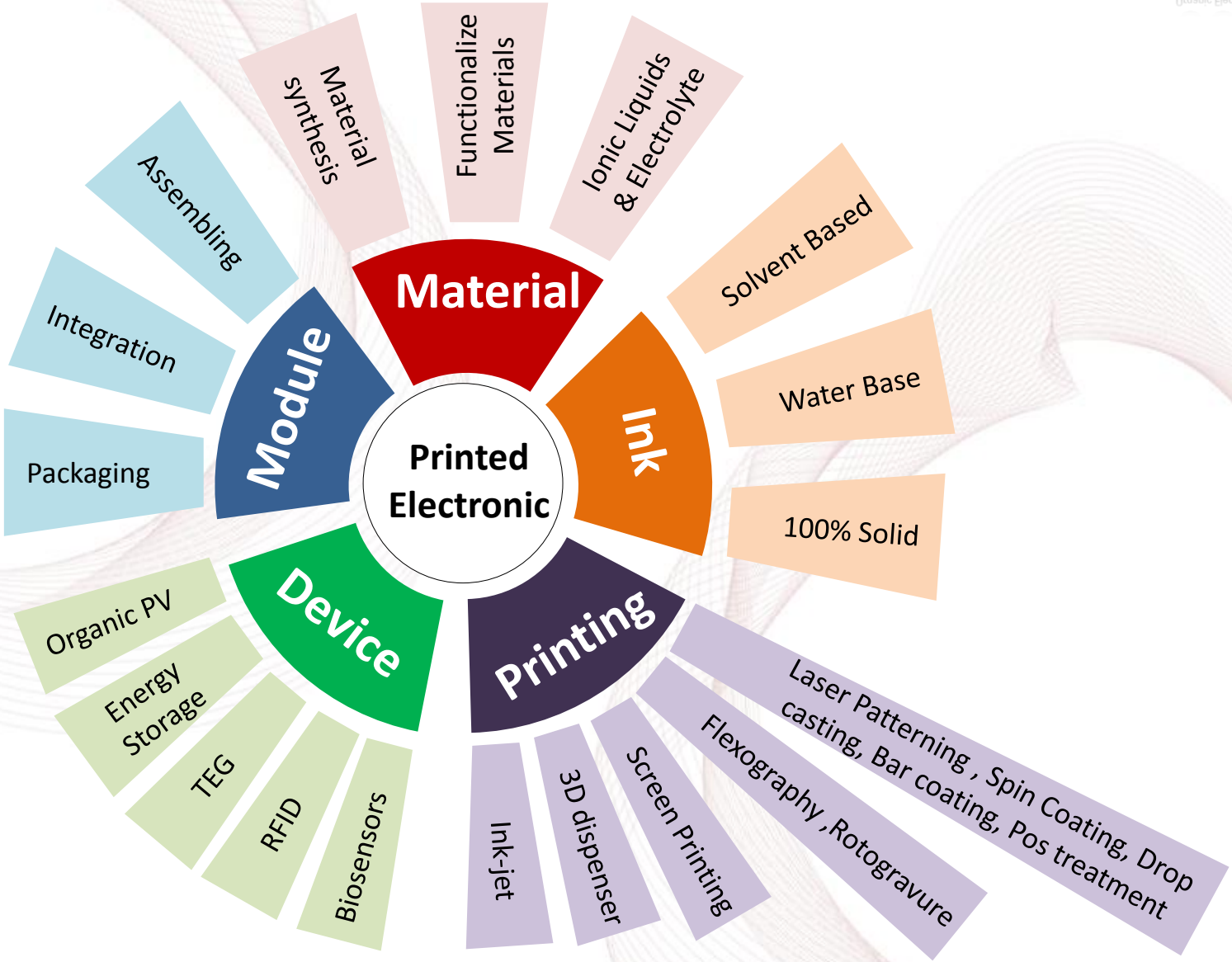
65 R+D+2i European projects being executed*
90 R+D+2i National projects being executed*
29 Lead projects
267 Private R+D+2i projects
3.305 Advanced technology solutions

*We participate in European projects with **538** partners, overall budget of **407M €** and collaborating with **34** countries

\+

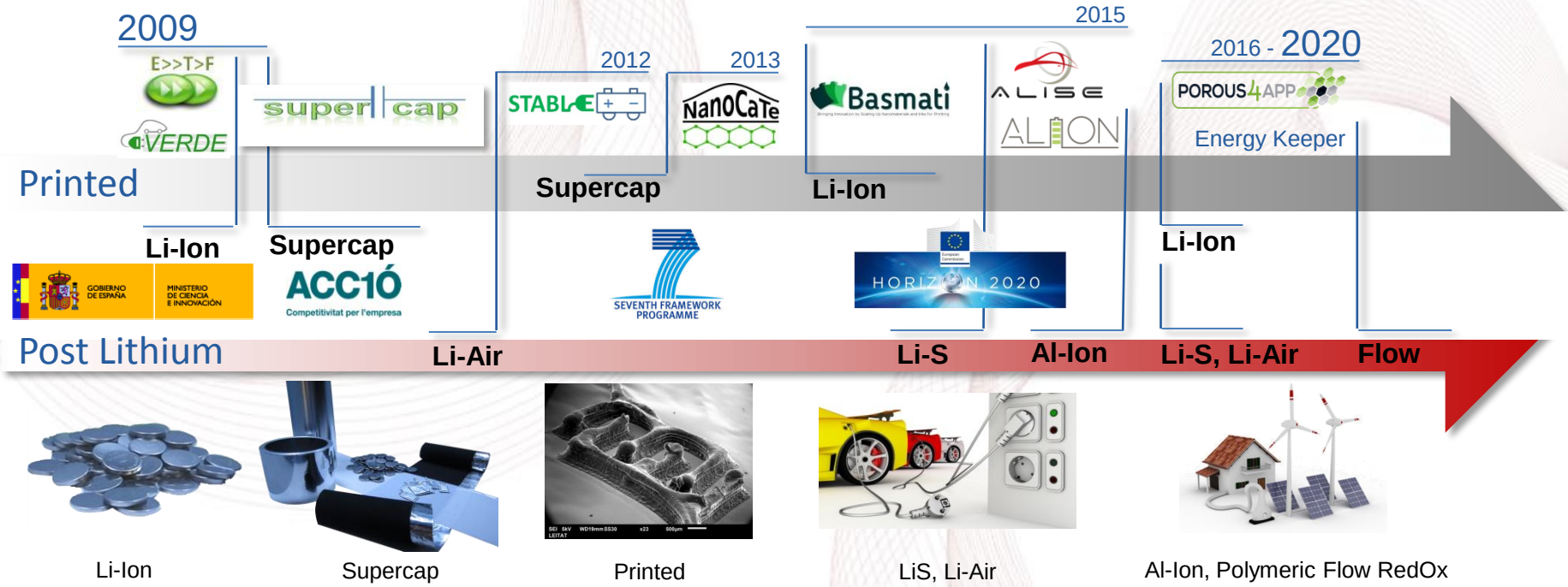
Corporate Social Responsibility

Printed electronic group at LEITAT



Energy Storage group overview

- Post lithium ion for EV and stationary (>400Wh/kg, Al-Ion, LiO_2, LiS, Flow Batteries)
- Printed batteries for small electronics (Supercap, Li-ion, Al-Air and hybrids)



Li-Ion

Supercap

Printed

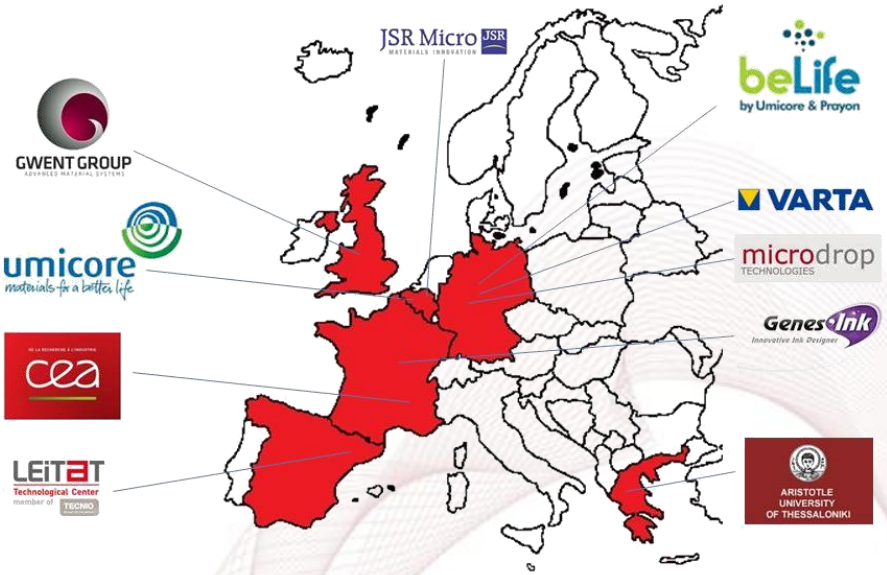
LiS, Li-Air

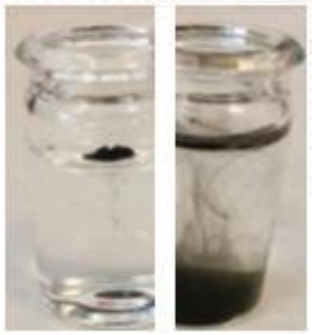
Al-Ion, Polymeric Flow RedOx

Energy Storage Know How

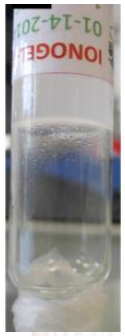
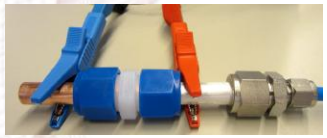
Basmati
Bringing Innovation by Scaling Up Nanomaterials and Inks for Printing

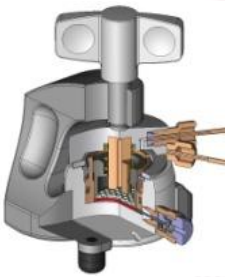
Bringing innovAtion by Scaling up nanoMATerials and Inks for printing
H2020-NMP-PILOTS-2014
Grant agreement n° [646159].
EU contribution: 5,000,360.00 euros
Duration : January 2015 – December 2018
Coordinating by UMICORE







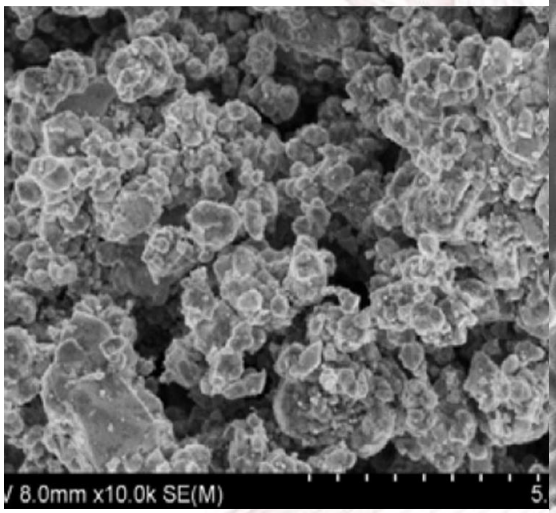



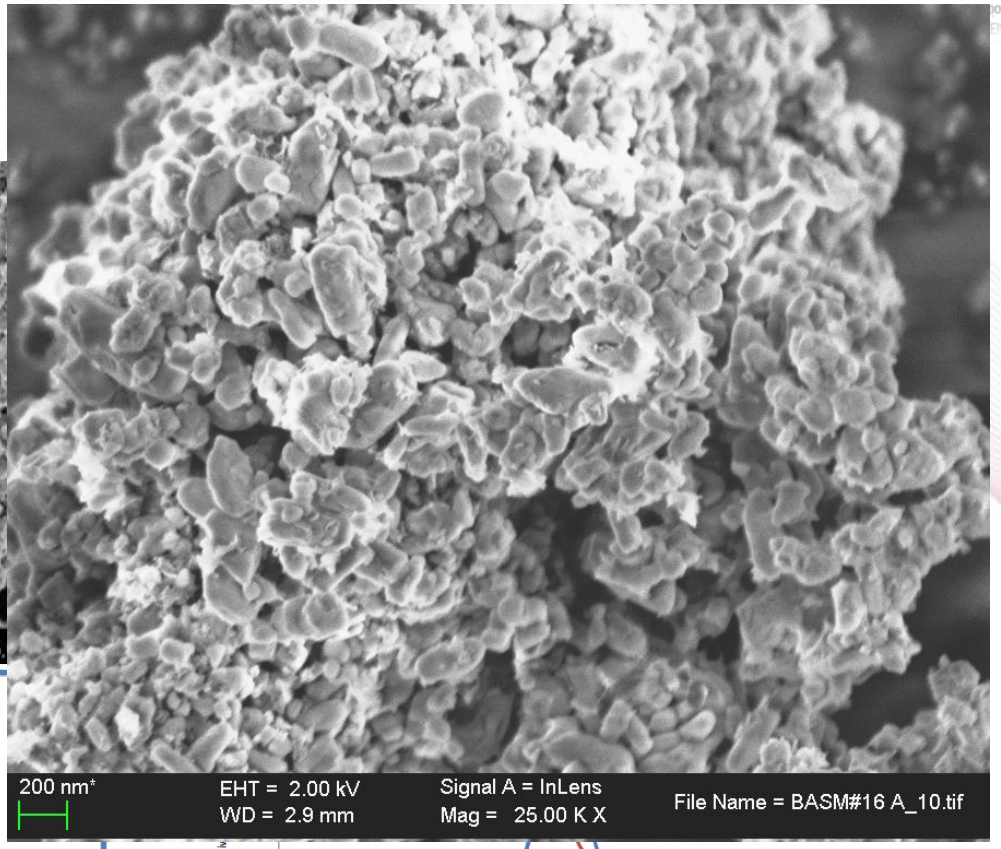


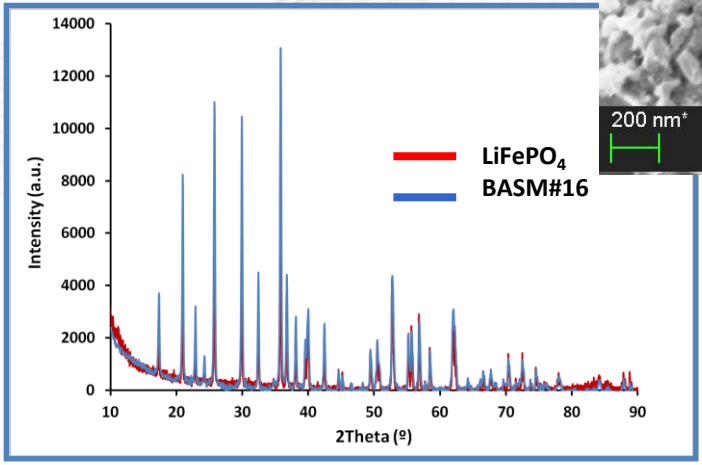
Material Synthesis	Functionalization	Ink	Coating	Calendaring	Electrolyte	Separator	Cells

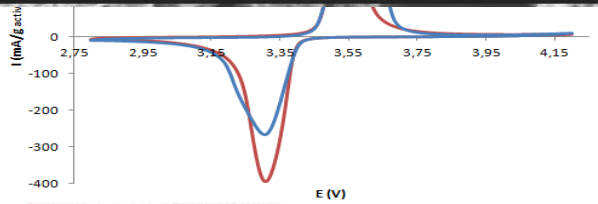
Synthesized nano-sized LFP

Commercially available LFP
(Micro+Nanoparticles)





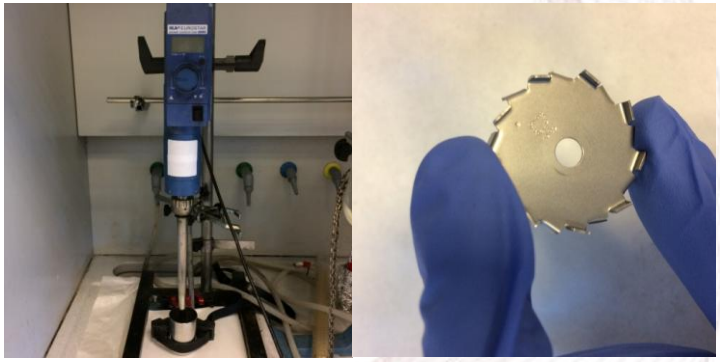




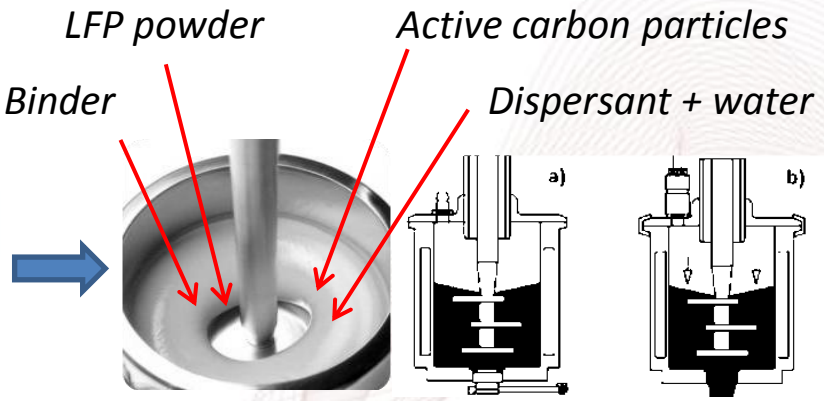
Sample	Charge specific capacity (mA·h/g)	Discharge specific capacity (mA·h/g)
LFP micro	143 ± 2	138 ± 10
BASM#16A	149 ± 13	140 ± 10

LFP-aqueous ink formulations

The project have been focused in more environmentally friendly water-based LFP inks and its optimization

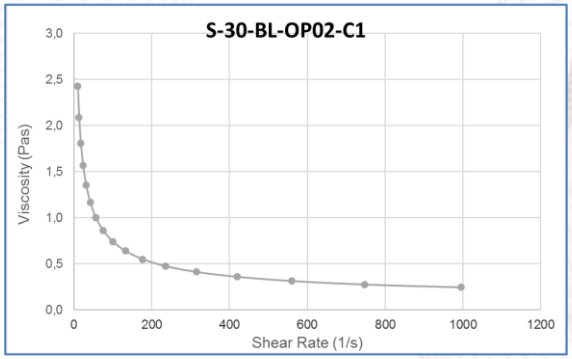


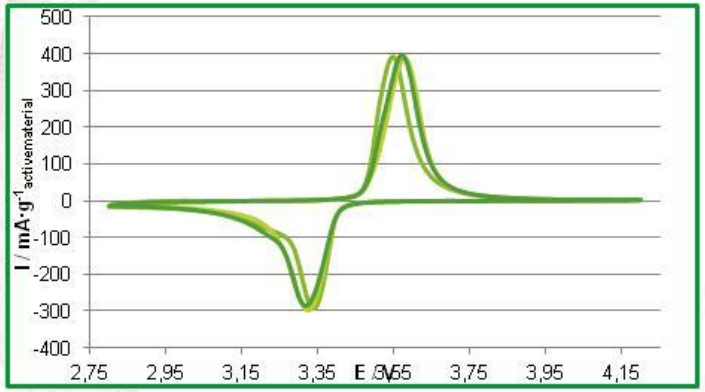
High speed disperser (left) and cowless disc (right) used at lab scale at LEITAT for LFP based formulations.



The process performed at lab scale at LEITAT for the formulation

Evaluation of applicability (tape casting)

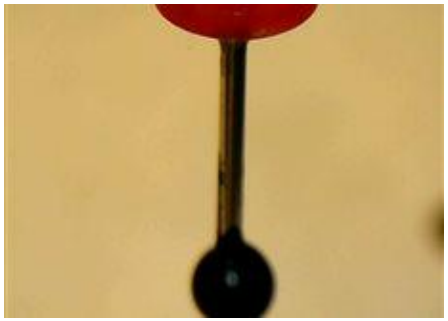




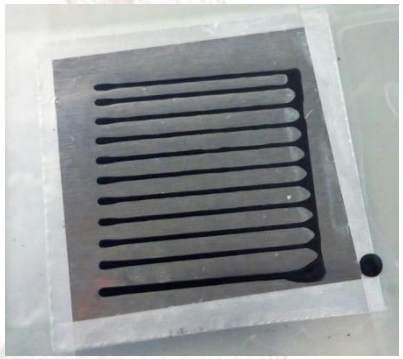
Characterization Inks: Rheology, Electrochemical performance

Printing process optimization-Dispenser

Dispensing test with stable formulation and basic Characterization Line:



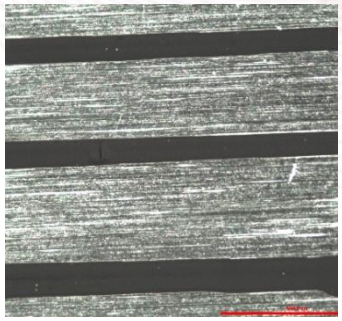
TIP-25GAGP
Inner diameter 250µm

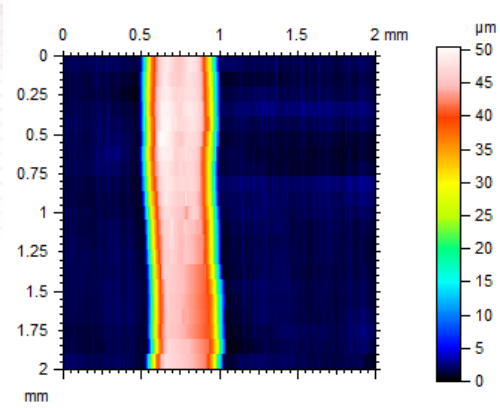


Active area Geometry	Value	unit
length electrodes	20000	µm
width electrodes	250	µm
Separator thickness/Gap	750	µm
Thickness Cathode	50.0	µm
Thickness Anode	50.0	µm
No. Fingers	10	
Electrode area	1	cm²
Volume Cathode	0.02500	cm³
Volume Anode	0.02500	cm³
Electrical Data		
Theoretical Capacity	2.75	mAh

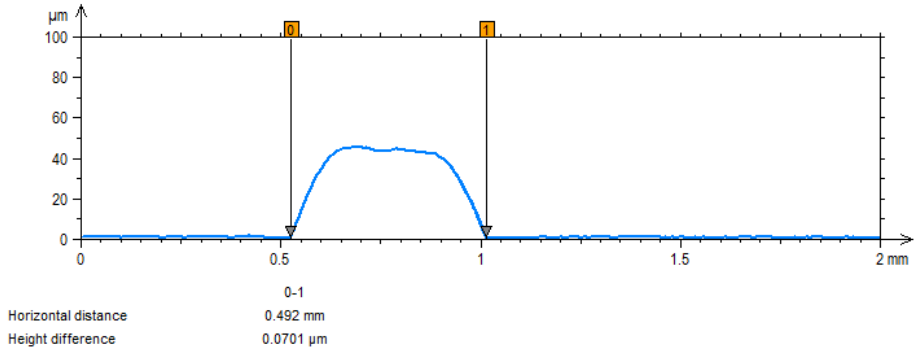
200µm

Electrical Data		
Theoretical Capacity	12.1	mAh





Perfilometer



Printed Supercapacitor for small electronic

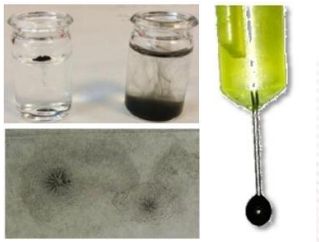
✓ Chemical spontaneous functionalization & permanent

- Carbon (activated carbon, graphite, CNT, graphene), LFP, NMC, LTO
- Covalent bond, Chemical Resistant, Mechanical Resistant, Electrochemical Resistant, Thermal Resistant
- We develop our own chemistry and could adapt to specific function
- 50 g/batches at laboratory scale
- Process scalable at pilot line level

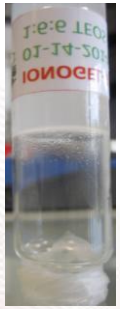
✓ Robust electrolyte

- Tested in lithium ion, supercap and Hybrid
- High temperature resistance (350ºC), No flamable
- Wide potential window (5V), free water
- Cheaper (no salt)
- Less toxic (no solvent)
- We develop our own chemistry
- 1L scale.

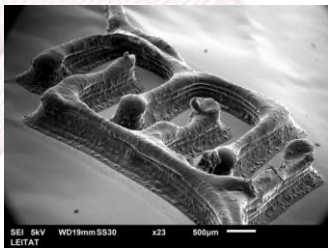
Aqueous ink



Gel electrolyte



3D printed Supercapacitor

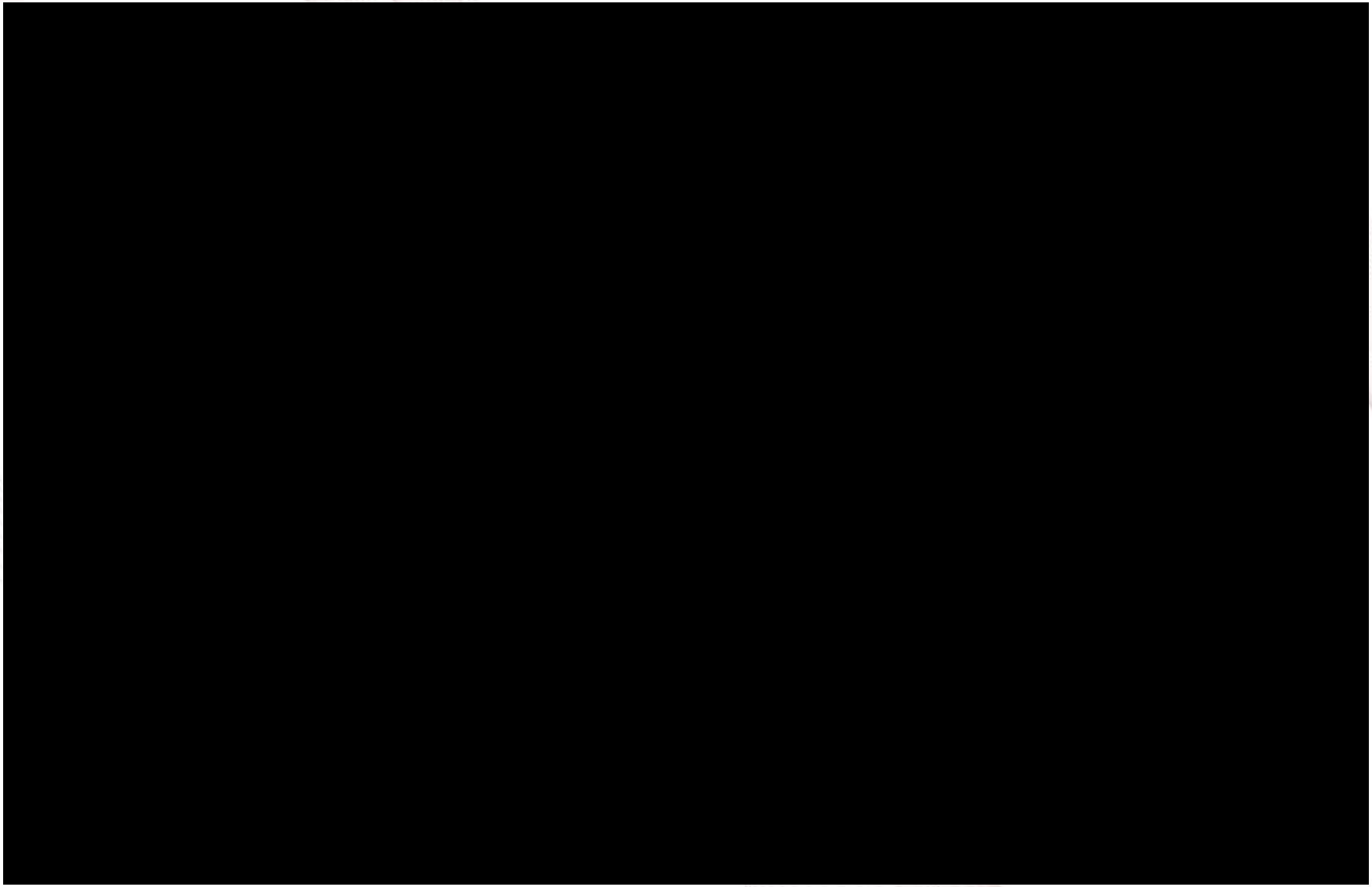


3D printing and device associated

- Aqueous Ink
- High electrical conductive electrode (CNT)
- Lithium ion, carbon/carbon supercap and hybrid
- No leakage

	State of Art	LEITAT
Capacity (F/cm^2)	18	200
Energy (mJ/cm^2)	56.6	428.4
Voltage	2.5	3.5

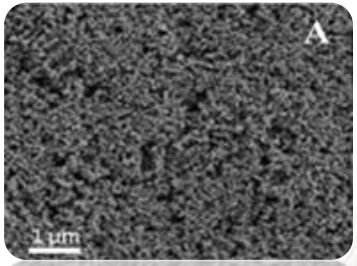
Printed Supercapacitor



Characterization

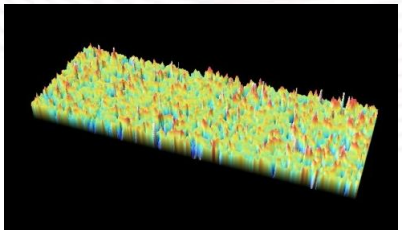
Rheological properties

Surface tension and contact angle

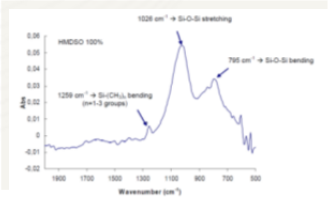


Surface morphology

Adhesion

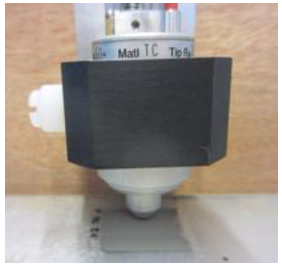


Surface roughness



Surface chemistry

Aging (UV/moisture) and anticorrosive performance

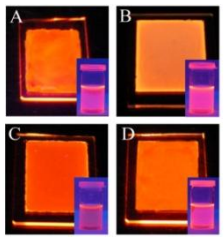


Electrical performance

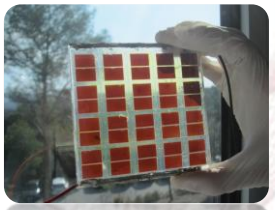
…and many others…

Other printed devices

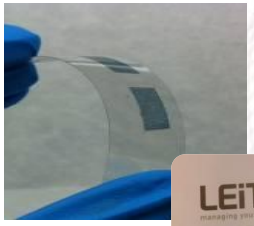
Wearable electronics



Luminescent inks



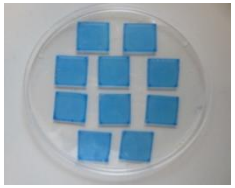
OPV and DSCC inks

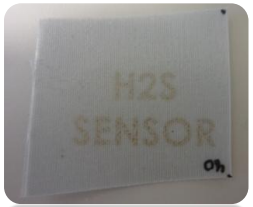


Thermoelectric inks

Smart packging

Microbatteries





Gas sensor inks

Printed Electronic Group (Projects)

National:

BIP: Gas sensor inks for food packaging, ACCIÓ, 2011-2012

i-PEGASUS: Green inks for food packaging laminates, CDTI, 2013.

International:

MICROFLEX: Microfabrication technologies for flexible substrates, NMP, 2008-2012.

PRINT4PACK: Low cost integrated autonomous RF T-sensors for food packaging, OLAE+, 2013-2015.

ORF4AUTO: Printing inks for integrated RF systems onto automotive elements, OLAE+, 2013-2015.

SMARTBLIND: OPV for BIPV (smart windows), 7FP-EeB, 2012-2015.

NANOTEG: Thermoelectric inks, devices and modules, 7FP-ENIAC, 2012-2015.

NANOCATE: Thermoelectric and supercap inks based on nanocarbons, 7FP-NMP, 2013-2017.

MATHERO: Green solvents for efficient, durable and reproducible OPV inks, 7FP-NMP, 2013-2016.

BASMATI: Nanomaterial based inks for high throughput printing technologies, H2020-NMP-PILOTS, 2015-2017

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Terrassa

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Ciudad de la Ciencia
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THANK YOU FOR YOUR ATTENTION

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managing your technologies
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