Project overview:
SiNERGY

sinergy-project.eu

L. Fonseca, IMB-CNM (CSIC)

'Energy harvesting systems' – FlexTEG 2015, Dresden, 25-26 June

Centre Nacional de Microelectrònica IMB

CSIC Consejo Superior de Investigaciones Científicas

Campus UAB, Bellaterra-Barcelona (Spain)

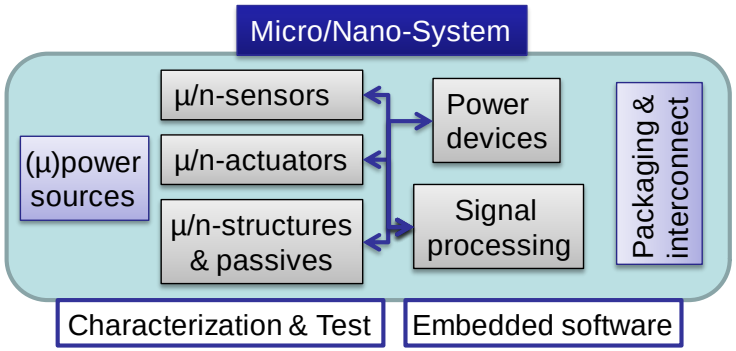
National Microelectronics Center

175 staff
10M€ budget (45% external resources)

Ten research groups: 'atoms to systems'
R&D @ TRL:1-5

1500m^2 Clean Room

Micro and nanotechnologies
Silicon and beyond...



MultiKET approach to ...

Title: Silicon Friendly Materials and Device solutions for Microenergy Applications

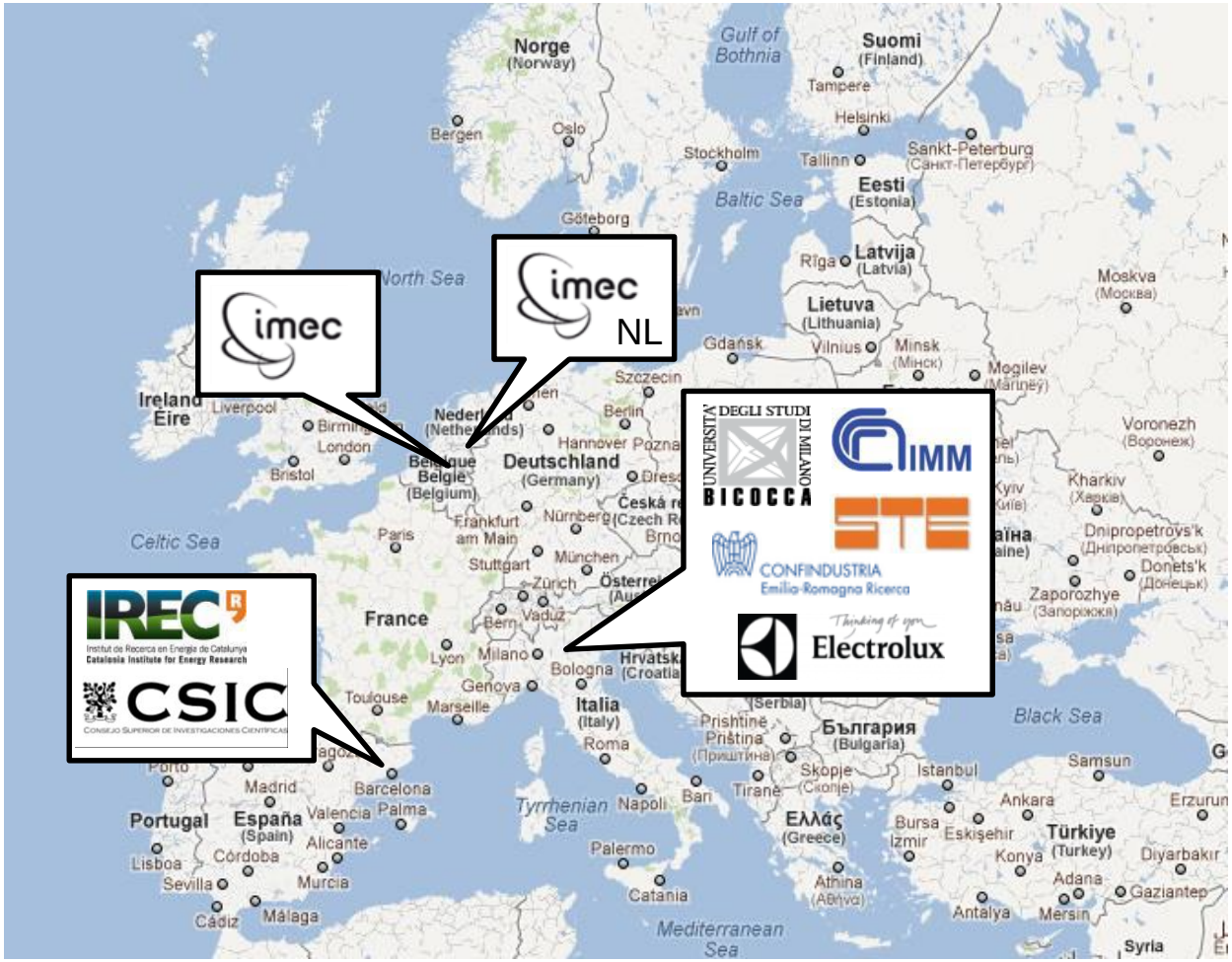
Acronym: **SiNERGY**

Call/topic: NMP.2013.2.2-4 Materials solutions for durable energy harvesters

Duration: 36 months

Funding: 3,794,913.00 € (4.824.460.00 €)

Partners: 9 (4 countries) - **coordinated by** Luis Fonseca (CSIC)



9 partners
(ES, IT, BE, NL)

Coordinator:
CSIC
(IMB-CNM)

Goal: Silicon materials and Silicon technologies & architectures for long term autonomy microenergy solutions

Focus: (1) Technology development at device level (2) Systems integration feasibility

Devices: (1) Harvesters based on thermoelectrics (2) Harvesters based on mechanical vibrations (3) thin film / 3D batteries

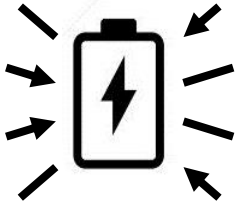
Why microenergy solutions:

Small Power for the next Big Thing

Functional autonomy

Energy autonomy

grid off-grid

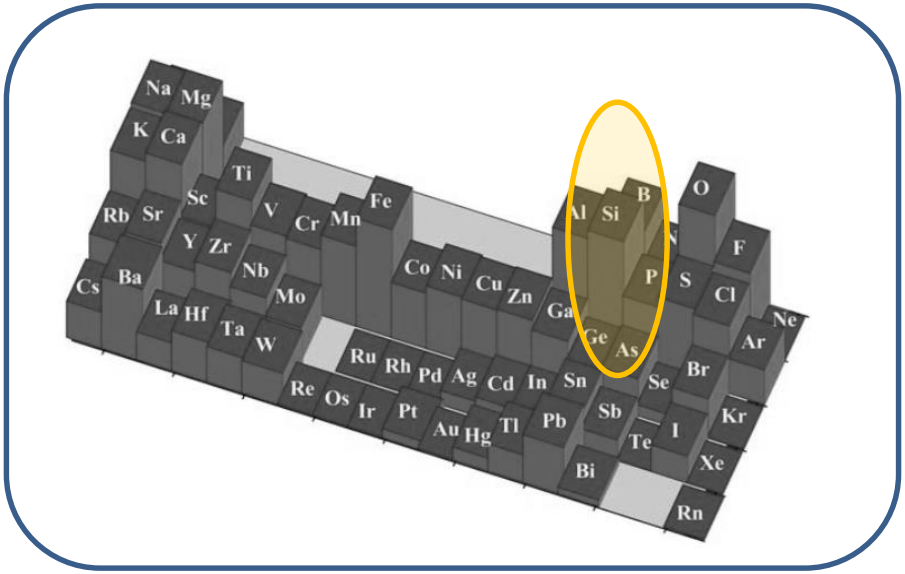


Energy harvesting

Get the energy, or replenish the battery, from the environment

NMP3-SL-2013-604169

Why Silicon materials and architectures:



Abundant material
Mature technology
Cost effectiveness and economy of scale
Miniaturized systems and dense architectures

- Predictive maintenance

Rotating-reciprocating machines
Large shop floors
High number of nodes
Difficult servicing

Smaller is cheaper

Test-bed for vibrations and thermal harvesting

- Tire Pressure monitoring

Intelligent tire
Large market volume
Small size

Smaller is better

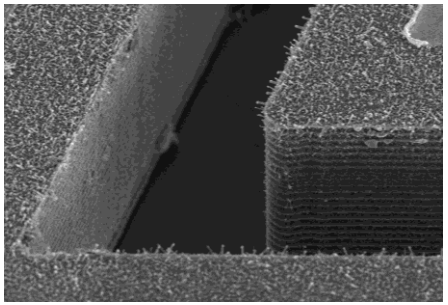
Test-bed for vibration harvesting

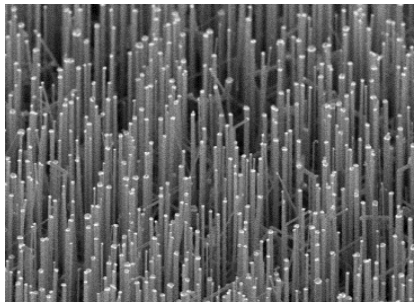
If many (sensors), better...

- Small

Less material and
energy consumption

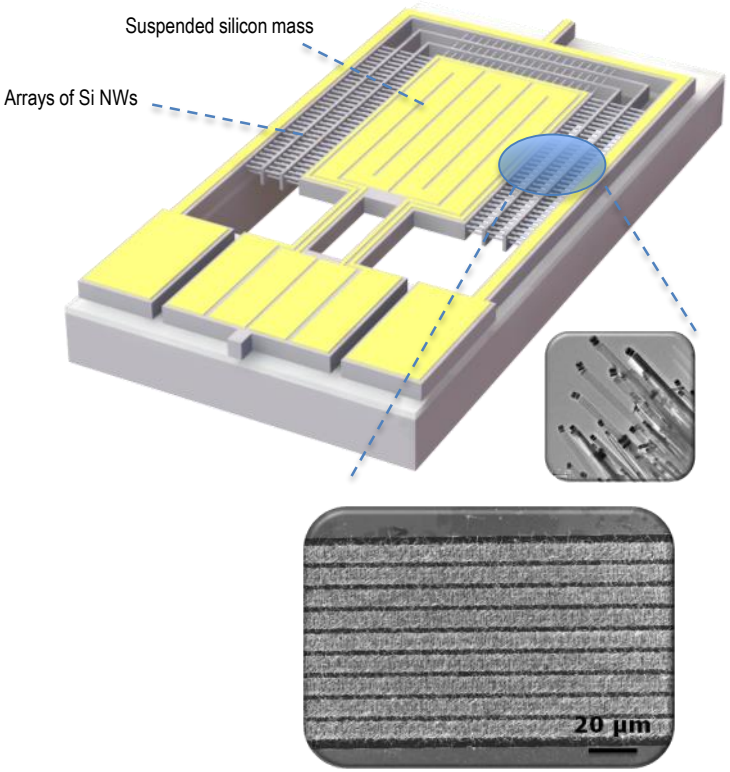
- but internally 'dense'



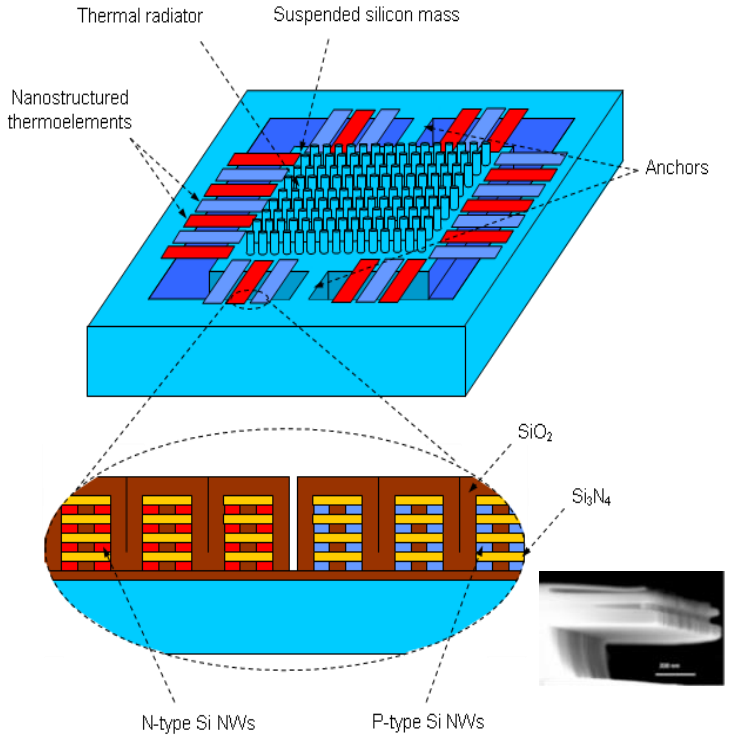


  - Micromachining: free surfaces & volumes (coupling with the environment)
  - 3D architectures (where to integrate nanomaterials)
  - high aspect ratios (high surface to volume ratio) → high density features

- 3D microstructures
  + bottom-up SiNWs

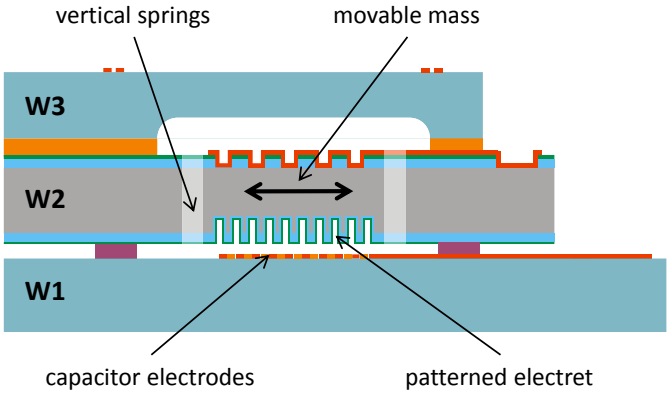


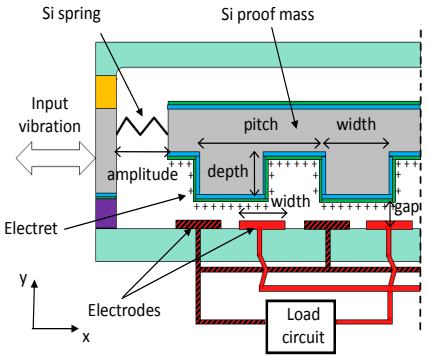
- 3D microstructures
  + top-down SiNWs



- 3D microstructures

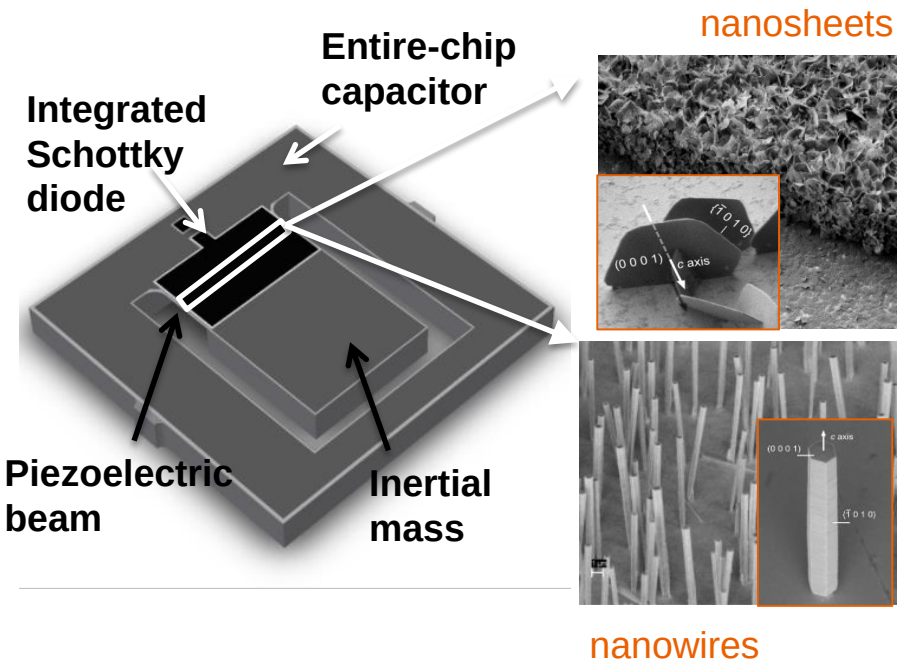
  + electrostatic





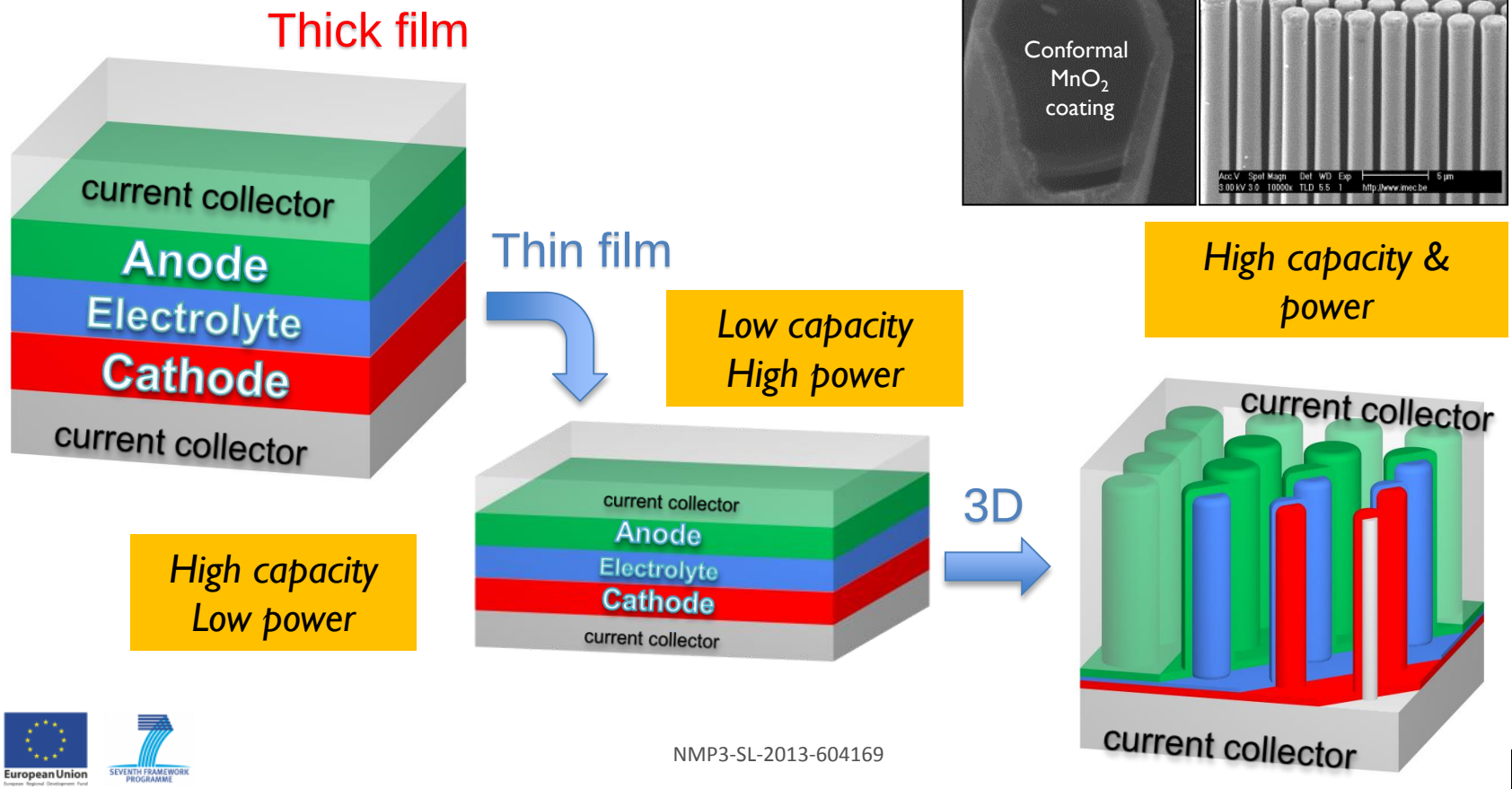
- 3D microstructures

  + bottom-up ZnO nanoX



- Materials for Si compatible batteries

- 3D microstructures



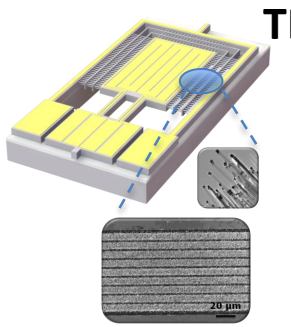
NMP3-SL-2013-604169

- **3D microstructures + materials**

➢ Nanomaterials:

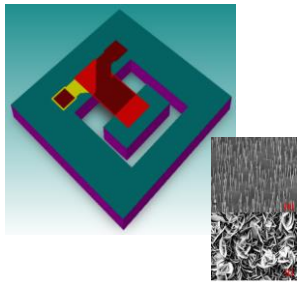
•Bottom-up

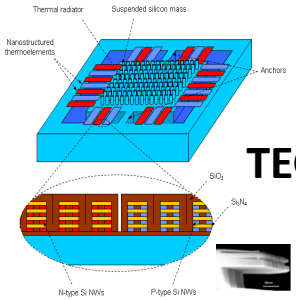
•Top-down



TEG #1

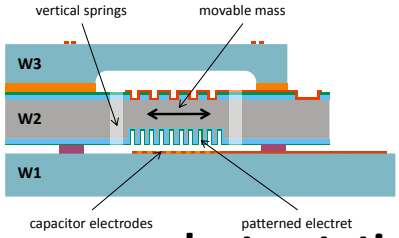
piezoelectric





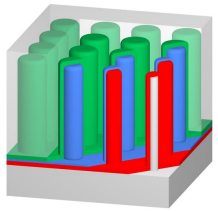
TEG #2

➢ Thin film materials



electrostatic

Solid state battery



- Without an 'install and forget' approach IoT/TS may not happen → (micro)energy autonomy is required
- Battery-free self-powered devices are the ultimate goal. EH is an option but there is still a gap between generation (µW) and consumption (mW) → secondary batteries needed
- Energy/power does not (down)scale well → high density features (3D architectures) need to be handled
- Let's try do harvesters/batteries **with the same technologies that are already used for fabricating miniaturised sensors reliably, cost-effectively and in high numbers** → Si µn-technologies (and silicon compatible materials)

SiNERGY is sponsoring a symposium in the E-MRS Spring meeting 2015:

Materials and systems for micro-energy harvesting and storage

Material and system issues for thermal energy microharvesters

Materials and system issues for mechanical energy microharvesters

Material and systems issues for microbatteries

Material and system issues for supercapacitors

Material and system issues for other microharvesters could be also considered

- We are looking for **invited speakers** and members of the **scientific committee**

This work was supported by FP7-NMP-2013-SMALL-7, SiNERGY (Silicon Friendly Materials and Device Solutions for Microenergy Applications), Contract n. 604169

sinergy-project.eu
Contact: luis.fonseca@imb-cnm.csic.es