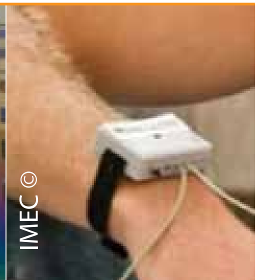
RESULTS

In this initial phase of the project efforts are concentrated in the design of the first generation of the different devices considered. These devices will be characterized and further refined. The SiNERGY website will keep track of the results achieved once they can be safely disclosed.

Even though SiNERGY focuses in the materials and technologies leading to harvesters and storage devices, attention will be paid to real applications. This knowledge will enable the correct dimensioning of the devices and will help us choosing a design and fabrication route that fulfil the power needs and overcome the constraints posed by those applications. In consequence, while the focus is placed on the devices themselves, system level integration issues will be considered as well, to keep in mind application-wise all the elements required by an eventual autonomous working sensor node, and to consider which of them may have an impact in some of our device architectural choices.

For that purpose the project consortium gathers partners with micro and nano-technological and materials expertise and partners with knowledge in industrial applications to guarantee that progress is not only done in technological grounds, but also that work is done steadily towards the future realistic application of the results.



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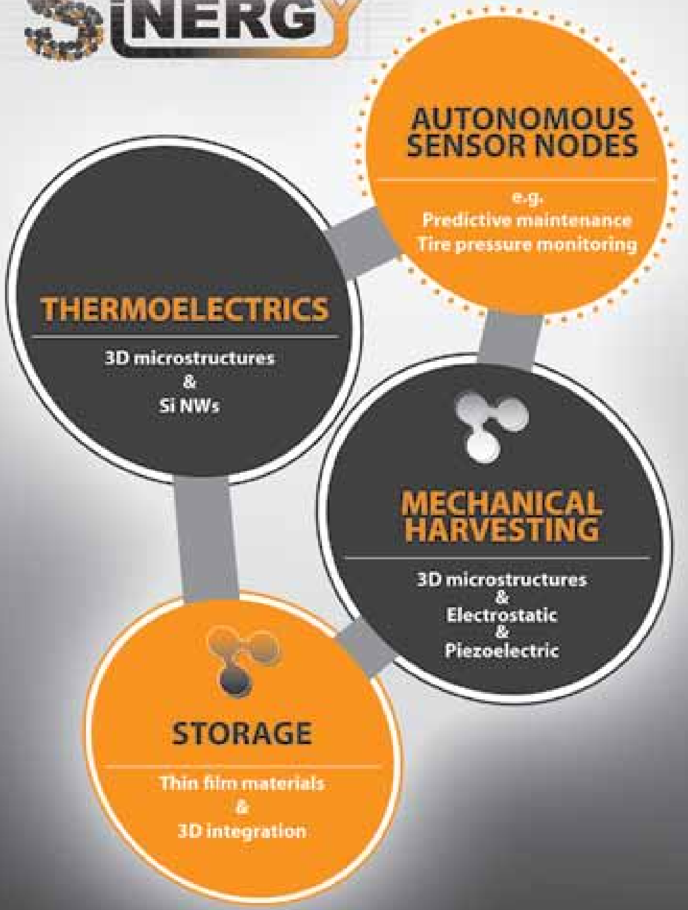

SILICON FRIENDLY MATERIALS AND DEVICE SOLUTIONS FOR MICROENERGY APPLICATIONS

THERMAL HARVESTING
MECHANICAL HARVESTING
THIN FILM BATTERIES

FP7-NMP-2013-SMALL-7 GA 604169

SEVENTH FRAMEWORK PROGRAMME

ABOUT THE PROJECT

SILICON FRIENDLY MATERIALS AND DEVICE SOLUTIONS FOR MICROENERGY APPLICATIONS

Call (part) Identifier: FP7-NMP-2013-SMALL-7
Duration: From 2013-11-01 to 2016-10-31

SiNERGY selects a series of relevant examples of **power microgeneration and storage** (thermoelectric generators, mechanical harvesters and microstructrured batteries) with the aim of pushing them further into their development and performance maturity. With that goal in mind, emphasis is placed on **thin films and nanostructured materials** and their integration route into a technology able to bring the eventual solutions closer to an exploitable phase.

For this reason, we consider **silicon technology** compatible materials as our starting point. The combination of those materials with device-making silicon micro and nanotechnologies is especially well positioned to make **breakthrough developments** in the microdomain regarding **energy harvesting and storage**.

Silicon technologies provide an enabling path to **miniaturization, 3D architectures** (improved energy densities), mass production with **economy of scale**, and the ability of **power intelligence integration**.

Being silicon technologies the ones used for the fabrication of the **sensors** themselves, they are the prime candidate for building microenergy solutions of similar robustness able to power such sensors during their whole lifetime.

Predictive maintenance of machinery in shop floors, tire pressure monitoring systems, and automatic food temperature control in smart cooking appliances are examples of possible applications that will be considered, which can benefit from a multiplicity of autonomous nodes or from very tiny ones.

Project budget: The overall budget of the project is of 4,824,461.00 €, of which 3,794,913.00 granted by the European Commission.

OBJECTIVES

SiNERGY, as a project, focuses on silicon and silicon friendly materials and technologies to explore energy harvesting and storage concepts for powering microsensors nodes.

Micro and nanotechnologies have already made possible the fabrication of small, low cost and good performance sensors that are called to be protagonists of continuous monitoring scenarios, distributed intelligence and the Internet-of-Things paradigm.

Energy autonomy keeps being one of the most desired enabling functionalities in the context of off-grid applications, such as wireless sensor networks. In many such applications, wired power is not feasible and batteries are normally used.

However, battery replacement will eventually become impractical (economically, environmentally, and logistically) not only for sensor networks in remote places or harsh environments, but also for more standard applications if the number of nodes explodes exponentially.

Harvesting energy, tapping into environmentally available sources such as heat and vibrations, may be a good solution in man-made scenarios applications. 100μW/cm^2 seem appropriate for many such applications. Coupling those harvester devices to secondary batteries to buffer enough energy to account for the power demand peaks required by the communication unit of wireless nodes would be an enabling energy autonomy solution. More energy efficient RF units are the other side of the coin. Less power hungry RF architectures and approaches will be attempted in some of the proof of concept devices.

ACTIVITIES

Silicon friendly materials and device solutions for thermoelectric harvesting

The goal is to accomplish performing thermoelectric microharvesters, namely thermoelectric generators optimized to convert heat flows into small yet high added value amounts of electric power. Silicon and silicon-related materials will be used. The activity will focus on silicon and silicide nanowires integrating low thermal conductivity material optimization with device design.

Both bottom-up and top-down approaches for nano-objects integration will be explored, tailoring the different fabrication parameters.

Silicon friendly materials and device solutions for mechanical energy harvesting

Two different devices will be pursued: electrostatic and piezoelectric harvesters. In the first case the efforts will be focused in integrating an optimized electret material in a robust microstructure to increase the obtained power output reliably. In the second, the integration into movable frames of high density arrays of nanoobjects with piezoelectric properties will be attempted to convert small vibrations into a useful power.

Silicon friendly materials and device solutions for solid-state microbatteries

The goal is to carry out the fabrication of a functional thin-film microbattery for on-chip or on-package storage. As a first step, planar thin-film devices will be attempted for material and interface optimisation (from a fast charge/discharge perspective). 3D microbatteries for increased contact area (high capacity and power) will be fabricated (fully compatible with Si technology) later-on and electrochemically characterised.