SiNERGY, a project on energy harvesting and microstorage empowered by Silicon technologies

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1. Abstract

Internet of Things and Trillion Sensors are buzzwords illustrating the path towards the next grand paradigm: Smart Everywhere. In many of those realizations long term autonomy of sensor systems is a must to tackle different societal challenges and innovation scenarios. Microenergy autonomy solutions based on energy harvesting offer a promising way in which, KETS mediated, silicon technology and silicon friendly materials may play a decisive role.

2. Project description

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 and distributed intelligence paradigms. 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. Energy densities of 100µW/cm2 seem appropriate for many such applications. Furthermore, 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 could be a quite enabling energy autonomy solution.

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

Within the project different approaches for thermal harvesters, mechanical harvesters and thin film/3D solid state batteries are considered. An exploding number of sensors makes small sensor size desirable. Their microenergy companions are then also under a downscale pressure. Energy harvesting sources tend to be low energy density sources. Capturing enough energy in such conditions demands architectures with high density features. Silicon micronanotechnologies offer the possibility of micromachining, which produces free surfaces and volumes that can couple with the environment, and quasi 3D architectures with high aspect ratios, into which nanomaterials may be integrated if need be, thus enabling such internal high density features. Examples of some of the proposed devices architectures and bottom-up or top-down nanomaterial integration will be shown and discussed

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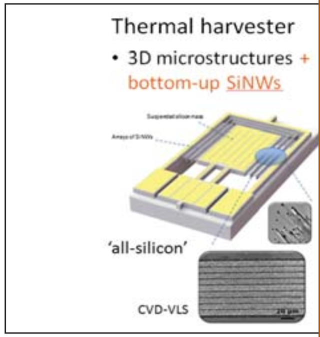

Fig.1. Example of a 3D silicon microplat thermoelectric device integrating bottom- nanowires as thermoelectric mate

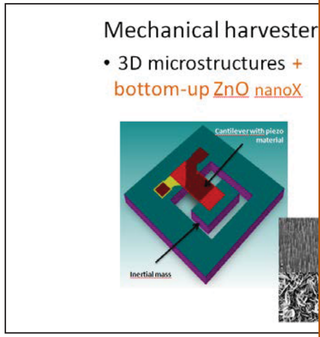

Fig.1. Example of a 3D silicon microplat mechanical harvesting device integrating piezoelectric nano-objects