JNRSE'2016

6ièmes Journées Nationales sur la Récupération et le Stockage de l'Energie pour l'alimentation de microsystèmes autonomes

Laboratoire IMS – Amphithéâtre JP Dom – Université de Bordeaux – Bât A31
351 Cours de la Libération 33405 Talence Cedex
Lundi 09 et Mardi 10 Mai 2016

*Les sixièmes **Journées Nationales sur la Récupération et le Stockage d'Energie** (JNRSE'2016) font suite aux cinq premières éditions qui se sont tenues à l'ESIEE (Paris) en 2010, au laboratoire TIMA (Grenoble) en 2012, puis au laboratoire LAAS (Toulouse) en 2013, au laboratoire SYMME (Annecy) en 2014 et au Laboratoire IEF Paris Sud en 2015. Le laboratoire IMS organise cette sixième édition les 09 et 10 mai 2016.*

Journées nationales sur la récupération et le stockage de l'énergie

Programme lundi 09 Mai 2016

8h30-9h30 : Accueil-café

9h30-9h40 : **Introduction des journées , H. Debéda, P. Basset, S. Basrour**

Chairs: Simon Hemour, IMS/ Adrien Badel, SYMME

9h40-10H20 : **Mickaël Lallart,** *Analysis of sources and conversion effects for energy harvesting and their application in self-powered device – are self-powered devices a viable alternative?*, LGEF INSA Lyon

10h20-11h00 : **Armaghan Salehian,** *Piezoelectric-based technologies for sensing and harvesting in smart grids,* Université de Waterloo, Canada

11h00-11h20: **Bogdan Vysotskyi,** *Bistable Microsystem for Electrostatic Energy Harvesting with Frequency-up conversionFor biomedical applications,* IEF Paris

11h20-11h40 : **François Morini**, *How good are ZnO nanowire-based nanogenerator to charge EnFilm micro-battery ?*, GREMAN Tours

11h40-12h00 : **Romain Berges**, A Flexible printed dual-band antenna dedicated to RF Energy Harvesting Application, IMS Bordeaux

12h00-13h30 : Buffet – Hall du Laboratoire IMS

13h30-15h00 : Café / Session posters

Chairs: Isabelle Dufour, IMS / Philippe Basset, ESIEE

15h00-15h40 : **Philippe Poulin**, *Electrostriction and giant permittivity of nanocomposites* CRPP Bordeaux

15h40-16h20 : **Nando Basile**, *Low-cost intelligence for smart sensor networks at 0.13u: ALTIS solutions and opportunities for collaboration*, Altis Semiconductor, Corbeil Essonne

16h20-16h40 **: Saima Siouane**, *MPPT and Output Voltage Control for Thermoelectric Generators Systems Using a Single Switch DC-DC Converter,* Institut Jean Lamour, Nancy

16h40-17h00 : **Achraf Kachroudi**, *Piezoelectric characterizations of piezo-electret PDMS material for energy harvesting,* TIMA Grenoble

17h00 : Clôture de la journée

Journées nationales sur la récupération et le stockage de l'énergie

Programme mardi 10 Mai 2016

8h30-9h00 : Accueil-café

Chairs: Jean-Michel Vinassa, IMS / Elie Lefeuvre, IEF

9h00-9h20 : **Eric Woirgard**, Présentation du GDR Seeds, IMS Université de Bordeaux

9h20-10H00: **Stephen Burrow**, *The rise and fall of vibration energy harvesting using non-linear devices,* University Bristol, GB

10h00-10h40 : **Brigitte Pecquenard**, *Thin film Li batteries, miniaturized power sources dedicated to microsystems and internet of things*, ICMCB Bordeaux

10h40-11h00 : **Kévin Malleron**, *Investigation on efficiency of magnetoelectric composites for energy harvesting*, UR2 - L2E Paris

11h00-11h30 : Pause café

Chairs: Ludivine Fadel, IMS / Marise Bafleur, LAAS

11h30-11h50 : **Hussein Nesser**, *Graphene-PDMS based electrostrictive microcantilever for energy harvesting,* IMS Bordeaux

11h50-12h10 : **Jie Wei**, *Inductorless Interface Circuits with Adjustable Bias Voltage for Electrostatic Vibration Energy Harvesters,* IEF Paris

12h15-14h00 : Buffet– Hall du Laboratoire IMS

14h00-15h00 : Café/ Session posters

Chairs: Hélène Debéda, IMS / Skandar Basrour, TIMA

15h00-15h20 : **Yingsiang Lu**, *Low-frequency wideband MEMS electrostatic vibration energy harvester powering a wireless sensor node,* ESIEE Paris

15h20-15h40 : **Thomas Monin,** *Piezoelectric spirals with tunable design for vibration harvesting applications from Hz to kHz,* Université de Sherbrooke, Canada

15h40 : Remise du prix ' Best paper A. Dudka'

15h50 -16h : Bilan et clôture des journées

JNRSE'2016

Recueil de résumés
Conférences invitées

Analysis of sources and conversion effects for energy harvesting and their application in self-powered device – are self-powered devices a viable alternative?

Mickaël LALLART
LGEF INSA Lyon,
Université de Lyon

mickael.lallart@insa-lyon.fr

Thanks to the progresses in low-power electronics, that allow achieving electronic functions with few amounts of energy, and in energy conversion materials and techniques, self-powered devices are more and more no longer chimerical. Such possibilities are also supported by increasing industrial and commercial demands in terms of autonomous sensors and sensor networks. However, the energy harvesting possibilities of microgenerators are still limited, and a particular attention has to be placed on the balance between the harvesting capabilities and the need of the electronic system connected to the harvester. Hence, the purpose of this talk is to discuss about the feasibility of self-powered devices.

First, an analysis of the typical sources as well as the associated possible effects for converting their energy into electricity will be exposed. From this analysis, a figure of merit for the source and conversion effect comparison will be established. From this criterion, it will be shown that, in order to harvest sufficient energy, only few sources and/or conversion effects are now mature enough to really consider the design of a realistic self-powered system. Then, concerning the later, some general design rules will be exposed, showing the need of really taking into account the global system (harvester + electronic device) as well as its environment in order to ensure a positive energy balance allowing the realistic operations of the system.

Piezoelectric-based technologies for sensing and harvesting in smart grids

Armaghan SALEHIAN
Department of Mechanical and Mechatronics Engineering
University of Waterloo

salehian@uwaterloo.ca

Grid capacity, reliability, and efficient distribution of power have been among some of the major challenges of power grids in the past few years. Lighter, self-contained, and more efficient sensing units with increased ability for wireless communication can enhance reliability in the power distribution lines significantly. Miniature smart material-based current measurement sensors and harvesting units have demonstrated great potential to help achieve the desired goals for designing smart grids.

Electrostriction and giant permittivity of nanocomposites

Philippe POULIN
Centre de Recherche Paul Pascal - CNRS,
Université de Bordeaux

poulin@crpp-bordeaux.cnrs.fr

The inclusion of conductive particles into insulating polymer matrices allows the synthesis of nanocomposites with tunable dielectric properties. In particular, giant permittivity is achieved when the conductive inclusions form near percolated networks. The permittivity of such nanocomposites strongly varies when the soft polymer matrix is deformed, giving rise to large electrostriction coefficients as needed in variable capacitors of energy harvesting devices.
Near percolated networks can easily be obtained with particles of anisotropic shape, such as carbon nanotubes, metal nanowires or graphene platelets. Because of their large aspect ratio, the particles exhibit a large excluded volume and a resultant low percolation threshold compared to spherical or quasi-spherical particles. Nevertheless, the homogeneous dispersion of anisotropic particles is technically difficult, and their spatial organization in the matrix is critical for the control of the material dielectric properties. We will present recent approaches to control the ordering of carbon nanotubes using emulsion templates to obtain enhanced dielectric permittivity and electrostriction coefficients [1]. We will also discuss differences or rod like particles from graphene flakes with giant anisotropy. The percolation behavior of graphene flakes has been recently predicted to be far more complicated than generally anticipated by excluded volume concepts [2]. Here, by characterizing the percolation transition in a liquid crystalline graphene based elastomer composite, we confirm experimentally that graphene flakes self-assemble into nematic liquid crystals (LCs) at concentrations below the percolation threshold [3]. We find that the competition of percolation and LC transition provides a new route towards high-permittivity materials. Near-percolated liquid crystalline graphene based composites display a giant permittivity along with a low loss tangent. The near percolated nanocomposites exhibit large permittivity variations in response to small strain deformations, giving rise to a giant electrostriction coefficient of about M= -5×10-14 m2/V2 at 100 Hz. The present materials are promising for being used in variable capacitors of energy harvesters. Their implementation in actual electronic devices is currently investigated.

[1] Luna, A., Yuan, J., Neri, W., Zakri, C., Poulin, P. and Colin, A., (2015) Giant Permittivity Polymer Nanocomposites Obtained by Curing a Direct Emulsion. Langmuir 31: 12231-12239.
[2] Mathew, M.; Schilling, T.; Oettel, M., Phys. Rev. E 2012, 85 (6), 061407.
[3] Graphene Liquid Crystal Retarded Percolation for High Permittivity Materials , J. Yuan, A. Luna, W. Neri, C. Zakri, T. Schilling, A. Colin, P. Poulin , Nat. Comm. 2015 6, 8700.

Low-cost intelligence for smart sensor networks at 0.13u: ALTIS solutions and opportunities for collaboration

Nando BASILE
Altis Semiconductor, Corbeil Essonnes
France

nando.basile@altissemiconductor.com

The present proliferation of Smart Sensor networks is linked on the efficiency to perform the needed sensing, signal treatment and data transmission tasks by minimizing the overall energy, either ensuring longer battery life enabling Energy Harvesting systems.
In the overwhelming majority of cases, such a need directly translates into duty-cycle operation with very long standby times, where the parasitic leakage currents easily become the key factor that will decide about the whole system.
Ultra-Low Leakage performance is therefore a primary factor in deciding the way a smart sensor node has to operate and it has to be managed by a correct combination of chip design architecture and performances of the underlying CMOS technology platform.
The goal of this presentation is to provide visibility of ALTIS efforts in conceiving disruptive design solutions, while leveraging on an optimal CMOS technology platform, with the aim to remove roadblocks and enable the deployment of autonomous, smart Sensor Nodes at competitive costs and volumes. We are confident that ALTIS work will stimulate a lot of interest and opportunities for collaboration with academical and industrial partners.

The rise and fall of vibration energy harvesting using non-linear devices.

Stephen BURROW
Dept. of Aerospace Engineering / Electrical Energy Management Group
Faculty of Engineering, University Bristol

Stephen.Burrow@bristol.ac.uk

Harvesting energy from vibrations has been a buoyant research topic in recent years for both the electronics and structural dynamics communities. A particular subset of vibration harvesters - those using non-linear compliant elements – have received a great deal of interest since they seemed to offer a solution to the intrinsic problems of linear, narrow band devices. Some ten years has passed since the first papers started to explore the potential of non-linear devices but today we are arguably no closer to demonstrating that the hypothesised benefits can be realised. In this talk the origins, development and conclusions of research undertaken in this area are described and critically reviewed.

Thin film Li batteries, miniaturized power sources dedicated to microsystems and internet of things

Brigitte PECQUENARD
ICMCB Bordeaux – CNRS,
Université de Bordeaux
brigitte.pecquenard@icmcb.cnrs.fr

The explosive growth of portable electronics, generally battery-powered, has triggered the race for the development of high-performance microprocessors, Systems-on-a-Chip (SoCs) or DRAM, using low power consumption integrated circuits. As a consequence, the energy supply of such optimized components can be operated today also by miniaturized power sources such as microbatteries (1 to 500 µAh). All-solid-state microbatteries have the advantage to be manufactured by vacuum deposition processes, widely used in the microelectronics industry. They are built up through the deposition by PVD techniques of current collectors, the positive electrode, the electrolyte and the negative electrode on a rigid or flexible substrate. Actually, about ten layers are stacked to form a complex system with a total thickness of about 10 µm. The choice of the active materials (electrodes, electrolyte) appears quite different from the one for conventional Li-ion batteries due to the specific applications of these micro-power sources and their manufacturing process. Therefore, our aim is to tailor thin film properties by tuning the sputtering parameters in order to improve the performance of each active constituent of the cell as well as the overall behavior of the microbattery [1-5].

[1] V. P. Phan, B. Pecquenard, F. Le Cras, *Adv. Funct. Mater.*, 22 (2012) 2580-2584
[2] M. Ulldemolins, F. Le Cras, B. Pecquenard, *Electrochem. Comm.*, 27 (2013) 22-25
[3] B. Pecquenard, F. Le Cras, D. Poinot, O. Sicardy, J.P. Manaud , *ACS Appl. Mater. Interfaces*, 6 (2014) 3413-3420
[4] F. Flamary, V. Pelé, L. Bourgeois, B. Pecquenard, F. Le Cras, *Electrochem. Comm.*, 51 (2015) 81-84
[5] F. Le Cras, B. Pecquenard, V. Dubois, V. P. Phan, D. Guy-Bouyssou, *Adv. Ener. Mater.*, 2015, DOI: 10.1002/aenm.201501061