ENVIRONMENTAL ENERGY HARVESTING HYBRID SYSTEM BY PHOTOVOLTAIC AND PIEZOELECTRIC CONVERSION, DC/DC TRANSFORMATION WITH MEMS INTEGRATION AND ADAPTIVE STORAGE

Goal of the project

The design, building and testing of the prototype of a hybrid system for energy harvesting from the ambient through photovoltaic conversion, DC/DC transformation with MEMS integration and adaptive storage, will be carried out. First key novel component of the device is the planar power micro-transformer for high frequency, with hybrid magnetic nanofluid/ferrite core and windings- a part of the DC/DC converter, fabricated in MEMS technology. A second key component is the photovoltaic cell, which relies on novel solutions.

Short description of the project

A prototype with wireless sensors powered by the harvesting system will be designed, built and tested. In this endeavor, there will be prepared a dedicated magnetic fluid to be used as core of a micro-transformer, which will be designed accordingly and tested. Further, an experimental model of the energy harvesting hybrid system will be elaborated, designed and tested. Finally, a prototype for the harvesting device will be designed and tested.

Project implemented by

- National Institute for R&D in Electrical Engineering ICPE-CA Bucharest (Coordinator)
- Politehnica University of Timisoara (Partner 1)
- Romanian Academy – Timisoara Branch (Partner 2)
- Politehnica University of Bucharest (Partner 3)
- SYSCOM PROCESS CONTROL LTD (Partner 4).

Implementation period

July 1st, 2014 – September 30, 2017

Main activities

The main activities are as follows:
(I) elaboration of the experimental model of the energy harvesting hybrid system by photovoltaic conversion and DC/DC transformation with MEMS integration;
(II) design and testing of the experimental model of the energy harvesting hybrid system by photovoltaic conversion and DC/DC transformation with MEMS integration;
(III) design and testing of the prototype of the energy harvesting hybrid system by photovoltaic conversion and DC/DC transformation with MEMS integration.

The 2016 year research aimed to complete the second activity listed above. Politehnica University team (P1), together with the Romanian Academy – Timisoara Branch team (P2), is responsible for the preparation and characterization (in terms of magnetic, rheological, electrical, thermal and structural properties) of the magnetic fluid used as magnetic fluid core of the power micro-transformer.

Results

The main result of the project will be the integration of an innovative photovoltaic conversion system and an original DC/DC converter, which utilizes a planar, spiral, MEMS, hybrid (magnetic nanofluid/ferrite) cored micro-transformer in an efficient device for energy harvesting. Regarding the use of a magnetic nanofluid core micro-transformer for the DC/DC converter, from the manufacturing point of view, it is expected that once the appropriate magnetic nanofluid characteristics are established, it will offer an easier way of obtaining the transformer core compared to a solid one. From the operating point of view, it is expected that by replacing the solid core with a liquid core will result in a better heat dissipation and reduction of the thermal stresses in the micro-transformer, leading to a longer life-cycle, maintaining or even improving the electric characteristics.
The results obtained in 2016 were disseminated through:

- one patent application: A/00713 /07.10.2016 (OSIM, RO), entitled "Planar transformer with magnetic nanofluid"; Authors: PISLARU – DANESCU L., POPA M., ILIE C.I., CHIHAIA R.A., BABUTANU C.A., NICOLAE S., BUNEA F., STOIAN F.D., HOLOTESCU S., MARINICA O.-M., MOREGA A.-M., MOREGA M., DUMITRU J.B., POPA N.C.; Owners: ICPE-CA Bucharest and UPT.
- a conference paper: Nicolae Calin POPA, Ladislau VEKAS, Nicolae CRAINIC, Floriana Daniela STOIAN, Sorin HOLOTESCU, Structural investigation of magnetic nano-fluids used in gravitational generator, presented at the International Conference on Nanotechnology, Nanomaterials & Thin Films for Energy Applications, Liverpool, UK, 27 – 29 July 2016.

Applicability and transferability of the results

The product can bring added value for further development as an end-product to the industrial partner. Possible applications are characterized by their placement in hard to reach places, isolated and without local and/or conventional sources. Among these are applications for industrial automation, monitoring of various parameters in industry (pressure transducers mounted in the gas distribution networks, device multiparameter probes mounted in drinking water distribution networks and others), in agriculture (humidity and soil temperature sensors), for surveillance and monitoring of perimeters.

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Research centre

Research Center for Engineering of Systems with Complex Fluids, Politehnica University of Timisoara,
URL: http://mh.mec.upt.ro/ccisfc/

Research team

The research team of Politehnica University of Timisoara is consisting of three senior researchers, one PhD student and two research assistants:

Assoc. Prof. Dr. - Eng. Floriana D. STOIAN – Project responsible for Partner 1,
Lect. Dr.- Eng. Math. Sorin HOLOTESCU,
Phys. Oana MARINICA,
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