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. A key novel component is the planar power micro-transformer for high frequency, with hybrid magnetic nanofluid/ferrite core and windings fabricated in MEMS technology, a part of the DC/DC converter. 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 was designed, built and tested. In this endeavor, there was prepared a dedicated magnetic fluid to be used as core of a micro-transformer, designed accordingly and tested. Further, an experimental model of the energy harvesting hybrid system was elaborated, designed and tested. Finally, a prototype for the harvesting device was designed and tested for a particular application.

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 2017 year research aimed to complete the third main activity. Politehnica University team (P1) was responsible for measuring the electrical properties of the magnetic nanofluid samples used in all tests and participating to the planned testing activities and dissemination.

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 2017 were disseminated through:

[1] Lucian Pîslaru-Dănescu, Gabriela Telipan, Floriana D. Stoian, Sorin Holotescu, Oana Maria Marinică, Chapter: Nanofluid with Colloidal Magnetic Fe3O4 Nanoparticles and Its Applications in Electrical Engineering, published in book "Nanofluid heat and mass transfer in engineering problems", Editor Mohsen Sheikholeslami Kandelousi, ISBN 978-953-51-3008-6, InTech Open, Croatia, 2017, DOI: 10.5772/65556.

[2]. Oana Maria Marinică, Study of Static Magnetic Properties of Transformer Oil Based Magnetic Fluids for Various Technical Applications Using Demagnetizing Field Correction, Journal of Nanomaterials, Volume 2017, Article ID 5407679, 9 pages, Hindawi, doi.org/10.1155/2017/5407679.

[3] Vlad Socoliuc, Daniela Susan-Resiga, Corina Vasilescu, Oana Marinică, Izabell Crăciunescu, Tünde Borbáth, István Borbáth, Alin Bosioc, Sebastian Muntean, Nicolae Calin Popa, Rodica Turcu, Ladislau Vékás, Ferrofluids and nano-micro composite fluids: high magnetic response and optimized magnetorheological behaviour tailored for specific applications, presented at 2nd Global Congress & Expo on Materials Science and Nanoscience, 25 – 27 September 2017, Valencia, Spain

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 Complex Fluid System Engineering,
Politehnica University 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:

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- Project responsible for Partner 1,
Lect. Dr.-Eng. Math. Sorin HOLOTESCU,
Phys. Oana MARINICA,
Assoc.Prof. Dr.-Eng. Nicolae Crainic,
Res. Assist. Florica BALANEAN,
Res. Assist. George GIULA.

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