26. Flexible temperature logger powered by solar cell and supercapacitor

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Inexpensive power sources are needed e.g. in RFID and wireless sensor network applications. By applying printing techniques the manufacturing costs can be minimized. It is also possible to introduce materials that are environmentally friendly, can be disposed of with normal household waste and are incinerable. We have developed supercapacitors that can be combined with energy harvesting components such as printed photovoltaic or RF energy harvesting circuits. [1] In this presentation we demonstrate the use of printed supercapacitor and commercially available organic photovoltaic cell (OPV) to power a flexible temperature logger.

The temperature logger consists of three main components, a coil antenna, an IC, and a power source to the IC. The integrated RFID (HF) microchip with built-in temperature sensor was a commercial product from AMS (AS39513). The external communication with the IC is performed over the NFC interface with an NFC enabled smart phone. The HF antenna was specially designed and matched for this IC, ensuring optimal performance.

The microchip does not only enable fully passive on-demand temperature measurements but enables also autonomous data logging. To enable recording of temperatures as a function of time the IC requires an external 3 V power source to be connected. As this temperature logger is planned to work in a semi-active mode to enable autonomous data logging, there was a need for a connected external power. Temperature logger under discussion could also be powered e.g. with standard CR2016 coin cell batteries, but then the flexibility of the product would be at least partially compromised. Flexible batteries are also available in the market, but their power capacity or recharging capabilities are limited or require extra recharging circuits. Supercapacitor with a photovoltaic cell provides a simple structure for the product´s external power source.

The materials for the supercapacitors were chosen to be compatible with printing methods, e.g. the activated carbon powder in the electrodes is bound with the biopolymer chitosan. Since we preferred aqueous electrolytes due to environmental and safety reasons, the voltage of our single supercapacitor cell is limited to about 1.2 V. This requires the use of three series connected cells to reach the preferred 3 V. Supercapacitors of various configurations were prepared. The length and width of the series connected supercapacitors was defined by the free area inside the antenna loop. Antenna transmit power measurements showed that 50 mm x 25 mm can be put inside the loop without severely disturbing the transmission properties. The structure and manufacturing method of the supercapacitors allow up-scaling, so that the properties can be tailored according to the application.

References

[1] J. Keskinen, S. Lehtimäki, A. Dastpak, S. Tuukkanen, T. Flyktman, T. Kraft, A. Railanmaa, D. Lupo, *Architectural Modifications for Flexible Supercapacitor Performance Optimization*, Electronic Materials Letters 12 (2016), 795-803.

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Figure 1. Temperature-logger with battery and supercapacitor and OPV replacing the battery

Biography

Prof. Dr. Donald Lupo joined the Department of Electronics at Tampere University of Technology as professor in August 2010. He received his Ph.D. in physical chemistry from Indiana University on energy transfer in liquids in 1984 and has been an internationally recognized researcher in functional materials for photonics and electronics since 1987, with publications in leading journals in the fields of nonlinear optics, organic LEDs, organic photovoltaics, paper-like displays and printed electronics. He is responsible within the Laboratory for Future Electronics at Tampere University of Technology. He was speaker of the Education working group at the Organic Electronics Association (OE-A) from 2010-2015, has been on the core editorial team of the OE-A roadmap since 2009 and recently co-edited a textbook on the fundamentals of organic and printed electronics.