Energy harvesting research on textiles for powering wearable IOT devices

UNIVERSITY OF Southampton

SEMS Smart Electronic Materials and Systems

Sheng Yong, Junjie Shi, Sasikumar Arumugam, Yi Li, Russel Torah, Steve Beeby

Introduction

Wearable electronics are typically functional accessories such as smart watches or Google glasses but more recently advances in electronic textiles (e-textiles) is enabling a new platform. E-textile implementations can address new applications such as wearable healthcare monitoring and as such act as a personal sensor node with wireless communications and are therefore a mobile IOT device. Powering all forms of wearable electronics is a challenge since conventional power supplies such as batteries are relatively bulky, inflexible and demand frequent recharge. Research in the Smart Electronic Materials and Systems (SEMS) Group is investigating flexible energy harvesting/storage systems to act as a mobile flexible power module for e-textiles and implants. Energy harvesting technology that, for example, convert the mechanical energy from human movement or solar energy into electrical energy. The electrical energy harvested is typically stored in a reservoir such as a supercapacitor. This poster presents an overview of 4 types of energy harvester and a textile supercapacitor demonstrated within the SEMS group.

Research Activities

Textile solar cell

A fully spray coated organic solar cells (figure 1) have been successfully fabricated directly on polyester cotton textile. The textile were pre-coated with polymer interface layer that reduces the textile surface roughness and enhances surface wettability. The solar cell achieved a maximum power conversion efficiency of 1.2%

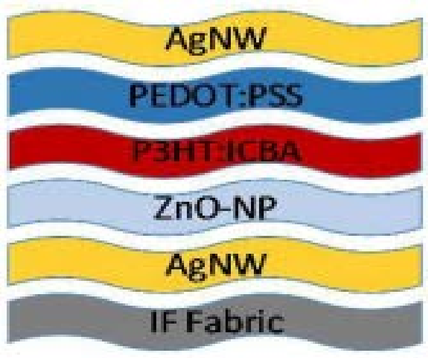
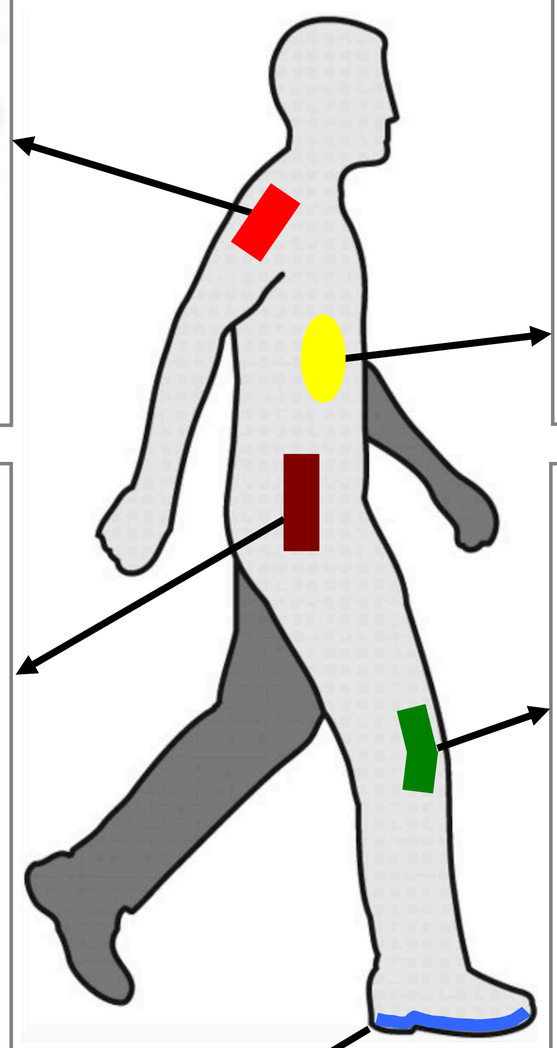


Figure 1 : Schematic of the textile solar cell device structure



Textile supercapacitor

A supercapacitor is an electrochemical energy storage device, it is used to store and buffer the output from the energy harvester. Our work showed a fully solid-state supercapacitor can be integrated in a single woven textile layer (figure 2). The proposed device has a high capacitance of 45 mF.cm^{-2} and excellent cyclical charge/discharge stability, flexibility and robustness.

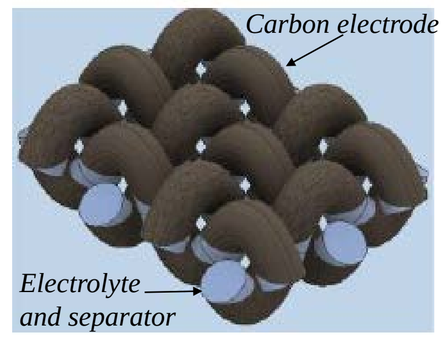


Figure 2 : Schematic of the textile solar cell device structure

Electromagnetic energy harvester

An electromagnetic energy harvester (figure 3) designed to be embedded in a hip implant a driven by human body motion. The energy harvester can deliver 54 μW.cm^{-3} at the resonant frequency of 10 Hz with an optimum resistive load of 2.66 kΩ.

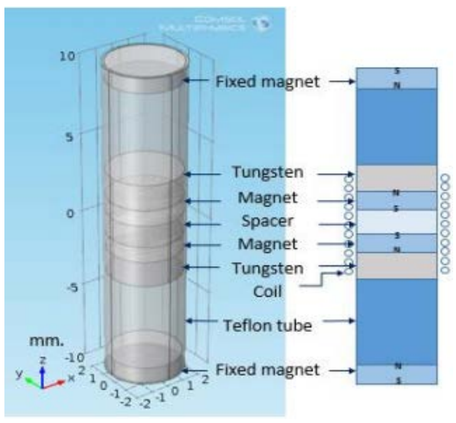


Figure 3 : Schematic of the Electromagnetic energy harvester

Textile ferroelectret

Ferroelectret materials are typically thin and flexible cellular polymer foams that generates electrical power from mechanical force. The novel ferroelectret presented here is assembled by sandwiching a textile between two FEP polymer films (figure 4). This ferroelectret structure generates an typical power output of 62.4 μW.cm^{-3} and is very simple to fabricate.

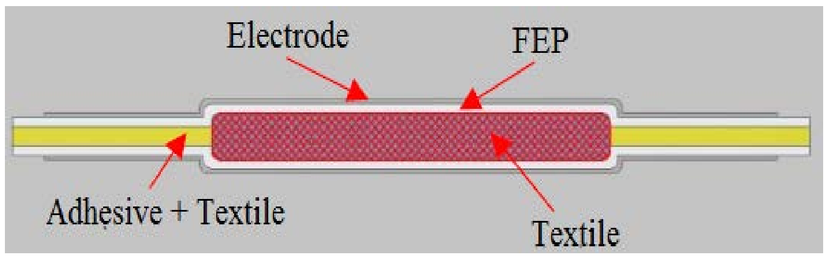


Figure 4 : Schematic of the textile ferroelecctret

Piezoelectric shoe-insole energy harvester

This work demonstrated a textile based shoe insole with a screen printed piezoelectric energy harvester (figure 5) using low temperature PZT film. The experimental results show that the flexible insole piezoelectric energy harvester produced average power output of 38 μW.cm^{-3}

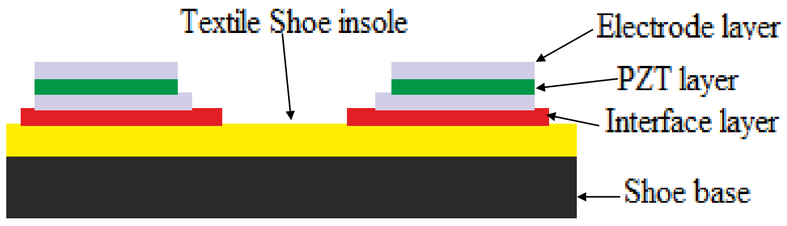


Figure 1 : Schematic of the textile solar cell device structure

Textile power supply module

This poster demonstrates the feasibility of integrating both energy harvesters and energy storage devices on textile which together can be used to power wearable electronic IOT devices. On going work is focused on realising combined harvesters and storage demonstrating a fully integrated textile power supply module.

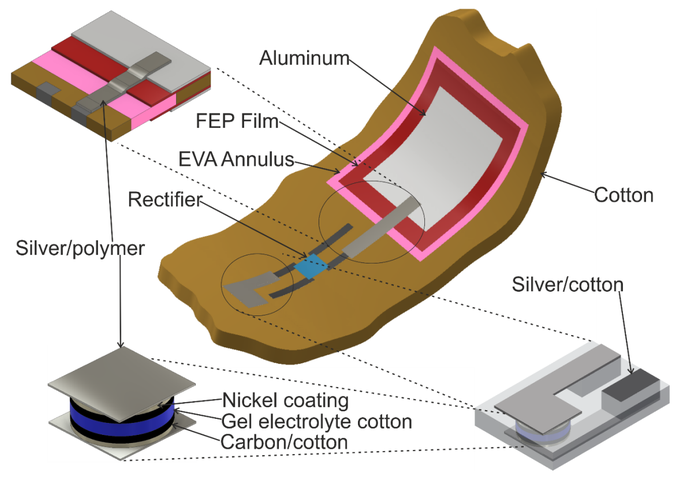


Figure 6: Schematic of the textile ferroelectret

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CENTRE FOR INTERNET OF THINGS AND PERVASIVE SYSTEMS

Prof Steve Beeby
Email: spb@ecs.soton.ac.uk
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