Fraunhofer IZM

FRAUNHOFER INSTITUTE FOR RELIABILITY AND MICROINTEGRATION IZM

MATerials for FLEXible ENergy Harvesting Devices, MATFLEXEND FP7

FP7 # 604093 MATFLEXEND is co-funded by the European Commission. The project runs from Oct 1st, 2013 till September 30th 2016

Fraunhofer IZM leads the FP7 MATFLEXEND project (2013 – 2016), which will provide wearable, flexible energy harvesting and storage devices that can be manufactured in a low-cost printing process, and durable materials for such purpose.

Summary

MATFLEXEND develops novel, durable materials for flexible energy harvesters for the power supply of wearables including smart textiles, shoes and other applications where mechanical compliance is needed. The technology addresses consumer, medical and a range of niche applications.

The harvesters include an array of mechanical-to-electrical energy converters that comprise capacitors whose effective electrode area is varied by elastic deformation, so that electrical energy can be extracted from them by suitable control electronics, and fed into an array of batteries. Both the capacitor and battery arrays are designed to be inherently flexible.

The harvesters will be designed such that they can scale to a variety of sizes, and can be mass-produced in a continuous process.

The consortium consists of 10 partners from 7 European countries and addresses a wide variety of skills including battery + capacitor materials research, micro patterning and fabrication technology, preparation of interfaces for wetting / dewetting characteristics, conductive polymers and coatings, as well as deposition methods including electrophoretic coating and printing.

Advantages

- Increase of energy density of capacitive harvester due to high-k dielectric
- Low force actuation and mechanical impedance match, as required for wearable applications
- Miniaturization which allows integration into smart cards and other miniaturized electronic products
- The footprint of the rechargeable micro battery can be easily tailored to the size of the application by change of the fabrication masks
- High power pulse performance of the buffer micro battery due to micro patterned electrodes.

Applications

Fotos: ComCard (left), SMARTEX (right)

The flexible harvester-battery devices will be integrated into smart cards and fabrics for wearable electronics applications.

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Technology

Fig.1a: Capacitive harvester principle: As the capacity is changed due to deformation of the flexible/liquid electrode, charges are supplied and drained at different voltage levels, thus generating electrical energy from mechanical motion. In comparison with parallel plate capacitive harvesters in air or vacuum, energy density can be increased greatly due to the high-k dielectrics which will be developed for that purpose.

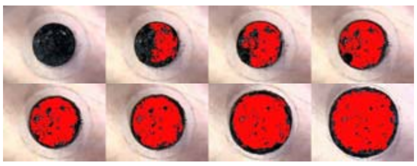

Fig. 1b: Visualization of effective electrode area with increasing pressure. One objective of the project is to reduce to a minimum the mechanical deformation energy to a minimum which is required to increase the effective electrode area to a maximum, thus increasing the efficiency of mechanical to electrical conversion.

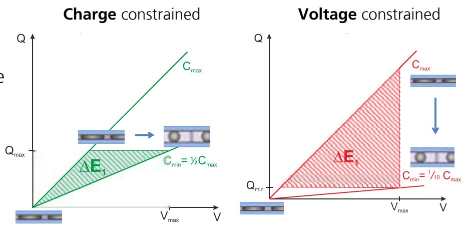

Fig. 2: A dedicated low-power electronic circuit is required for high efficiency energy conversion. Different conversion cycles can be implemented depending on the capacitor characteristics and the complexity of the circuit. Conventional parallel plate capacitor harvesters with varying plate distance show only medium change in capacity, and use the charge constrained circuit (left). By contrast, Matflexend can realize Cmin/Cmax < 0.1 and thus offers a higher electrical energy gain in the voltage constrained mode (right) at the same maximum capacity Cmax and same maximum voltage Vmax. To minimize the cost of the electrical circuit and harvester packaging low voltage (ca. 40 V) operation of MATFLEXEND harvesters is intended.

Material Research

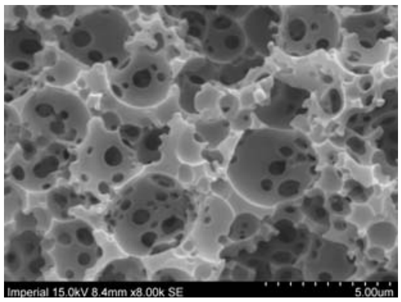

Foto: University Vienna / IMPERIAL College London

Fig. 3: Printable electrolytes for lithium ion batteries will be developed based on polyHIPE and ionic liquids. Foto: conventional polyHIPE.

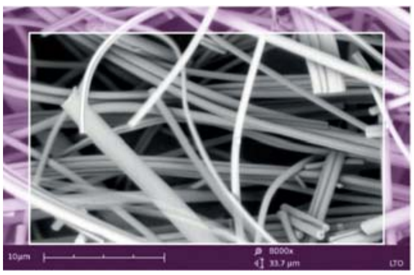

Foto: PARDAM

Fig. 4: Novel inorganic nano fibers will be investigated as lithium intercalation electrode materials.