PrintAmp

Printed Energy and Power Storage

"Printed Electronics Needs Printed Power"

Summary

PrintAmp, an R/D group at UCLA has developed new charge storage device architectures that use nano-scale materials. The random network, or film formed of electrically conducting nanoscale wires, carbon nanotubes and inorganic nano-wires is used as part of the novel architecture. The configuration allows the fabrication of thin, printable charge storage devices.

The materials

Nano-scale materials, such as inorganic wires and carbon nanotubes are rapidly emerging as high surface area and high electrical conductivity materials. Due to these attributes, they are eminently suited for applications in the charge storage device arena.

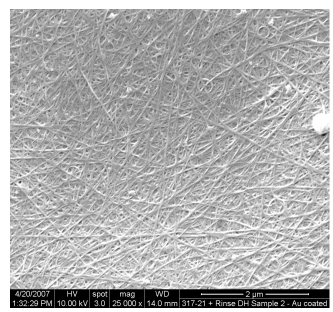

Fig.1. Nanowire network architecture.

The building blocks are nano-scale electrically conducting wires and other nano-structures elements that carbon nanotubes, the World's smallest conducting wires. Their diameter is typically 10 nm or less, the conductivitie, per weight are comparable to copper and silicon and exceed that of any conducting polymer by orders of magnitude. High electrical conductivity, high porosity/surface area, high flexibility and mechanical strength and environmental robustness are additional attributes that are exploited.

Thin films with tailored functionality. Thin films composed of a random network of nano-scale electrically conducting materials provide a large number of conducting pathways. An appropriate analogy of the architecture is that of an interconnected network of freeways, providing a fast transport medium – potentially significantly faster that a uniform, but lower conductivity medium (analogous to surface roads or the terrain itself). Just like a spider web, the network is flexible, and the tubes have robust environmental resistance. The network can be combined with other nano-scale materials to provide appropriate functionality, needed for increased capacitance, and for battery functionality. At the same time, these attributes also can also lead to electrode materials for fuel cells.

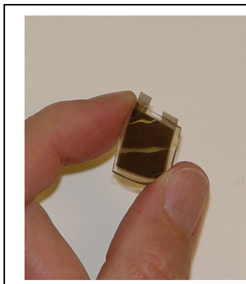
Fig.2. Printed battery proof--of-concept device.

Charge storage devices

PrintAmp has used carbon nanotubes as elements of the network. The material, through its high porosity and high electrical conductivity enables novel device geometries, and the group at UCLA has developed ***supercapacitors*** and ***batteries*** with high surface area/electrically conducting nanoscale networks as the charge collector+electrode. This novel device architecture has several attributes. It enables:

- Simpler device architecture

- Roll-to-roll fabrication fully compatible with the “Printed Electronics” concept
- Use of environment friendly materials
- Use of polymer, instead of liquid electrolytes
- Straightforward integration with other “printed electronics” products

The performance of the devices fabricated to date already is comparable with conventional charge storage devices, both in terms of stored energy and power (Fig.3).

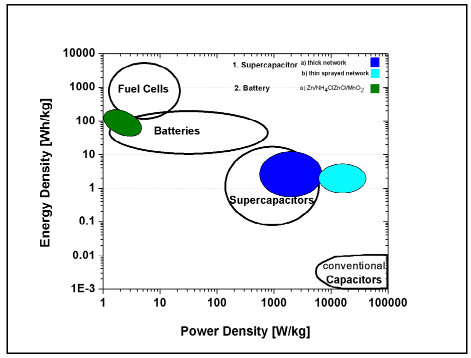

Fig.3. Energy and power density of commercial devices (open circles) and devices fabricated at UCLA (filled areas).

Fabrication technology

A variety of room temperature storage device fabrication routes have been explored and demonstrated at UCLA. Room temperature layer by layer deposition of the various components lies at the hart of the fab technology, with roll-to-roll deposition as the preferred method of large volume device fabrication.

Applications and Market

The different devices – supercapacitors, primary and secondary batteries offer different advantages, and also entry points to the various market segments.

Single use, and disposable primary batteries will have applications in security (***RFID tags, sensors***) in medical applications (***medical diagnostics and beauty patches***) and in the more distant future in ***wearable devices*** for smart clothing and drug delivery. Devices that can be recharged, secondary batteries and supercapacitors will have their place in consumer electronics and tandem, ***charge generation/storage devices.*** With the ever decreasing device dimensions, smaller power requirements both primary and secondary batteries will have entry points to consumer electronics, when issues like robustness are resolved. Disposable, single used devices, primary batteries together with supercapacitors will first enter the market, followed by secondary, rechargeable batteries.

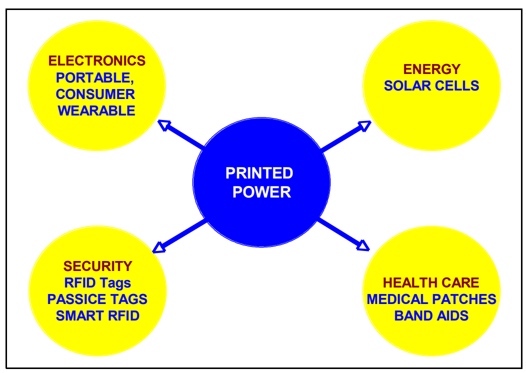

Fig 4: Market segments served by printed charge storage devices.

Intellectual property

Several patent applications, covering super-capacitors and batteries support the technology and path of commercialization.

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