Thin Supercapacitors by Screen Printing Approach

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- PBC Tech has developed thin, flexible supercapacitors for energy storage/power applications.

- A brief approach is described herein.

Basic Supercapacitor GEN1 Prototype Device

- Size: 45X55X0.450, mm
- Cap = 0.225 Min.
- ESR = 80 mΩ Max.
- Operating Temp. -30 to 70 C.
- This size is chosen to establish basic technology.

Power WRAPPER™

Application Market: Mobile Wireless Devices

Battery life is a key industry pain point in the fast growing connected-devices market.

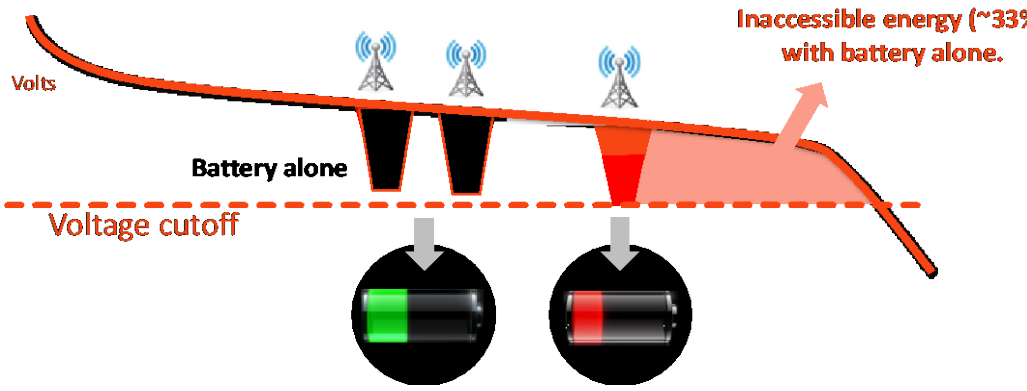
Peak power pulses degrade battery capacity and run-time

Manufacturers do not seem to have too many choices – throttle peak performance or use a larger battery

Apple Limits Performance in Old iPhones to Prevent Shutdowns

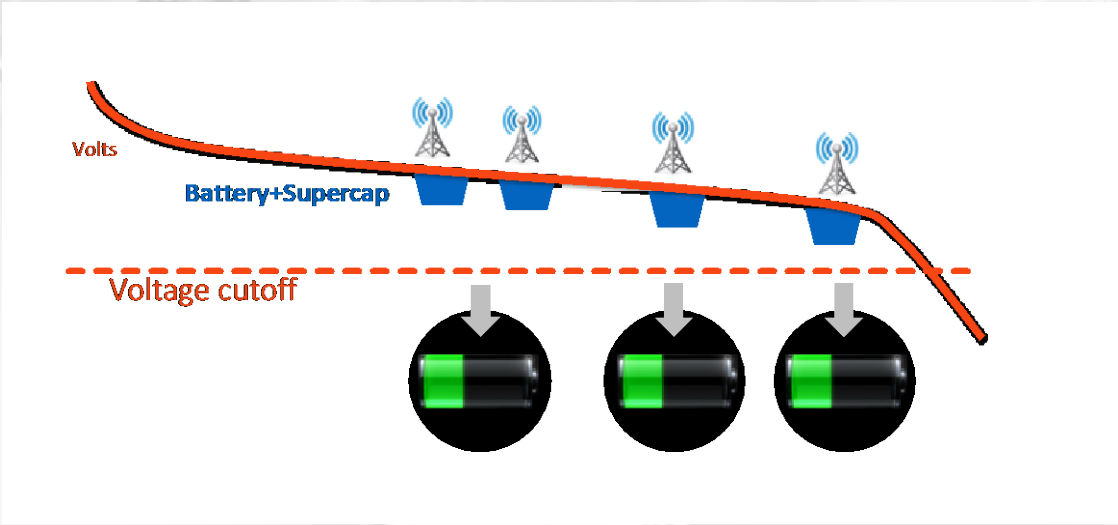
Dec 2017

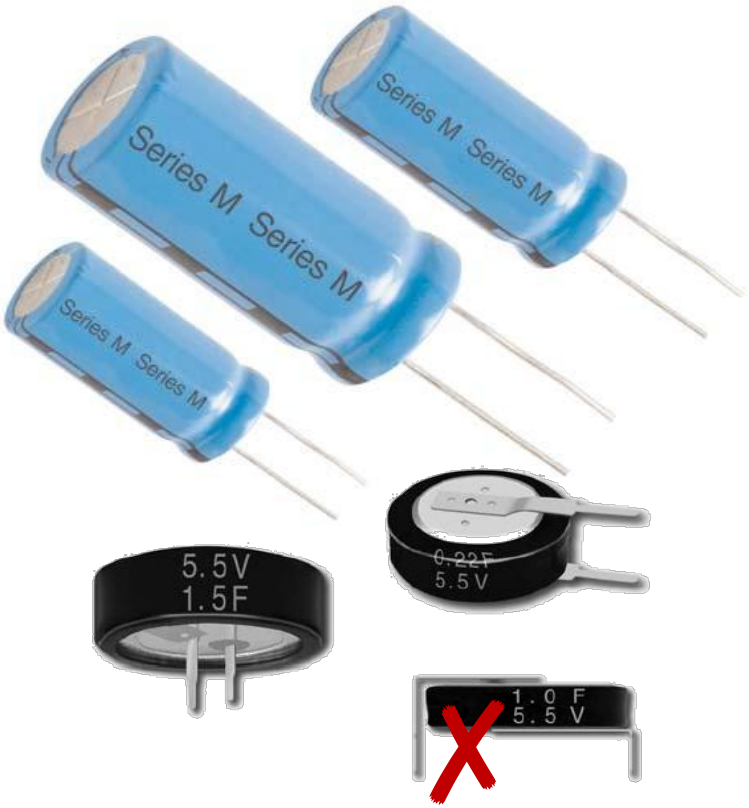
Peak power pulses degrade battery capacity and run-time



Supercapacitor are an excellent peak power decoupler

Supercapacitors complement batteries for peak power





However, today's products are too bulky to fit small form factors

and traditional capacitors have 1/100 energy compared to supercapacitors

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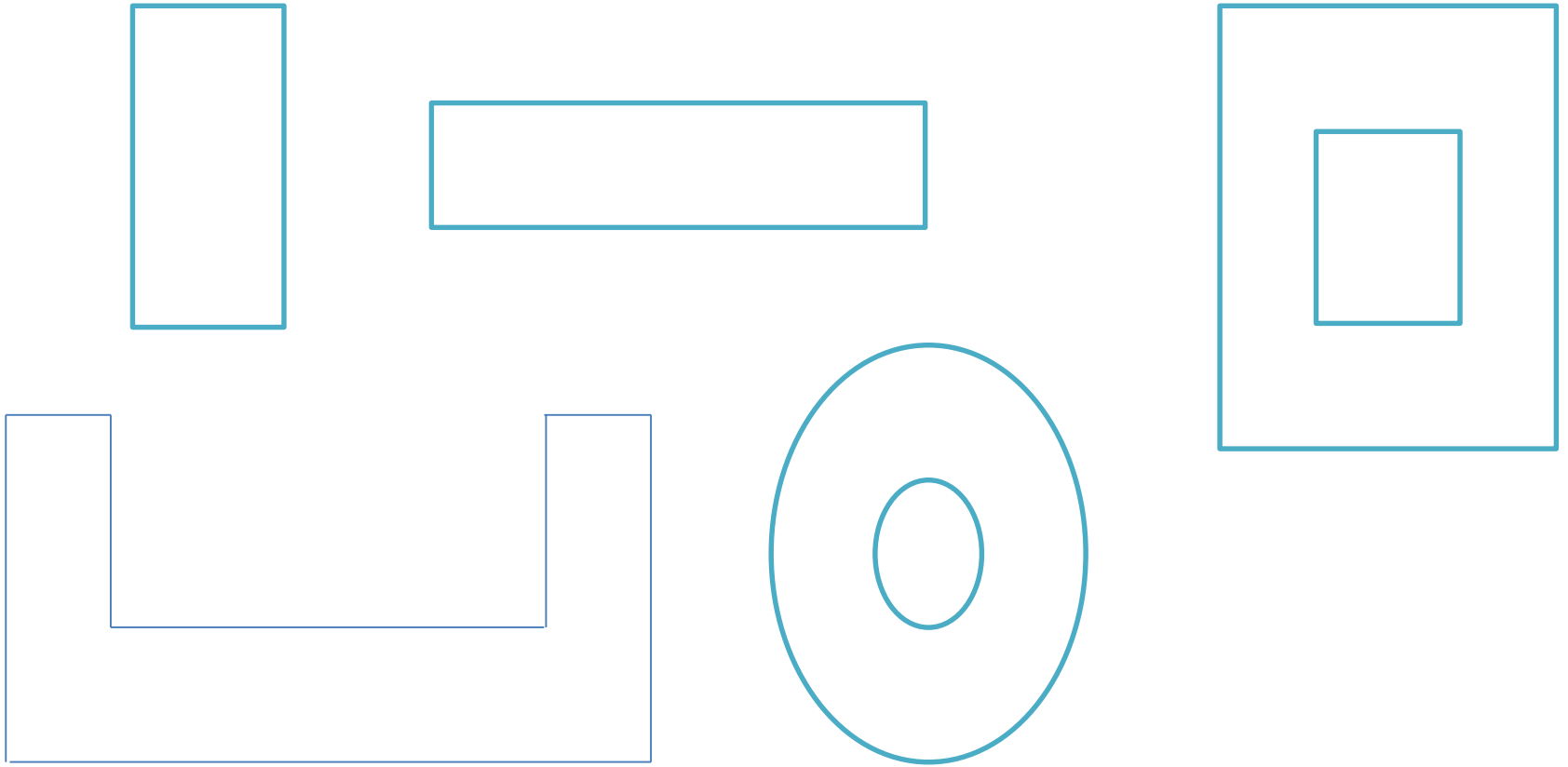
- Using above technology many shapes and sizes can be made.



Printing And Manufacturability

- To make these various shape and size devices and designing for manufacturability, we have chosen screen printing method for electrode making.

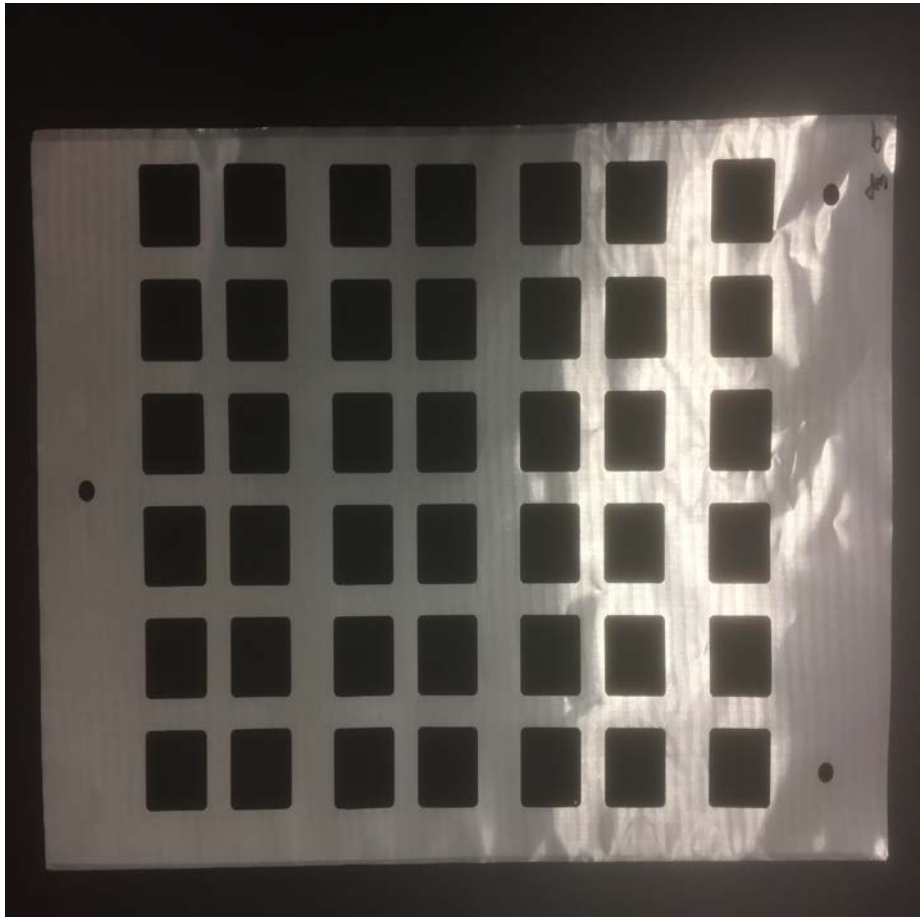
- Industry standard is coating with slot die.

Advantages With Screen Printing

- Control over basic thickness and thickness control is possible. (+/- 0.5 µ variation in thickness), thickness can be varied from 5 µ to 35 µ.
- Coating does not have to be removed from printed foil to make seals.
- This method can be used to make products from few hundred to millions.
- Relatively quick and less capital intensive method.

Printed electrode sheet- pre cut

electrodes are printed 42 to a sheet, then cut all at once using a die into desired shape, 5mm bare aluminum border surrounding electrode with 8mm tab extending from one edge.

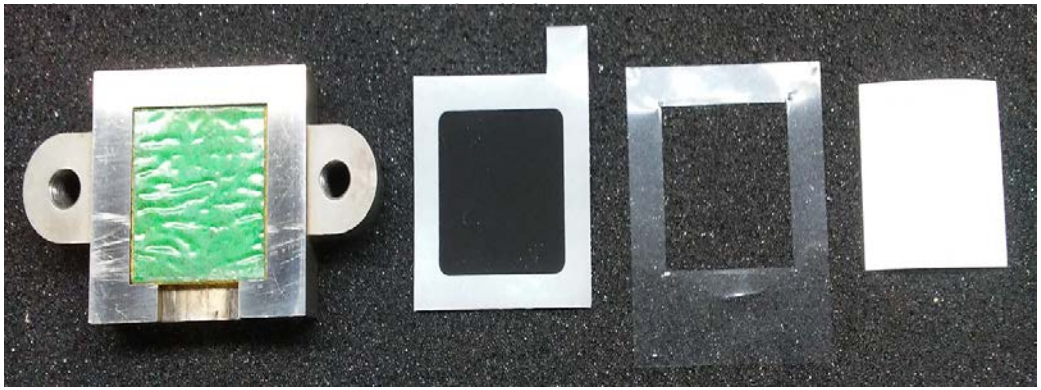


Assembly Process

Components of assembled cell

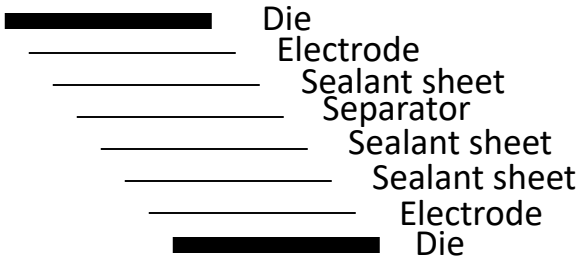
- Electrode x2
- Sealant sheet x 3
- Separator

Components are stacked on top of one another between two metal dies as follows: electrode-> 2x sealant sheet-> separator-> 1x sealant sheet-> electrode and placed in a



Die Electrode Sealant sheet Separator

Side view



Materials and Cell Structure

- Electrodes are made by printing carbon based inks on current collectors.
- Current collectors are Al foil.

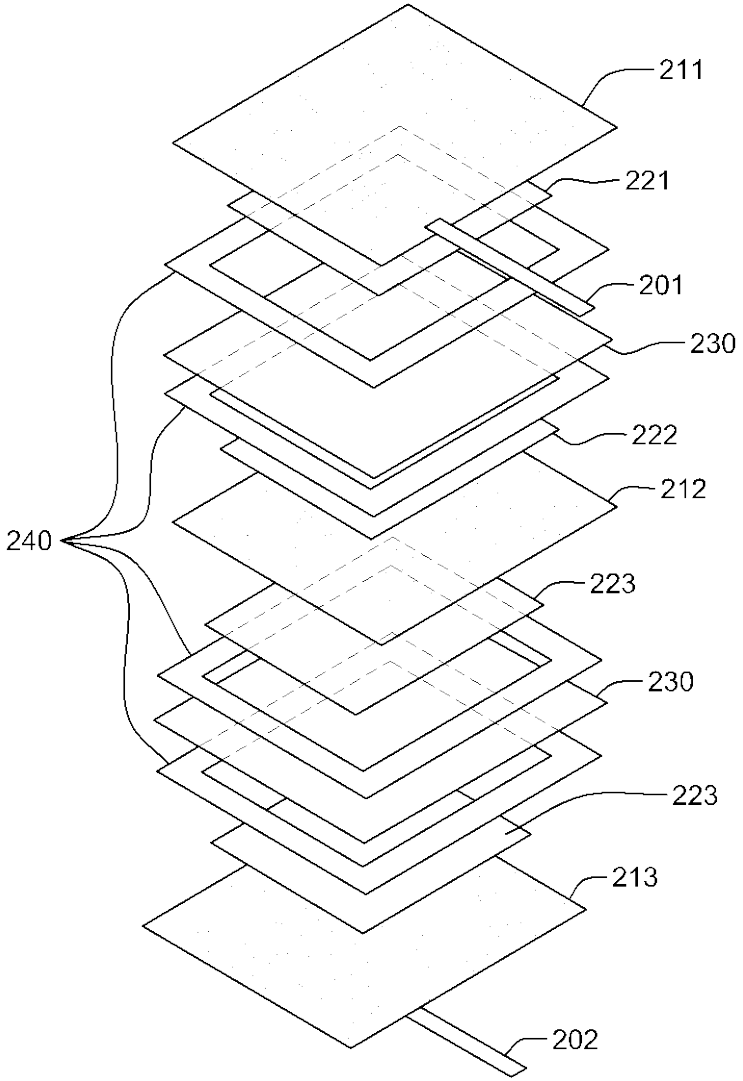


FIG. 2A

Electrode Ink Development

- Water-based conducting inks were developed in-house.
  - Water-based, and environmentally friendly.
  - Rheology can be tailored
  - Device properties can be manipulated by adjusting ink components.

Material properties are comparable to or better than existing devices.

Advantages of Screen printing Approach

- Easily scalable
- Low capital cost, no costly tooling changes
- Low wastage.
- Shapes and sizes of devices can vary easily.
- Low manufacturing cost and better from quality perspective.

- Using above approach devices are made and currently under reliability testing.