The Role of Printed Carbon-Zinc Thin Film Batteries in Interactive Printed Media

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Company Background

- Mid-1990’s: Eveready Battery test strip
  - >6 billion produced for pennies
- 1998: Eveready starts printed battery project
  - ~$10 million invested in technology development
- 2001: Eveready concentrates on products sold directly to consumers
  - Eveready decides to license printed battery technology
- 2002: Company formed as Thin Battery Technologies
  - Backed by VC’s
  - License technology
  - Complete product development
- 2005: Commercial sales start
- 2007: $6.2 million Series A financing completed
- 2008: Company changes name to Blue Spark Technologies
What are Printed Batteries

- Thin and Flexible
  - Smallest less than 0.020” or 500 microns
- Carbon – Zinc battery technology
  - “Old School”
  - Zinc and MnO₂ active chemistry
- Manufactured roll to roll using screen printing processes
- Eco Friendly and renewable
Printed Cells
In–Line Printing

- Roll to roll
- Multiple screen printing
- Multiple drying
Basic 1.5 V Unit Cell construction

• Multi Ply Substrate
  – Polyester laminate
  – Mechanical stability
  – Chemical stability
  – Printing compatibility
  – Controlled permeability
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
  - Carbon-based
  - Large area
  - Low resistance
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
- Cathode contact
  - Silver
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
- Cathode contact
- Cathode
  - MnO$_2$
  - Carbon
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
- Cathode contact
- Cathode
- Anode
  - Laminated Zn foil
  - Co-planar design
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
- Cathode contact
- Cathode
- Anode
- Adhesive sealant
  - Pressure sensitive
  - Heat activated
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
- Cathode contact
- Cathode
- Anode
- Adhesive sealant
- Separator
  - Paper
  - Better referred to as “carrier”
  - Retains electrolyte
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
- Cathode contact
- Cathode
- Anode
- Adhesive sealant
- Separator
- Electrolyte
  - Main constituent is $\text{ZnCl}_2$
Basic 1.5 V Unit Cell construction

- Multi-ply substrate
- Cathode collector
- Cathode contact
- Cathode
- Anode
- Adhesive sealant
- Separator
- Electrolyte
- Multi-ply substrate
“Thin” is “In”

- Form factors are driving new applications
  - BAP RFID Smart Labels
  - Powered smart cards
  - Disposable and returnable temperature data loggers
  - Interactive Packaging
- Coin cell batteries don’t run through printers…
- Printing is the key to high volume production
- Shared substrates enable lower total cost of integration
Battery Features

- 1.5V/cell carbon-zinc MnO₂ chemistry
- Co-planar architecture for easy integration
- Eco-friendly recyclable materials
- Highly flexible, 40 mm bend radius
- -30 to +65 deg C operating temperature
- Energy capacity dependent on size
Radio Frequency based applications
- Battery-assisted passive RFID
- Low cost active RFID
- RF linked sensors
  - Time, temperature, humidity, shock, vibration
- Real time locating systems

Promotional and Novelty
- Greeting cards
- Interactive packaging
- Toys

Smart card
- One time password
- Proximity detection combined with personal ID
- Loyalty and gift cards

Transdermal patches
- Drug delivery
- Wound care
- Cosmetics
Interactive printed media

Printed electronics adds value to printed products.

'Interactivity'
User interactivity with a product key to add value.

Such as:
- Attention grabbing
- Attention holding
- Educational
- Informative
- Compliance
- Regulation
- Entertainment
- Curiosity
Interactive printed media

Conductive inks and capacitive/resistive touch sensitivity enable the whole product surface as a user interface.

The touch sensitive surface is part of the print process or converted as an insert.

Display effects such as LEDs or electrochromic along with sound devices form user output.

Control modules, such as those from Novalia, contains the drive electronics and software to coordinate input/output devices and customer specific interaction flow.
Printing **communicates** through text and graphics. However this communication is only ‘**one way**’.

Printed electronics enables ‘**two way**’ communication *and interaction*; representing huge potential for value add.

**Inspired creative design** identifies opportunities.

Result:

‘**can’t put down**’ products that are an **experience**.
Case Study – Novalia

Novalia has developed an electronic **controller unit**, which, when integrated with printed tracks, drives display and sound effects and controls and coordinates user input.

Control units are supplied at varying combinations of price point and functionality.

Integrating a control unit with a printed item is as simple as sticking a stamp on an envelope.

Control units can be supplied pre-attached to printed substrate in roll or sheet form.

Using functional inks as part of the graphics, art and electronics are part of the same thing.
LinkArt – greeting card
LinkArt – greeting card
Children's Book – Always Changing Story
There's a box behind the bush... I think it's from the zoo!
Ohh.... IT GROWLED!
IT’S A BEAR!

IT’S BROWN, GOT A TINY TAIL, ATE THE FISH AND WENT GROWL... WHAT DO YOU THINK IT IS?!
START AGAIN....

IT PRODARED!
IT'S A LION!

IT'S YELLOW, GOT SHARP TEETH, ATE THE HAM AND WENT RRROAR... WHAT DO YOU THINK IT IS?!
Conclusion

Printed electronics enables a printed item to be interactive, flexible power source enables manufacturability.

Interactivity enables communication

Your experience with an item depends on your personal interaction with the item

‘What you get out depends on what you put in’

Applications limited only by our imagination!
Thank You!

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