Printed Wearables

Electronic Inks for the Wearable World

Welcome to
The Global Collaboratory™

Printed Electronics USA2014

Outline

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2. Directions in Wearable Tech
3. Smart Clothing
   - Printed Wearable Possibilities
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   - Construction Examples
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4. Summary

The DuPont Legacy in Clothing Innovation Continues

- From the brand that introduced Nylon®, Lycra®, and Kevlar® to the textile industry
- Answering the question:

  "Can we **print a circuit** into a shirt, **connecting sensors** to a central device?"
- Microcircuit Materials (MCM) is a leading innovator and high-volume supplier of electronic inks and pastes

Directions in Wearables

Feature	Smart Clothing	Wearable Tech
Look	• Digital Enhancements	• Compliments Smartphone
Feel	• Fabric	• Fun and Simple • Advanced Plastic or Metal
Function	• Health and Environment Monitoring • Performance Enhancement	• Device interface • Health and Environment Monitoring • Information and Communication
Conceptual Examples	 Ralph Lauren	 Nike iWatch Concepts

Printed Wearable Possibilities

Prototype Biometric Fitness Shirt

- A manufacturing-ready solution for smart clothing enabled by DuPont electronic inks
- Thin and comfortable
- Washable up to 100 cycles
- Stable through repeated elongation
- DuPont is developing complete material suite: conductors, encapsulants, and sensors

Shirt developed in cooperation with Maxim Integrated
Shirt on display at Demonstration Alley and DuPont Booth E16

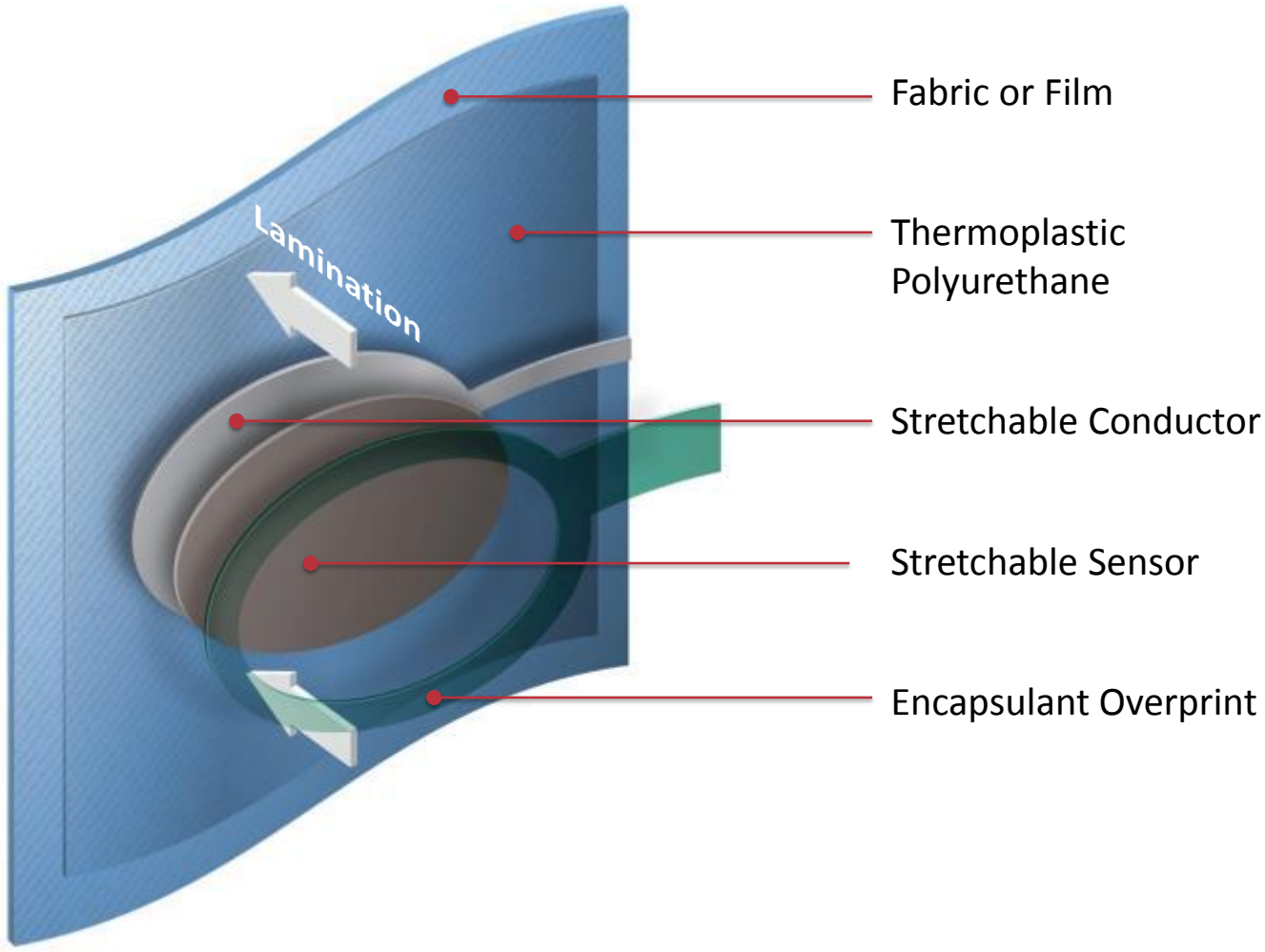
maxim integrated™

New Products

Material	Product ID	Description
Silver Conductor	PE872	Conductor for signal transfer • Stretchable • Washable
Encapsulant	PE772	Wearable Applications • Stretchable • Washable

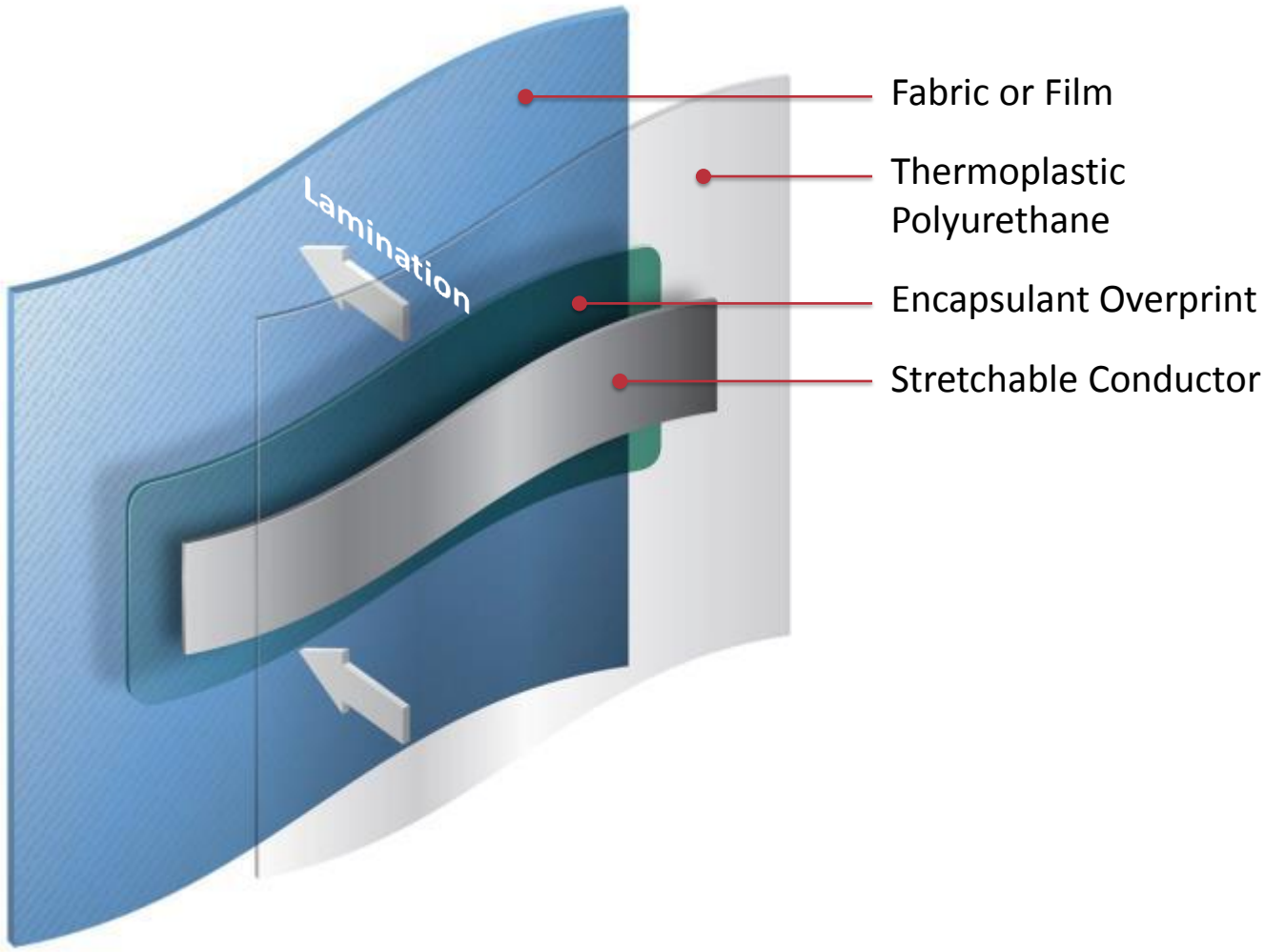
Lamination Construction Examples

Printed Sensors

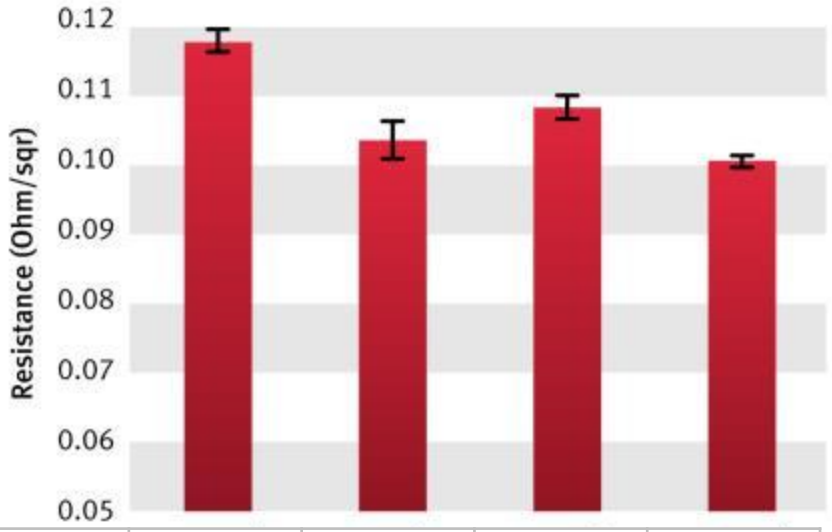


Lamination Construction Examples

Printed Conductor Traces



Conductivity Measurements



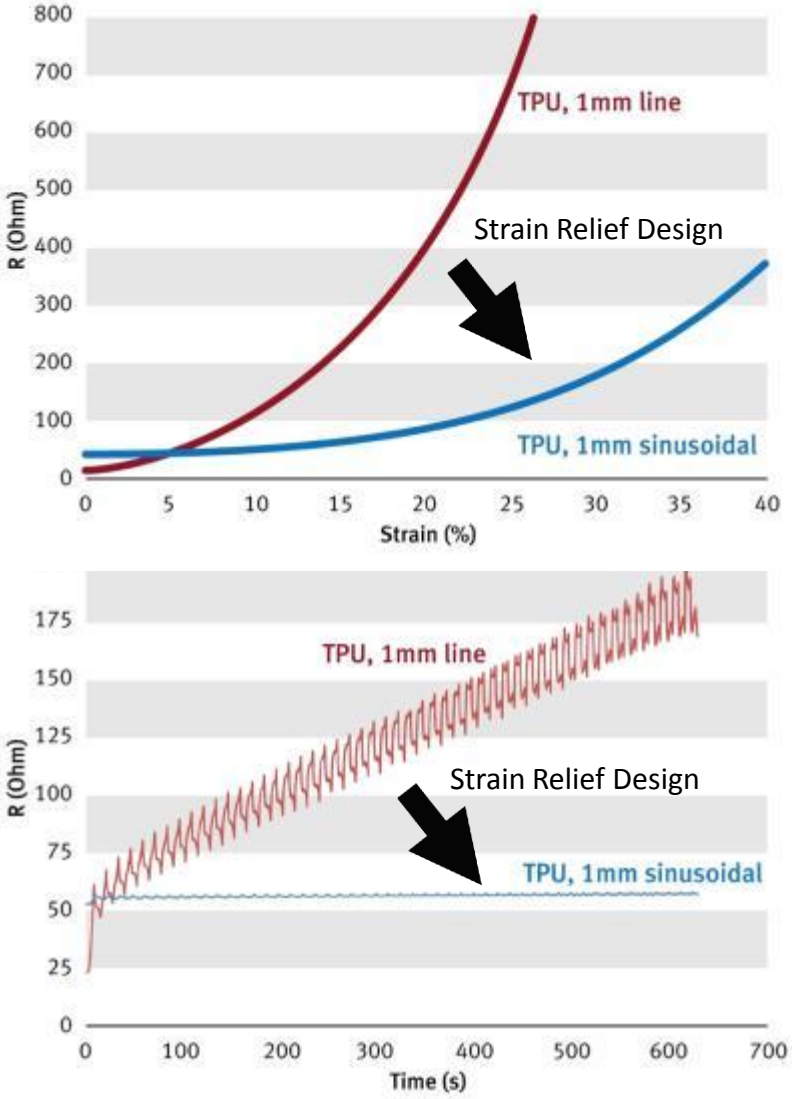
Substrate	TPU	TPU	TPU	Cetus
Ink Layer 1	PE872	PE872	PE872	PE872
Ink Layer 2		Carbon	Ag/AgCl	

- 20 cm trace, 0.5 cm wide → 0.7 Ω
- Conductors work well on TPU films and synthetic fabrics
- Encapsulant overprint defines connection pads and sensor areas
- Stretchable sensor materials available for testing

The above data is based on internal, controlled experiments and evaluations within particular test designs and parameters and should not be interpreted as establishing specifications or performance expectations in any particular environment or application or as establishing any warranty or guarantee.

Stretchability and the Effects of Strain

- Conductor printed on TPU film, 10cm trace length
- **Trace width & strain relief design** can enable **>15% strain and 4% oscillating strain** with minimal change in resistance
- Data generated in collaboration with NCSU and ASSIST (Booth T30)



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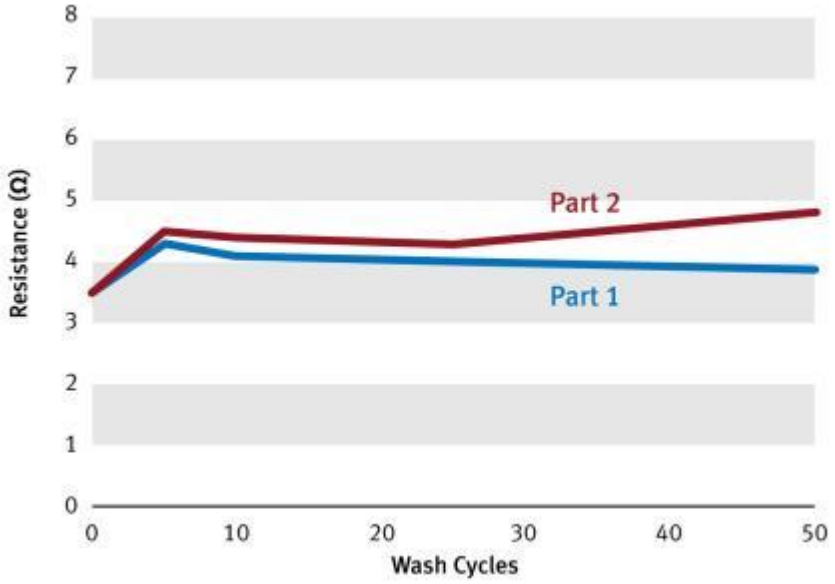
Washability – Various Solutions Available

- **Ink system is PE872 conductor and PE772 encapsulant**
- Stable performance demonstrated with overprint approach
- Testing done by CLOTHING+, who integrate flexible circuits into textile structures.



CLOTHING+

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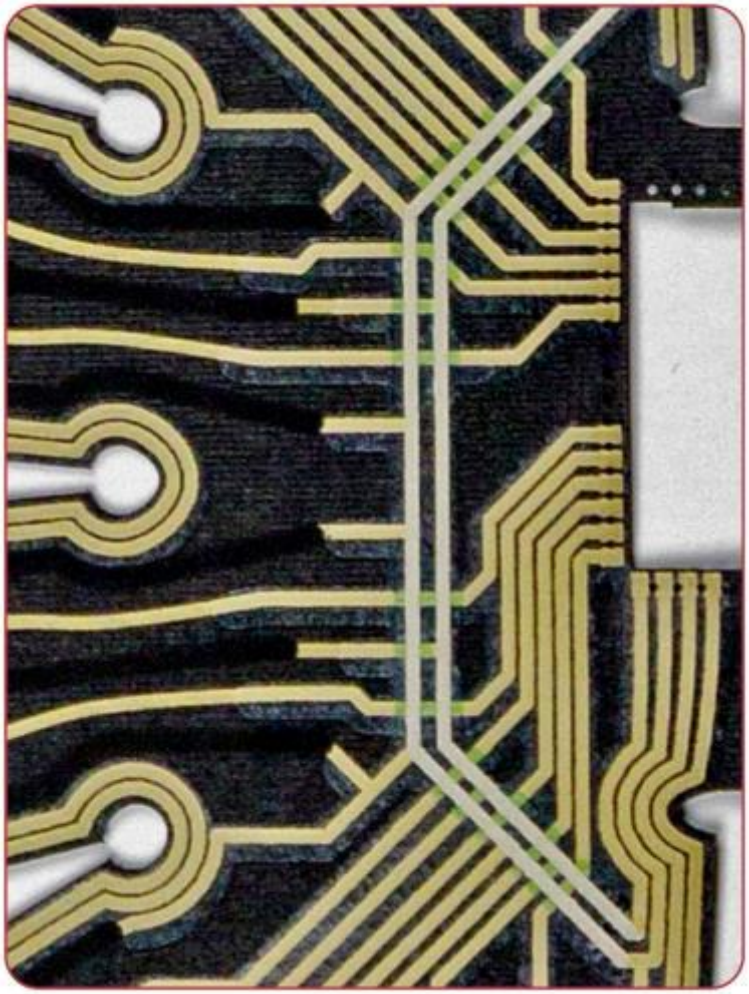
Direct Print on Fabric

- Customers may choose direct print on fabric
- Best performance to date with high density synthetic fabrics
- Overprint with encapsulant recommended
- Washing remains a challenge for direct print approach



Direct print on fabric (image from BeBop Sensors)

BeBop sensors

Electronic Inks for the Wearable World

- DuPont is introducing a stretchable ink suite for the wearables market
- Manufacturing-ready solution for smart clothing enabled by electronic inks
  - Thin and comfortable
  - Washable up to 100 cycles
  - Stable through repeated elongation
- Screen print formulations as needed for high volume and low cost
- Material selection guidance and post-sales support available
- Currently engaging commercial partners to expand wearable market development

WE'RE SOLVING THE WORLD'S GREATEST CHALLENGES

TOGETHER

Together we can accomplish what no one can do alone.

WELCOME TO THE GLOBAL COLLABORATORY