Thin film deposition and laser patterning for high volume manufacture of electrical structures

-Conducted by Brunel and Hull Universities
Context…

-RFID
Context...

-Large area displays
Context...

-Low-power systems
Context...

-Sensor arrays
Context…

- High resolution electrical interconnect
Consortium…

-Brunel University
  -Cleaner Electronics Research Group
    (Dr. Blue Ramsey, Dr. Sam Duby)

-Hull University
  -Laser Group
    (Dr. Howard Snelling)
Consortium…

-Cardiff University (Thermoelectrics Group)
-Centre for Process Innovation (CPI)
-Cressington Scientific Instruments
-Blue Venutures Conservation
-Dupont Teijinn Films
-Teer Coatings
-Adcal Labels

(All UK based)
Thin film thermocouples...
Thin films...

- Sputtering
- Thermal Evaporation
Thin films…

-Food packaging
Thin films…

-Large area functional coatings
Thin films...

-Electrically functional thin films
Thin films...

-Electron scattering
Thin films...

- Limitations to conductivity

-Film thickness Vs. Electron mean free path

a.

b.

mean free path of an electron
Thin films...

- Limitations to conductivity
- Vacuum quality
- Speed of deposition
- Substrate temperature
- Material being deposited
- Time between deposition runs
Thin films...

-Current patterning technologies
Our work...

-Laser patterning
Our work...

- Selective material ablation
Our work...

- Thin film laser patterning
Our work...

-Single reel-to-reel process

1. P-type material deposited.
2. N-type material deposited.
3. Laser ablates material patterning structure.
4. Finished patterned metallised structure.
Our work…

-Complete, functional structures
Our work…

-Wide area, single envelope patterning
Thermocouple characterisation…

![Graph showing voltage (mV) vs. temperature difference (°C) for different types of thermocouples.](image)

- **T-type**
- **Ni/Fe thin film**
- **R-type**

**Axes:**
- **Y-axis:** Voltage (mV) ranging from 0 to 6
- **X-axis:** Temperature difference (°C) ranging from 0 to 140
Applications...

- Temperature sensing arrays
- Large area interconnect
- Passive components
- Segmented displays
- Heating elements
- Antennae
Advantages...

- No need for cleaning between production runs
- Suitability for high volume production
- Minimal to no retooling time required
- Environmentally friendly processes
- Large area patterning
- Flexible processes
WEEE and RoHS...

- No sacrificial process agents
- Minimal raw material use
- No toxic constituents
- No ‘wet’ chemistry
Thin film thermocouples...

- Advantages over bulk material counterparts
Thin film thermocouples…

-Advanced engine design
Thin film thermocouples…

- Turbine blades
Thin film thermocouples...

-Monitor airflow
Thermocouple specific applications...

- Construction of thermoelectric generator mats
Thin film thermocouples...

- Waste heat harvesting
- Microchips
Thin film thermocouples...

- Waste heat harvesting
- Bio-implants (pacemakers, drug dosing)
Thin film thermocouples...

- Waste heat harvesting

- Industrial processes
Thin film thermocouples…

- Waste heat harvesting

- Car engines
Thin film thermocouples...

- Waste heat harvesting

- Photovoltaic panels
Current work...

Collaboration with manufacturers

- Teer Coatings
- Centre for Process Innovation (CPI)
Thank you…