

Manufacturing multilayer thin films for photovoltaics

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Introduction

WMG aims to act as a bridge between cutting edge research and practice in industry

2012



International
Institute for
Product and Service
Innovation

2008



International
Digital Laboratory

1995



International
Manufacturing
Centre

1986



International
Automotive
Research Centre

3 further initiatives announced in 2013

- International Institute for Nanocomposites Manufacturing
- National Automotive Innovation Campus
- Automotive Composite Research Centre

1. To research the potential for non-contact printing methods (such as inkjet) to produce:
 - Multilayer photovoltaic structures
 - Processed from solution
 - Low temperatures ($\leq 150^{\circ}\text{C}$)
 - Flexible substrates
2. To investigate the potential of embedding multiple coatings onto mass manufactured plastic products

Spin coating:

- is the most common solution processing technique used to fabricate PV devices
- results in smooth and homogeneous films
- it is not well-suited to commercial scale up

Therefore, an alternative is required which:

- is suited to commercial scale up
- has minimal material wastage
- is low cost

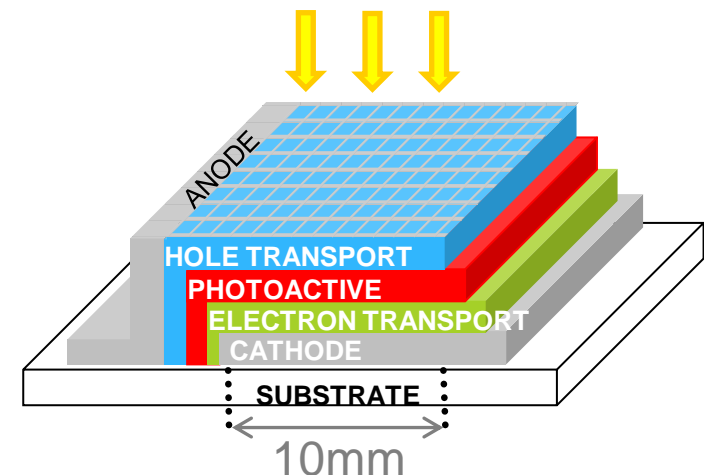
Early work

- Ideal materials and structure for an inkjet printed device
- Dimatix DMP-2800 materials printer
- Inkjet printed
 - Nanoparticle silver
 - PEDOT:PSS
 - P3HT:PCBM dichlorobenzene solution
 - ZnO dispersion in ethanol



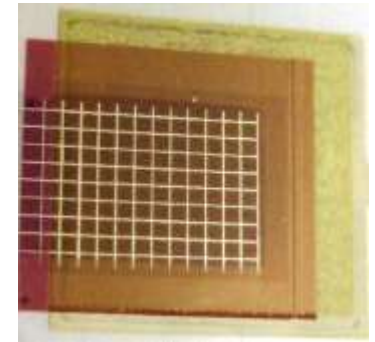
Dimatix DMP-2800

Top illuminated
(Inverted structure)



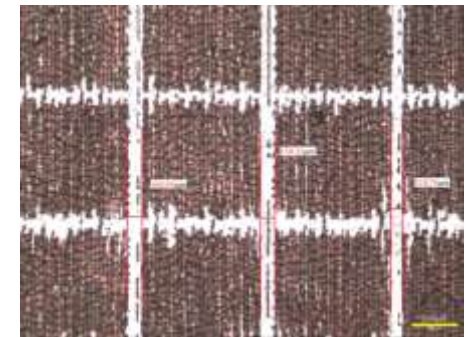
Early results

- PEDOT:PSS, silver and P3HT:PCBM solution jet well
- PEDOT:PSS required addition of IPA and surfactants to improve wetting
- Resolution of the silver tracks was better in the print direction (approx. $160\mu\text{m}$ line width)
- ZnO produced a visibly rough surface



← 10mm →

Inkjet printed device



Magnified Ag grid

Future work

- Alternative ETL materials (Cs_2CO_3 , PEO, TiO_x)
- Further analysis on ink formulations (Rheology etc.)
- Analysis of surface roughness
- Printing on flexible substrates (Kapton, PET, PEN, coated paper)
- Embedding coatings onto plastic products (in-mould films).



Haake mars iii
rheometer



Atomic force
microscope

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Thank you for listening