
**PROJECT NO: FP6-513272**

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# FLEXTRONIC

The Development of a Novel Laser-Inkjet Hybrid Printing Technology for Additive Printed, High Resolution, Mass Customised Conductive Copper Tracks

# Final Publishable Report

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1. Lead Contractor: TOVOLI PRINTERS SRL
2. SME Contractor: SARANTEL LTD
3. SME Contractor: VIPEM HACKERT GmbH
4. SME Contractor: UVASOL LTD
5. SME Contractor: POINT L- BULGARIA LTD.
6. SME Contractor: CODICO DISTRIBUTORS LTD
7. SME Contractor: CLICKTOUCH NV
8. RTD Performer: PERA INNOVATION LIMITED
9. RTD Performer: NETHERLANDS ORGANIZATION FOR APPLIED SCIENTIFIC RESEARCH
10. SME Contractor: OPTEK LTD

**SUMMARY**

UVaSol, a UK company specialising in printing, together with a European Consortium of small to medium sized (SME) companies have completed a thirty month European Research project, **Flextronic** to develop the technology to adapt and enhance current inkjet printing to enable printers to print low-cost electrically conductive products onto films, components and products.

The project has successfully developed surface processes to enable the printing of well adhered fine definition circuit tracks and formulated conductive inks suitable for use in inkjet heads to print onto flexible polymer films. This has resulted in the production of two prototype manufacturing cells to demonstrate the Flextronic technology as batch-to-batch and continuous processes. Prototype plaques and circuits have been manufactured utilising the technology and successfully tested electrically. Further testing is being carried out post-project to determine their long term performance.

The partners have agreed a preferred exploitation route through a new company initiated by the Exploitation Manager, Vipem, with the partners investing start-up capital in return for share holdings. Vipem and UVaSol have started discussions with LE companies to licence the Flextronic technology.

## OVERVIEW

Our principal objective was to develop the technology to adapt and enhance current inkjet printing to enable printers to print low-cost electrically conductive products onto films, components and products.

### Economic Objectives

- Displacing imports, of **€2.7M p.a**., safeguarding 17 jobs.
- Increasing domestic sales into Europe, of **€27.2M p.a**., creating 170 jobs.
- Exports into global markets, of **€17.6M p.a**., creating 110 jobs.
- Growth in the market population of 1.8%, giving **€0.72M p.a**., creating 5 jobs

### Scientific Objectives

- Enhance the scientific understanding surface free energy values of 10 polymer films and barium titanate before and after excimer laser treatment under 2 atmospheres (Air and Nitrogen) with varying power densities

### Technological Objectives

- Produce a novel, laser- inkjet printing system that can:
    - produce conductive copper tracks on thermoplastic films and barium titanate in line with IEC 60326 PT2 standards for delamination
    - produce conductive copper tracks on thermoplastic films with a minimum track width of 10μm at 10μm separation and depth of between 20 and 1μm
    - deposit conductive copper ink with conductor track of thickness 20μm, +/- 10% and width 1mm +/-1 μm on barium titanate.
- to produce a novel, laser- inkjet printing system at a capital cost for a typical system of €50,000 and production cost for a typical flip-chip printing €0.1 FCB and antenna of €1
- with no (zero) tooling to effectively reduce change over times from one design to another to less than 1 second allowing mass customisation
- to increase scientific understanding of the surface characteristics (surface free energy) of 10 laser ablated polymer films and barium titanate
- to develop a software control system to allow real-time control of the laser and inkjet printing head and design of circuitry
- to compound conductive copper inks:
    - Which whilst liquid has a surface tension between 0.02 – 0.04 $Nm^{-1}$ and viscosity between 0.01 and 0.03 $Nsm^{-2}$ at the jetting temperature
    - with a bulk copper resistivity of 1.7 x $10^{-8}$ Ω-m at standard temperature when dry

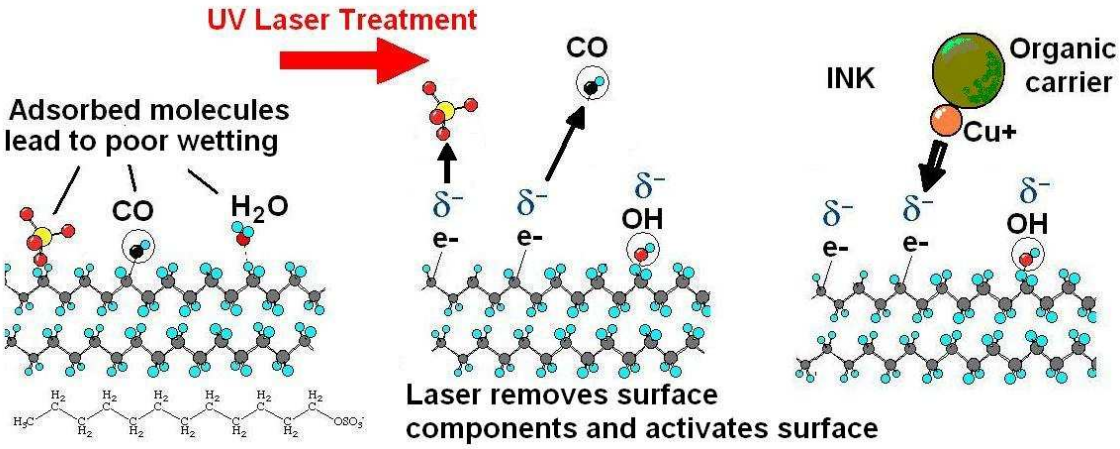
## APPROACH

The structure of the project was such that the work programme could be conveniently divided into three main areas of focus:

- Development of surface processes to enable the printing of well adhered fine definition circuit tracks
- Development of conductive inks suitable for use in inkjet heads
- Development of manufacturing cells

### Development of Surface Treatment Processes

Flextronic has proved that a uV laser can be used to alter the surface of a polymer enabling the printing of high definition circuit tracks on the surface. The result showed that this occurred due to both a photochemical effect (creating an electro negative surface and enabling increased chemical bonding) and a surface roughening effect enabling increase mechanical keying.




### Conductive Inks

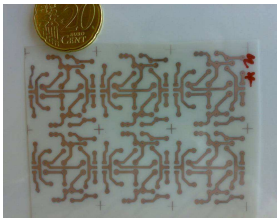
A series of catalytic inks were formulated to optimise seeding onto polymer films and with viscosities suitable for ink-jet printing. The down-selected inks were formulated to the necessary volumes for printing and successfully proved in trials.

**Manufacturing Cells**

Two separate manufacturing cells were developed for batch-to batch and continuous processing. The **Flextronic** process was optimised for the cells and prototype circuits successfully printed onto flexible polymer films. The prototype circuits have been successfully electrically tested and are undergoing post project testing for long-term performance

**PROJECT RESULTS**

The main results of the project are as follows:



- The successful development of surface processes to enable the printing of well adhered fine definition circuit tracks
- Formulation of conductive inks suitable for use in inkjet heads
- Development of manufacturing cells for batch-to batch and continuous processing
- The production of prototype circuits printed onto flexible polymer films using the **Flextronic** technology

**CONCLUSIONS**

The project has successfully developed surface processes to enable the printing of well adhered fine definition circuit tracks and formulated conductive inks suitable for use in inkjet heads to print onto flexible polymer films. This has resulted in the production of two prototype manufacturing cells to demonstrate the Flextronic technology as batch-to-batch and continuous processes. Prototype plaques and circuits have been manufactured utilising the technology and successfully tested electrically. Further testing is being carried out post-project to determine their long term performance.

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**ACKNOWLEDGEMENTS**

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