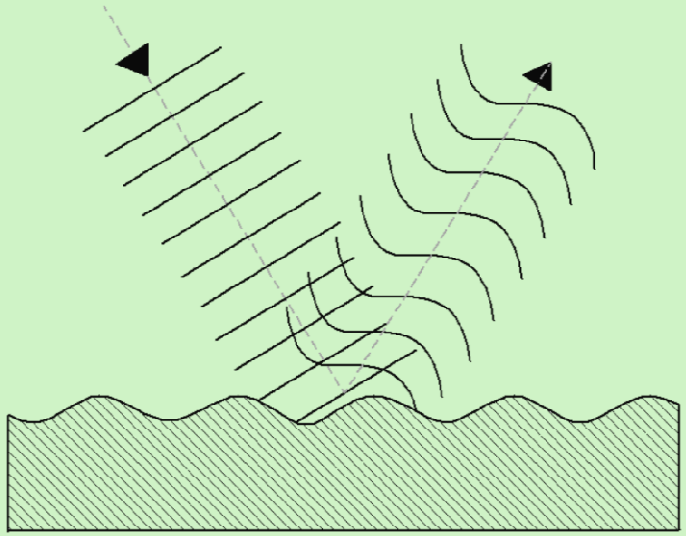
# Laser manufacture of diffraction gratings on metal surfaces with single stage process

**Author:** Marcus Ardron EngD student and Senior Design Engineer for Renishaw PLC

**Event : JWI conference**

Date: 8th July 2011

# Smoothly varying phase grating



Plane illumination of profiled reflective surface → reflection with phase structure

Features sequentially melted into metal

▼

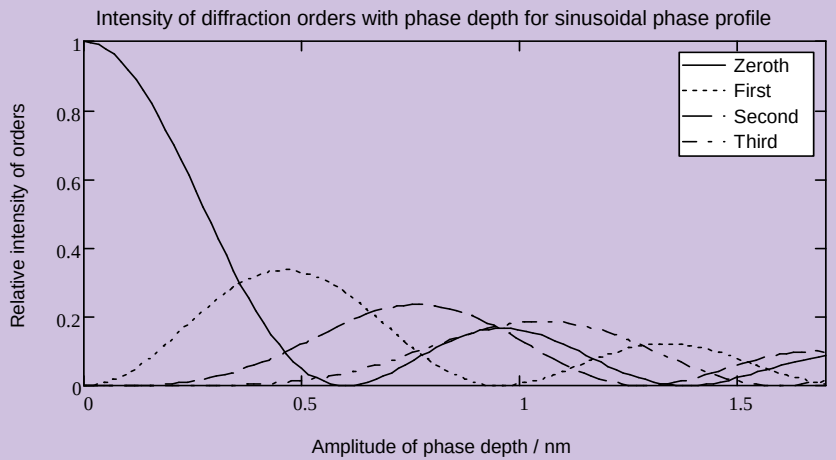
Surface tension gives smooth undulations

▼

Imperfect diffraction grating

▼

MTF of optics blocks unwanted diffraction orders



# SMART microsystems

**Dr. Gerard Cummins**, Institute of Integrated Systems, Heriot Watt University

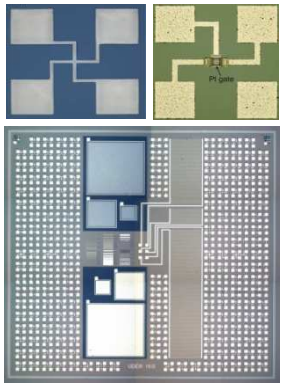
**Agile Manufacturing Conference**

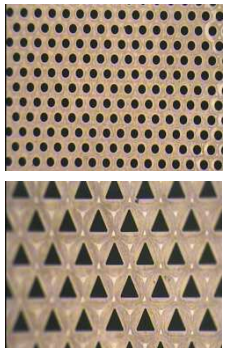
08/06/11

# SMART microsystems

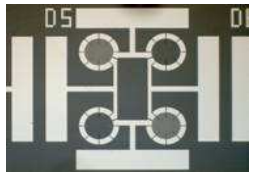
Microsystems technology is a significant element of the UK manufacturing industry with larger core companies employing 43,000 with over £2.3bn p.a turnover.

The SMART microsystems project is collaborating with industrial partners to develop innovative microsystems technology to enable the rapid customisation of CMOS foundry wafers for a variety of more than Moore applications. Technologies being investigated include inkjet printing, stencil printing, electroplating, silicon carbide micromaching and 3D integration.

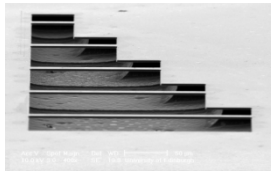




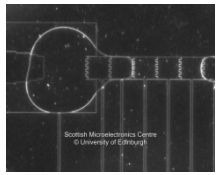
**Sub-100 micron ultrafine pitch microstencil patterns**

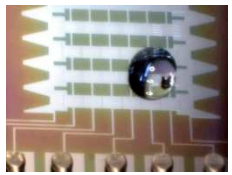


**Silicon carbide pressure sensor**

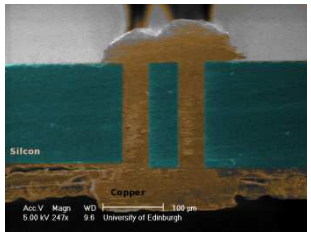


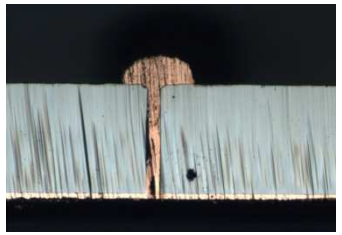
**Silicon carbide cantilevers**





**Electrical test structures fabricated with novel photosensitive organometallic materials from Ceimig**



**Coloured SEM image of copper through-wafer vias**

**Electrowetting on dielectric electrodes for manipulation and transport of droplets**

# Electrowetting

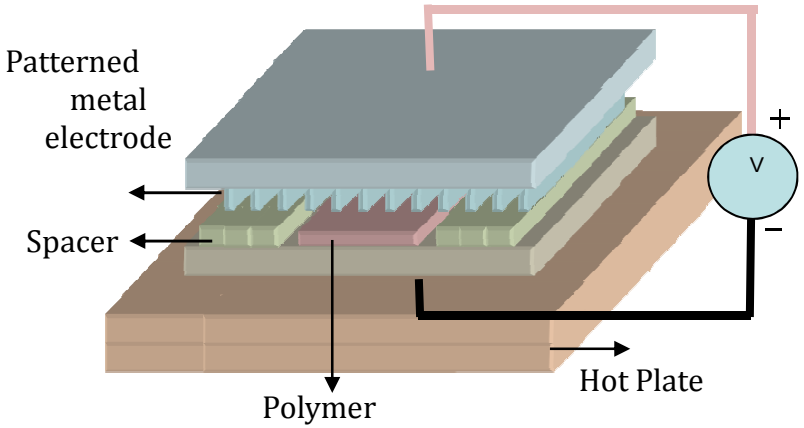
**Marc Desmulliez, Scott Cargill**, Heriot-Watt University

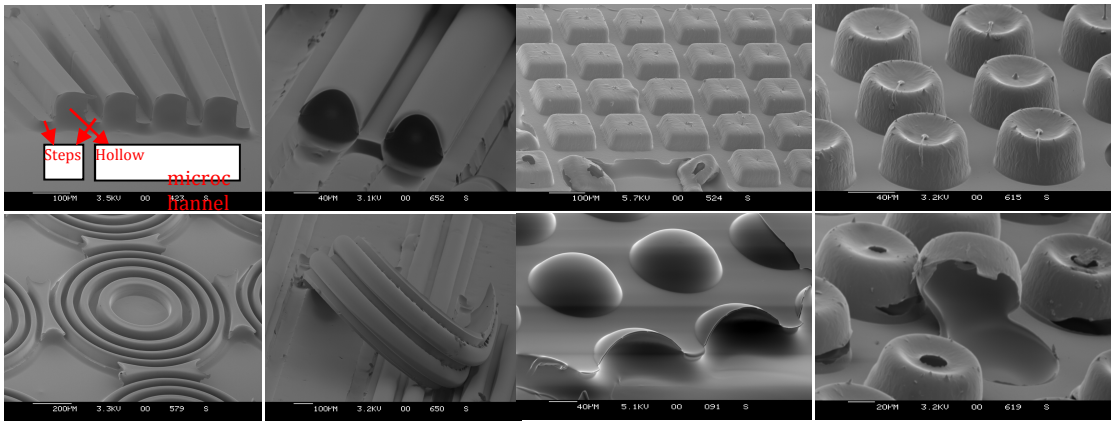
**JWI-IMRC Conference in Agile Mnufacturing**

8 July 2011

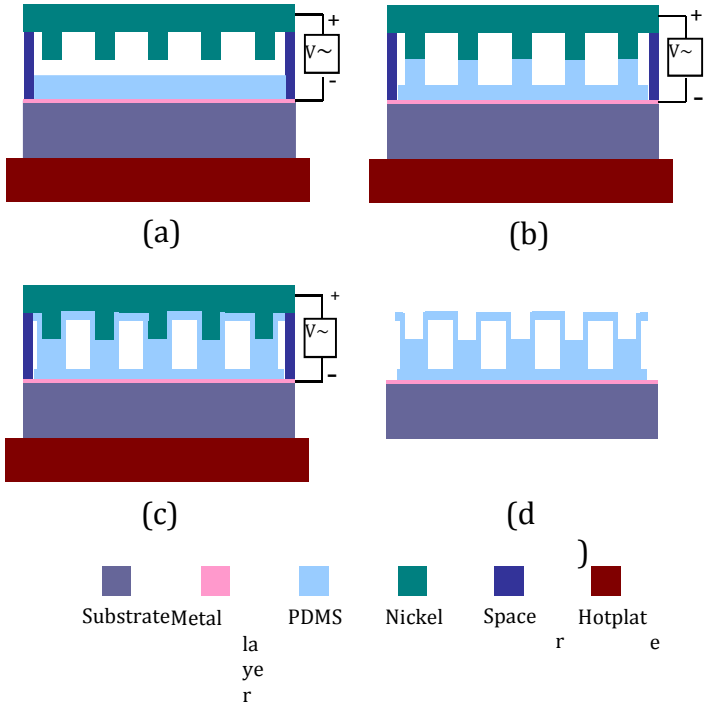
# Electrowetting

## Experimental set up




## Physical process




## Results

# Haptic Devices and Virtual Machining

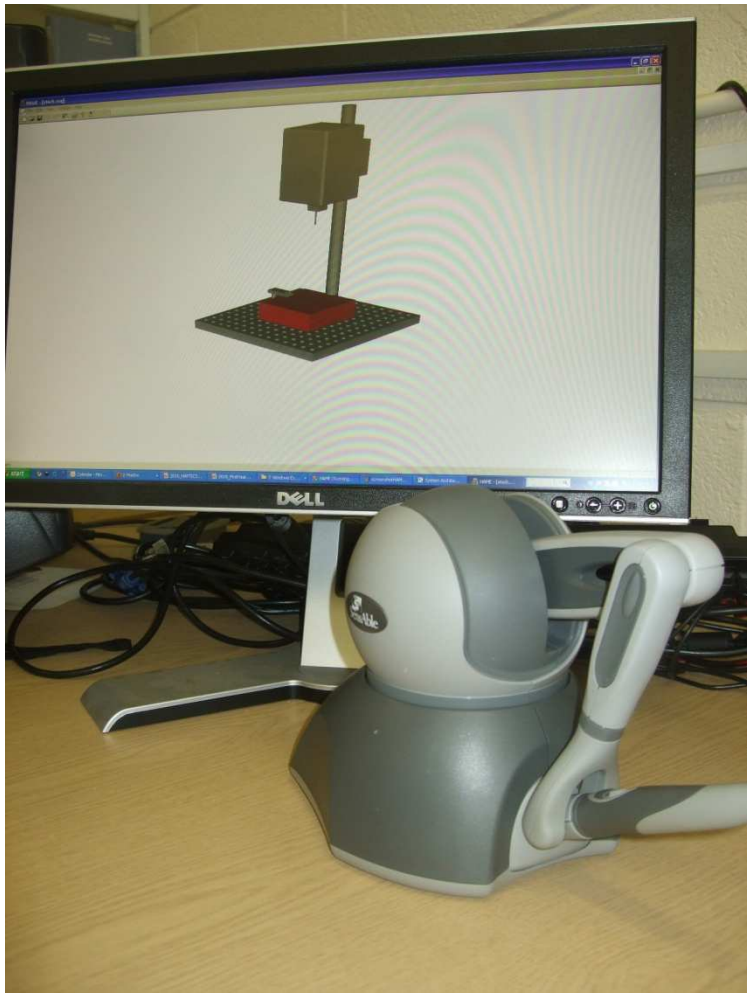
**Craig Fletcher**, Heriot Watt University

**James Watt Institute –Innovative Manufacturing Research Centre Conference**

Friday, July 08, 2011

# Haptic Devices and Virtual Machining

**I am investigating the use of virtual environments and haptic devices to rapidly prototype the machining of products**



# Haptic Aided Virtual Manufacturing & Assembly Tasks

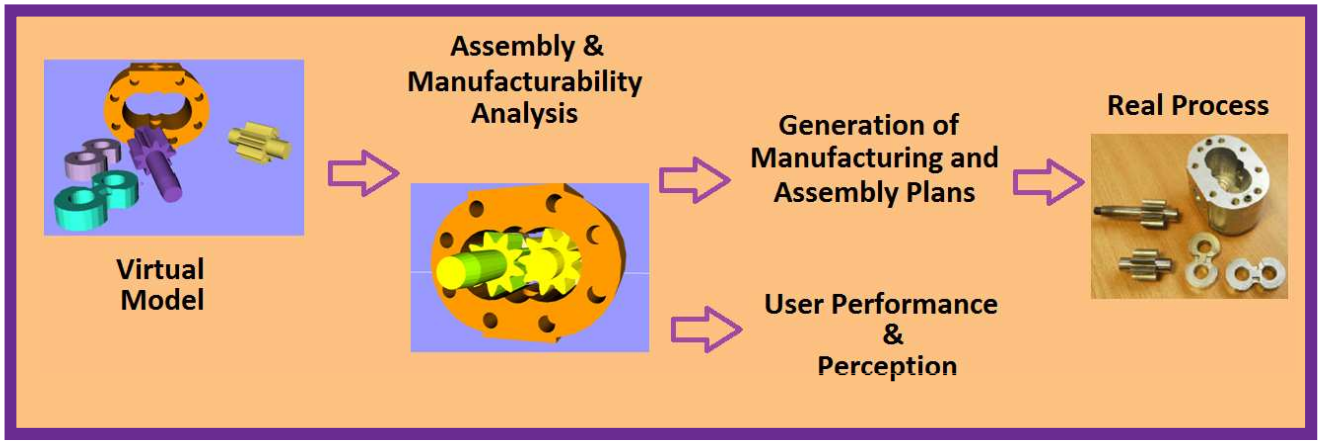
**Germánico Gonzalez Badillo, Hugo Iván Medellin Castillo,**
Universidad Autónoma de San Luis Potosi

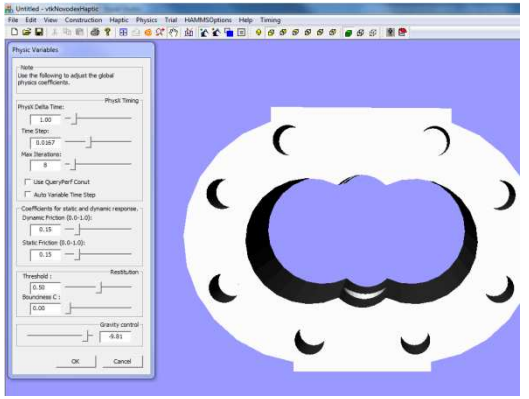
**Theodore Lim,**
Heriot-Watt University

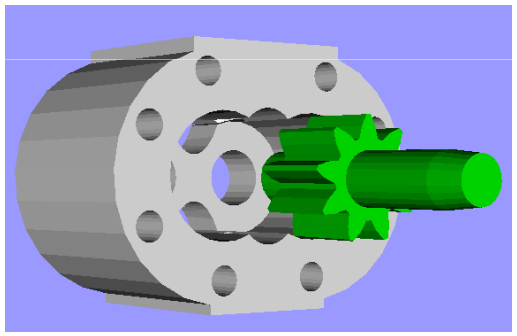
**JWI - Agile Manufacturing Conference**

**8 July 2011**

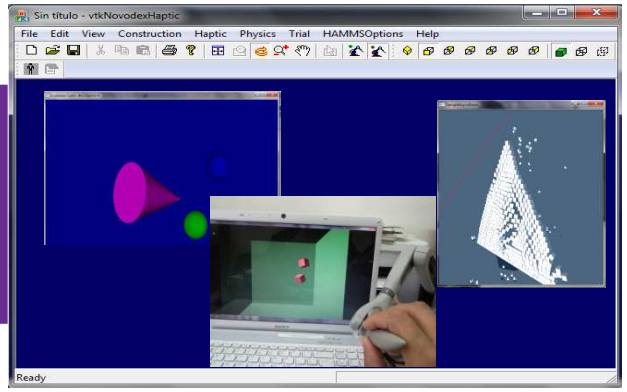
# Haptic Aided Virtual Manufacturing & Assembly Tasks

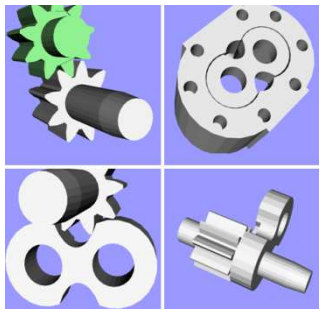


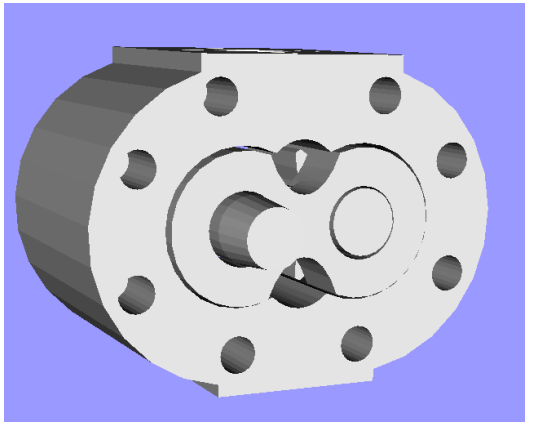





**VTK+**
**PhysX / Bullet+**
**OpenHaptics**





# Development of a virtual platform using haptic devices for Surgical Training

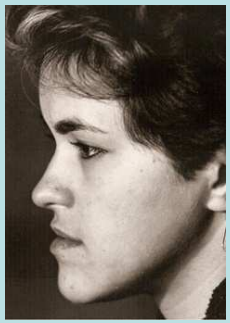
**Eder Govea [1], Hugo Medellin [1], Theodore Lim[2], Raymond Sung[2]**

[1]Universidad Autónoma de San Luis Potosi, [2]Heriot-Watt University

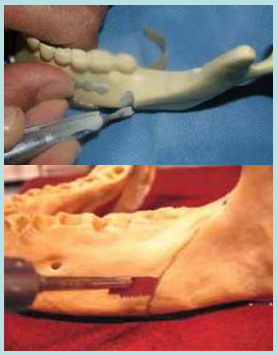
**2011 JWI Conference**

July 8, 2011

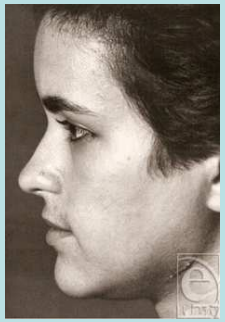
# Development of a virtual platform using haptic devices for Surgical Training



Before



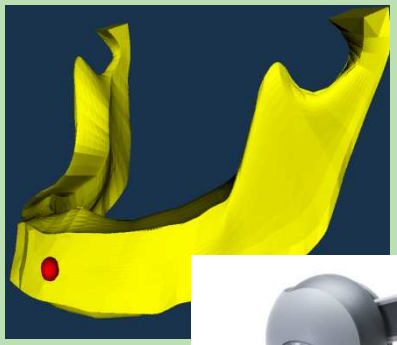
Osteotomy



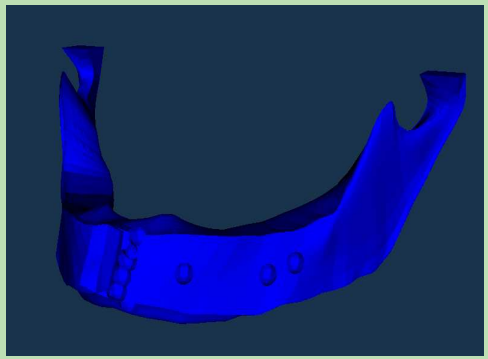
After

Practice = Nice Medic

Patient data



Model 3D & Haptic



Virtual osteotomy for training

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# Texture Browsing Environments

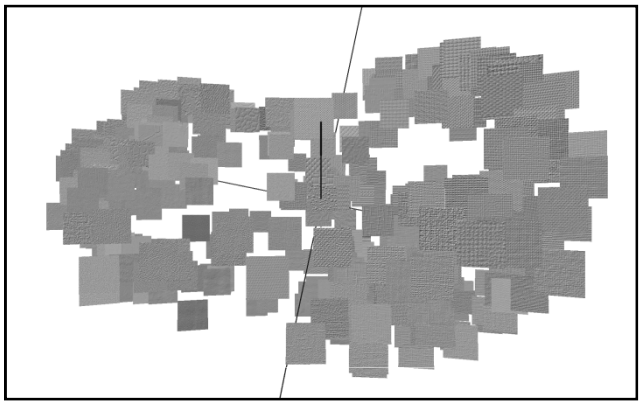
**Fraser Halley**, Texture Lab



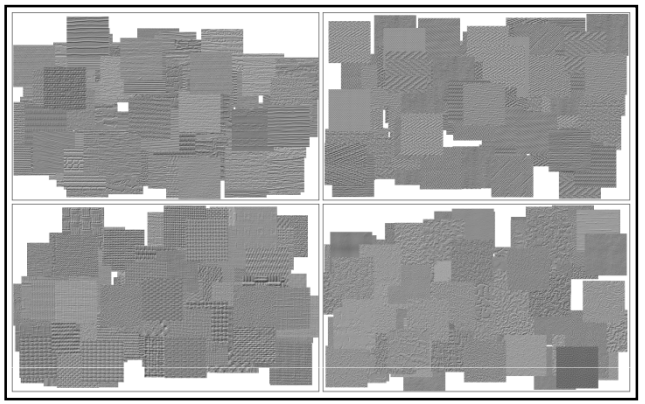
IMRC Innovative Manufacturing Research Centres

EPSRC Engineering and Physical Sciences Research Council

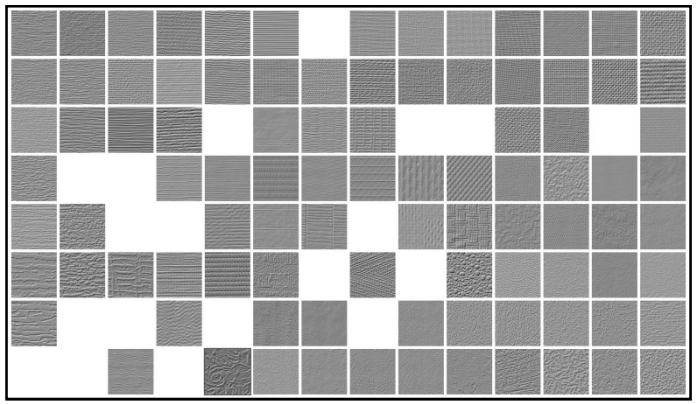
# Texture Browsing Environments



3D MDS



Rapid-Fire Image Preview



SOM Grid

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# Integration of a ns-laser into a 5-Axis Parallel Robot


**Dipl. Ing. (FH) Stephan Kloss**,

Renishaw plc.

**JWI Conference 02011**

08/07/02011



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EPSRC Engineering and Physical Sciences Research Council

# Integration of a ns-laser into a 5-Axis Parallel Robot

## Use Equator as Platform for Laser Material Processing on Free-form Surfaces!

- **Integration of commercially available ns fiber laser into parallel robot:**
  - **λ =1064nm, reprate: 20 - 100kHz, max. Pulse Energy: 500µJ, 1/e²-Ø Beam = 5mm, M² = 1.5, Pulse Length 50ns**
- **Effector optics housing integrated into Equator motion system to allow movement of spot relative to workpiece**
- **Real-time Autofocus control (20 fps) via machine vision**
- **Direct process control of machining process on substrate surface**
- **Machining on Free-form surfaces shown (cylinder, sphere…)**

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# Want to know more?

# Come to my poster.

# Thanks!

**Dipl. Ing. (FH) Stephan Kloss**

Tel: +44 (1453) 52 3654

e-mail: Stephan.Kloss@renishaw.com

# Creative Design of Parallel Manipulators

**Xianwen Kong and Guangbo Hao**, Heriot-Watt University

**James-Watt Institute-Innovative Manufacturing Research Conference**

8 July 2011

# Compliant Parallel Manipulators and Disassembly-free Reconfigurable Parallel Manipulators

**SCARA (serial) manipulator**

**Parallel Manipulator**

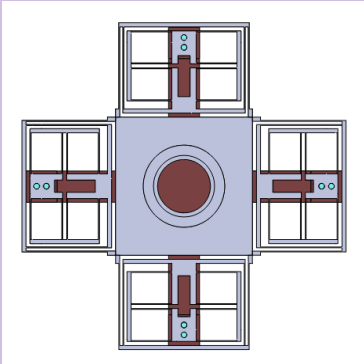
(Based on Kong and Gosselin, US patent, 2006)

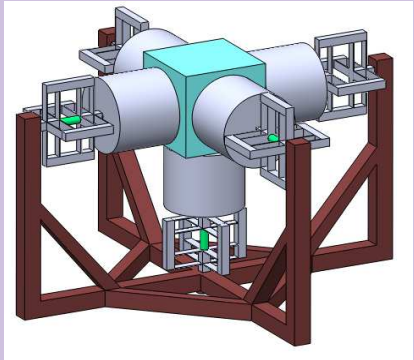
**Characteristics**

* High accuracy
* **…**

**Applications**

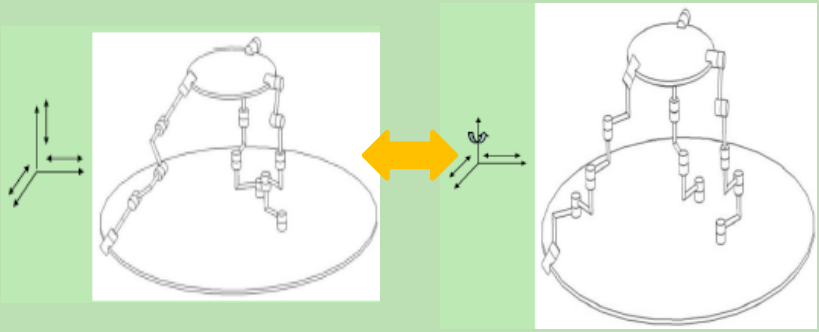
* Assembly robots
* Precision motion stages
* MEMS sensors and actuators





(a) XY decoupled CPM (b) XYZ decoupled CPM

**Compliant parallel manipulators for large range translation**



(a) Translation mode (b) Planar mode

**Disassembly-free reconfigurable parallel manipulator: 3-DOF**

# Real-time Monitoring of Yeast Cell Growth using Microcantilever Sensors

Y. Liu[1,2], L. Schweizer[3], W. Wang[1,2], R.L. Reuben[1,2], M. Schweizer[3] and W. Shu[1,2]

1. Mechanical Engineering, School of Engineering and Physical Sciences, Heriot-Watt University, EH14 4AS
2. Joint Research Institute for Integrated Systems, School of Engineering and Physical Sciences, Heriot-Watt University, EH14, 4AS
3. School of Life Sciences, Heriot-Watt University, EH14 4AS

## Agile Manufacturing

8 July 2011



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# Real-time Monitoring of Yeast Cell Growth using Microcantilever Sensors

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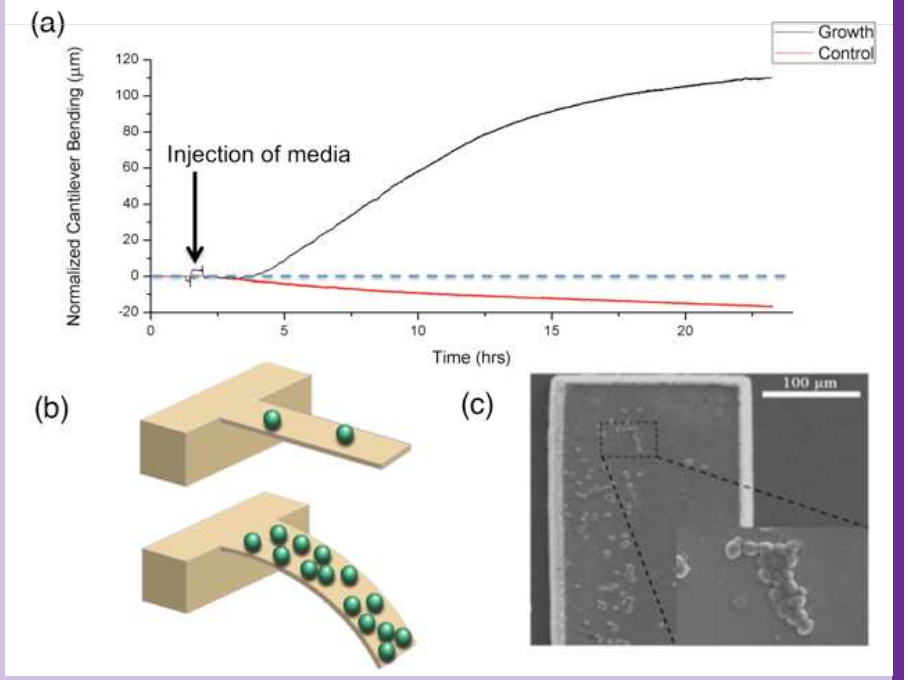
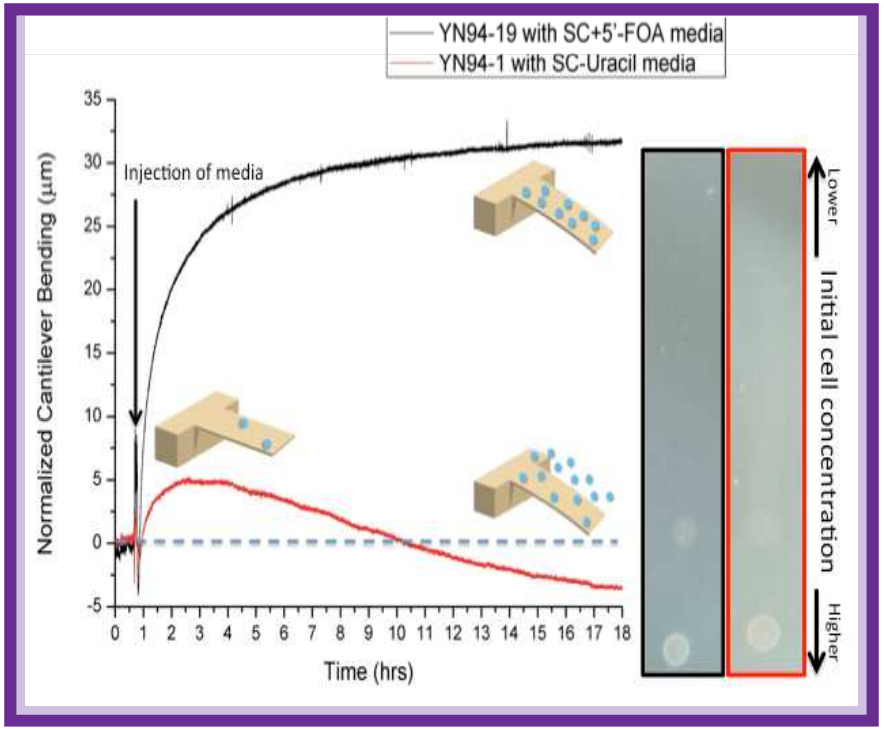
- The ability to monitor precisely cell proliferation is fundamental to many biomedical applications including infectious diseases, drug discovery and testing, and public health applications, such as food and water quality
- Real-time monitoring of *Saccharomyces cerevisiae* cell growth using microcantilever sensors is reported.



# Development of a hybrid micro machining process and its test-bed

**Wenlong Chang, Xichun Luo*, James M Ritchie**,
School of Engineering and Physical Sciences, Heriot-Watt University

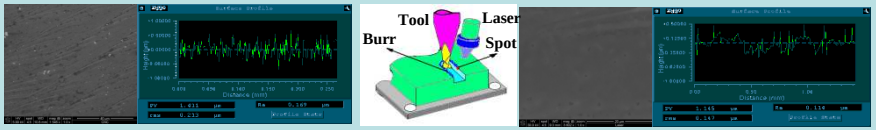
**Event : James Watt Institute - Innovative Manufacturing Research Centre Conference**

Date: July 08, 2011

# Development of a hybrid micro machining process and its test-bed

## Laser assisted micro milling

Micro burrs are generated after micro milling processes because of material plastic deformation. A laser deburring process is developed to remove micro burrs generated by micro milling processes in order to obtain high quality micro fluidic injection mould.

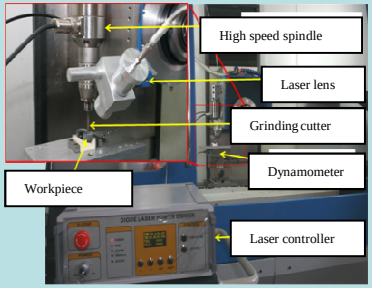



Surface roughness after micromilling

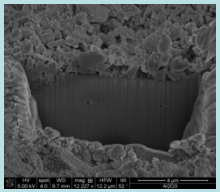
Surface roughness after laser deburring

Laser assisted micro milling

## Laser assisted grinding hard steel




The machined surface roughness was better than solo grinding process and applying coolant. No subsurface damage was observed in the SEM images of cross sections when laser assisted grinding process was used.

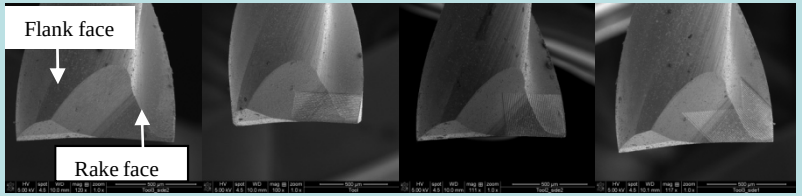


No subsurface damage after laser assisting grinding

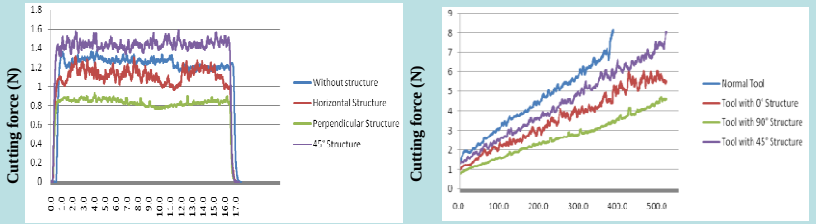
| Surface roughness (Ra) µm | White light interferometer | | | AFM |
|---|---|---|---|---|
| Conventional grinding with coolant | 182.543 | 225.197 | 200.041 | 164.43 |
| Laser assisting grinding with air coolant | 353.432 | 317.939 | 332.425 | 294.32 |
| Laser assisting grinding | 111.546 | 173.448 | 134.776 | 112.85 |

## On-line structuring micro milling cutters

Laser machining milling cutter is an approach which can repair milling cutters or fabricate micro structures on the rake face of cutters in order to defer tool wear.



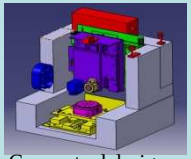

Normal milling cutter & three types of microstuctured cutters



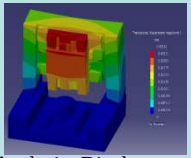

Cutting forces when using the four milling cutters

## Conceptual design & analysis

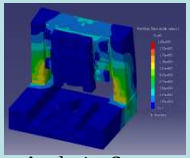
In the conceptual design stage, several machine structures have been propose to accommodate the hybrid machining process. Finite element analysis is used to model the deformation and stress under gravity and calculate the natural frequency of the proposed hybrid machining centre.



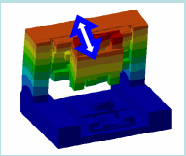
Conceptual design



Analysis- Displacement



Analysis- Stress



Analysis- Frequency

# Advanced Micro-machining of an Optical Fibre Cantilever Sensor

J.Li, F. Albri, J.N. Su, R.R.J. Maier, W.N. MacPherson and D.P. Hand

**JWI - Innovative Manufacturing Research Centre Conference**

08/07/2011

# Advanced Micro-machining of an Optical Fibre Cantilever Sensor

Micro Cantilevers are multi purpose sensing elements

They can be used for sensing of

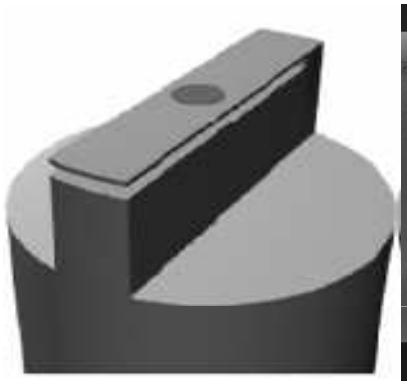
- ❖ Bio – molecules
- ❖ Acceleration, motion, orientation  etc…..

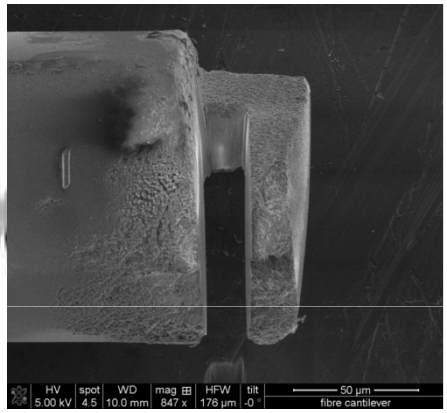
Previous work used costly and time consuming focussed ion beam machining [FIB]

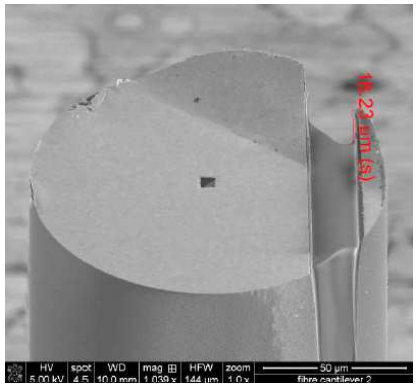
Here we demonstrate the benefits of combining

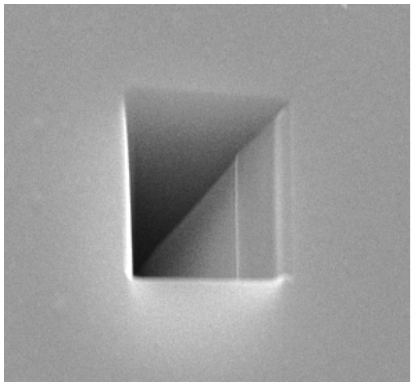
- ❖ Highly efficient ps-laser machining
  with
- ❖ FIB to generate sensing elements

manufactured onto the end of an optical fibre





# Does Highlight Disparity Improve Perception of Gloss on Rough Surfaces?

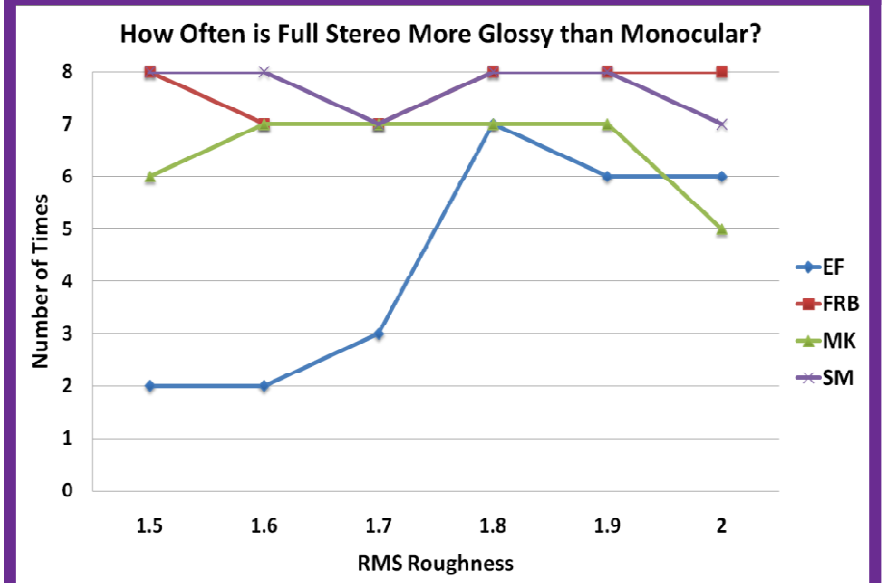
**Thomas S Methven, Prof Mike Chantler**, Texture Lab

**JWI - Innovative Manufacturing Research Centre Conference**

08/07/2011

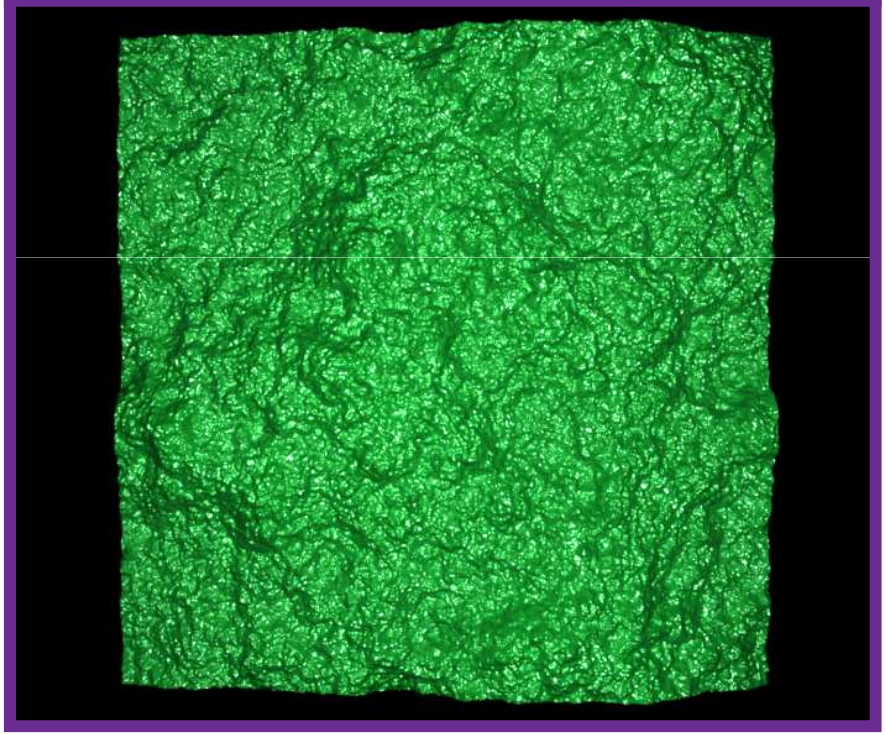
# Does Highlight Disparity Improve Perception of Gloss on Rough Surfaces?

## Pilot Study Results




- What previous work has been done?
- Why are we doing this work?
- What did we find in our pilot study?

## Rough, Glossy Surfaces



# $CO_2$ laser based rapid prototyping of autonomous microfluidic systems

*Dr Mazher-Iqbal Mohammed and Professor Marc P.Y. Desmulliez*

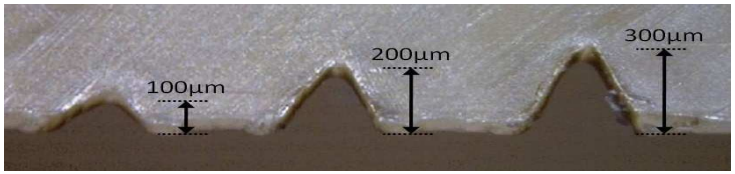
*Microsystems Engineering Centre (MISEC), School of EPS*

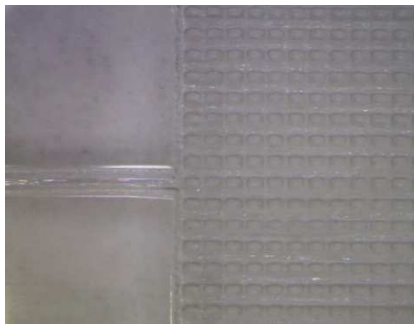
**James Watt Institute for High Value Manufacturing (JWI)**

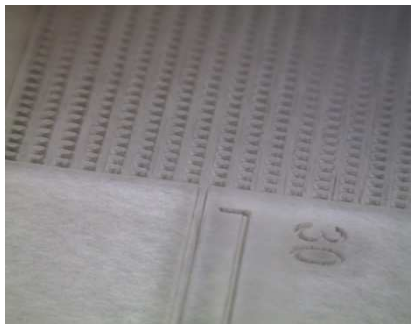
8th July 2011

# $CO_2$ Laser Rapid Prototyping

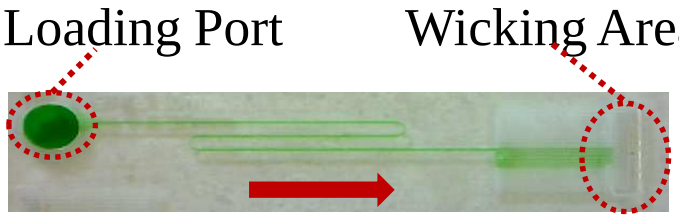
## Manufacturing

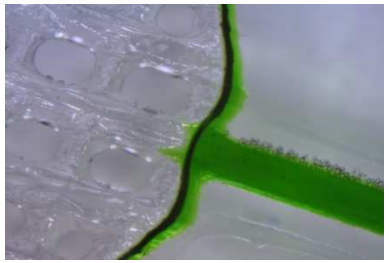


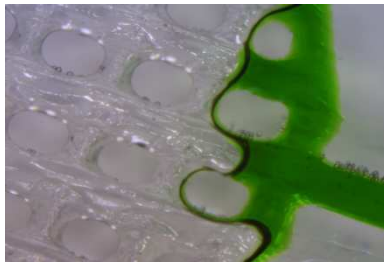





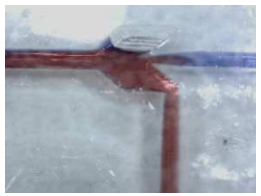
## Autonomous Capillary Systems

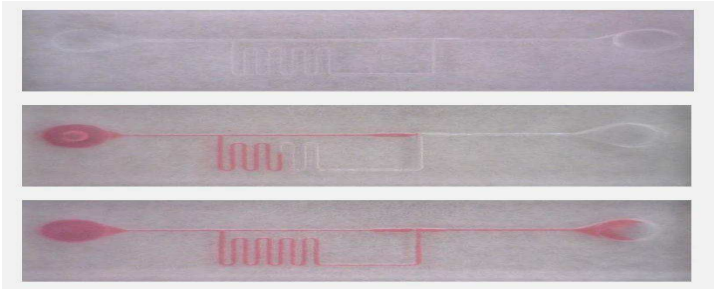




## Surface Tension Flow Control





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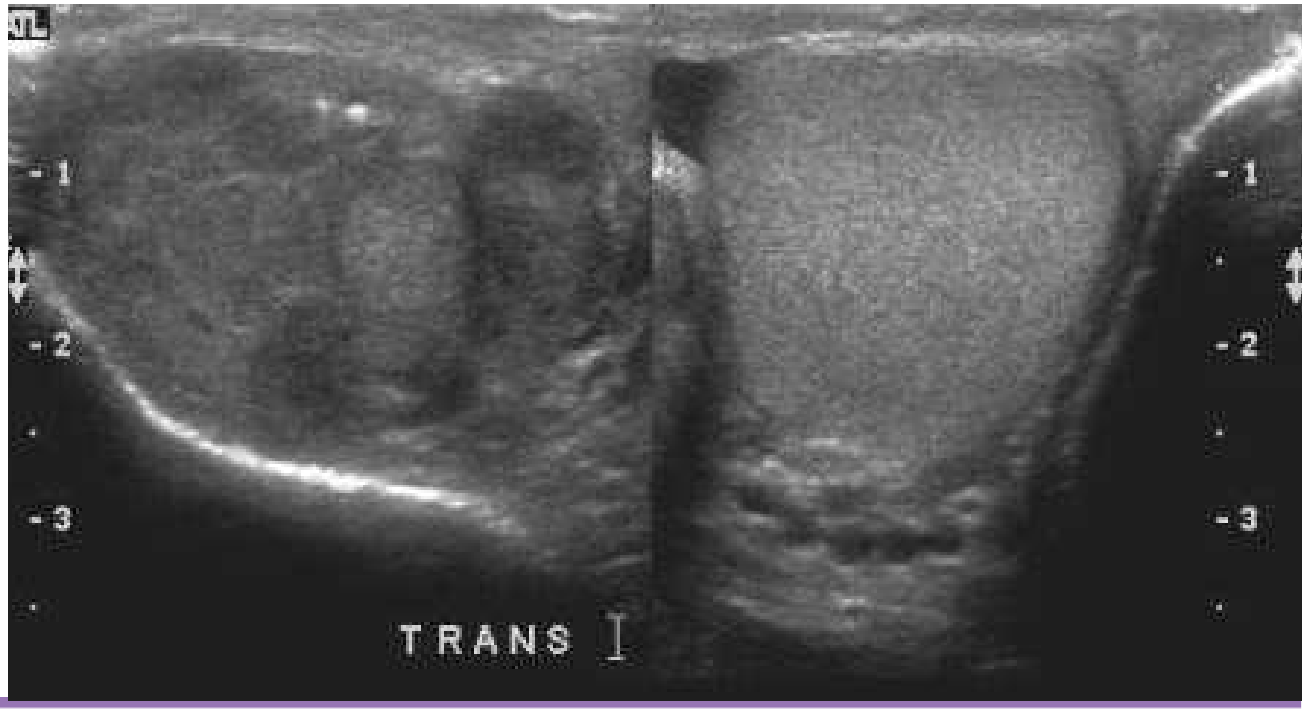
MIcroSystems Engineering Centre @ HERIOT WATT UNIVERSITY

UNIVERSITY OF DUNDEE

# Design, manufacturing and packaging of a micro ultrasonic transducer for medical application

**Jack Hoyd-Gigg Ng *et al.***



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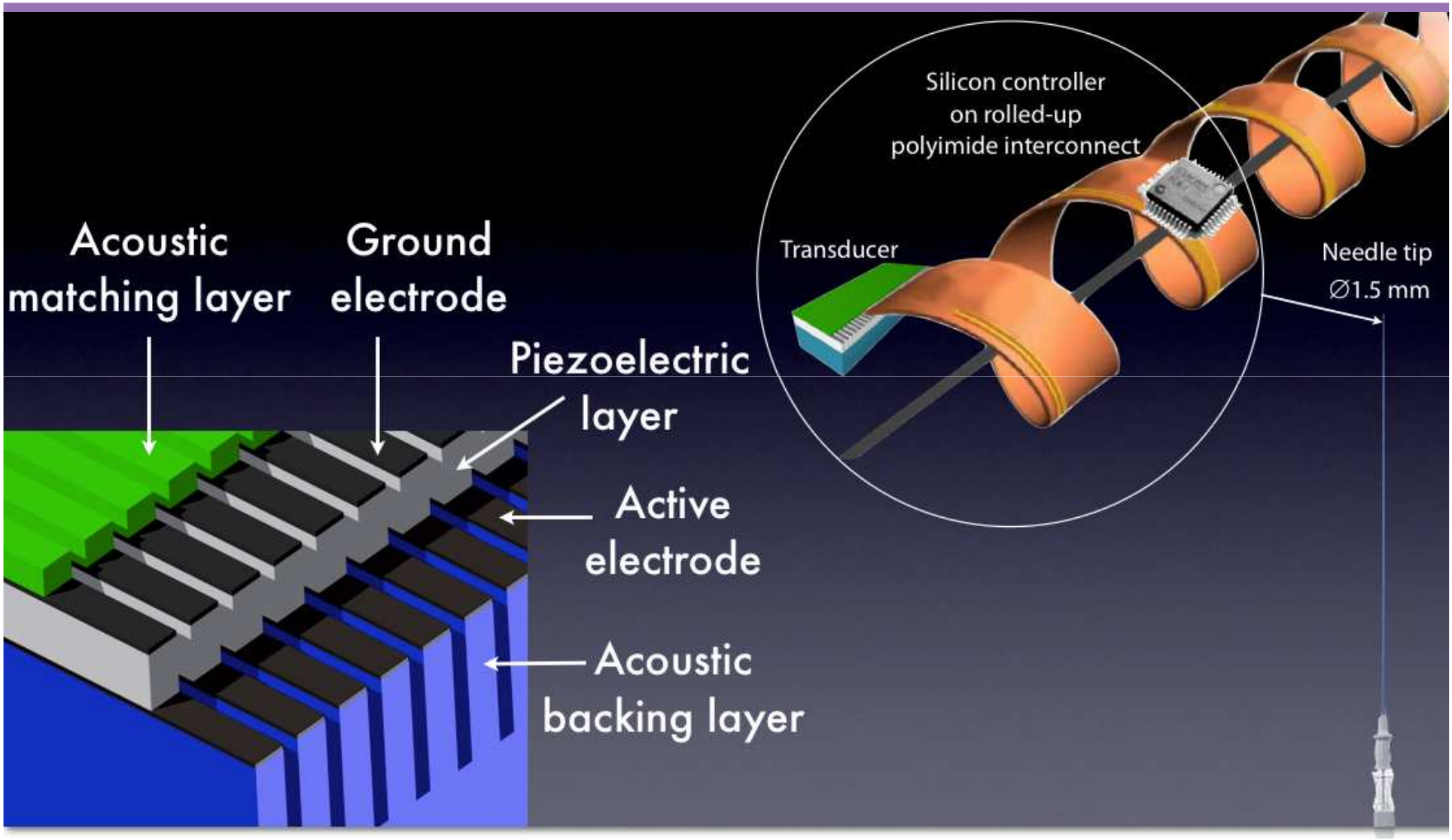
# Ultrasound in a needle



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# Interactivity to Enhance Perception:

Increased interactivity in mobile visual presentation tools facilitates more accurate rating of textile properties.


authors:

Pawel M. Orzechowski, Douglas Atkinson,
Dr Stefano Padilla, Dr Sharon Baurley,
Prof Mike Chantler





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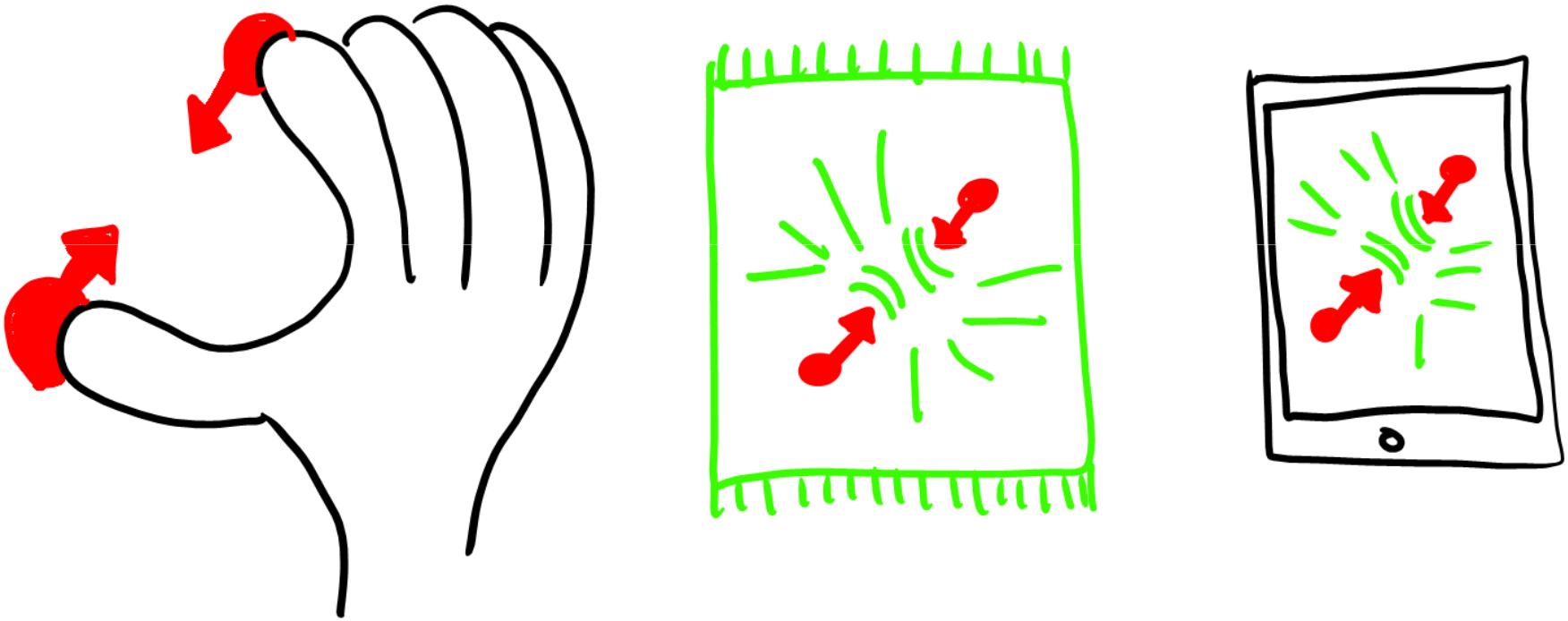
# Interactivity to Enhance Perception



# Are single still images sufficient to communicate qualities of texture-rich products?

**Dr. Stefano Padilla,** Heriot-Watt University

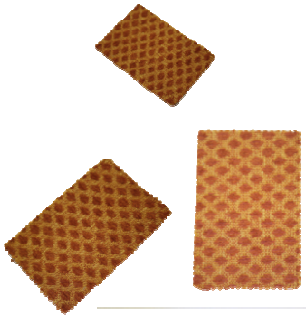
**James Watt Institute - Innovative Manufacturing Research Centre Conference 2011**
Friday 8 July 2011

# Are single still images sufficient to communicate qualities of texture-rich products?



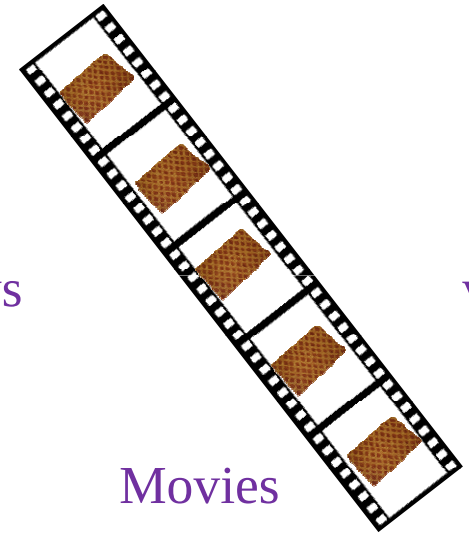
Real

vs



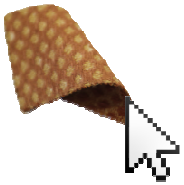
Multiple View

vs



Movies

vs



Interactive

# Title of Talk: Open-Ended Single Mode Resonant Microwave Applicator for Electronic Chip Packaging Applications

**Authors**, Affiliation: S.K. Pavuluri *etal*

MIcrosystems Engineering Centre (MISEC), School of Engineering and Physical Sciences,

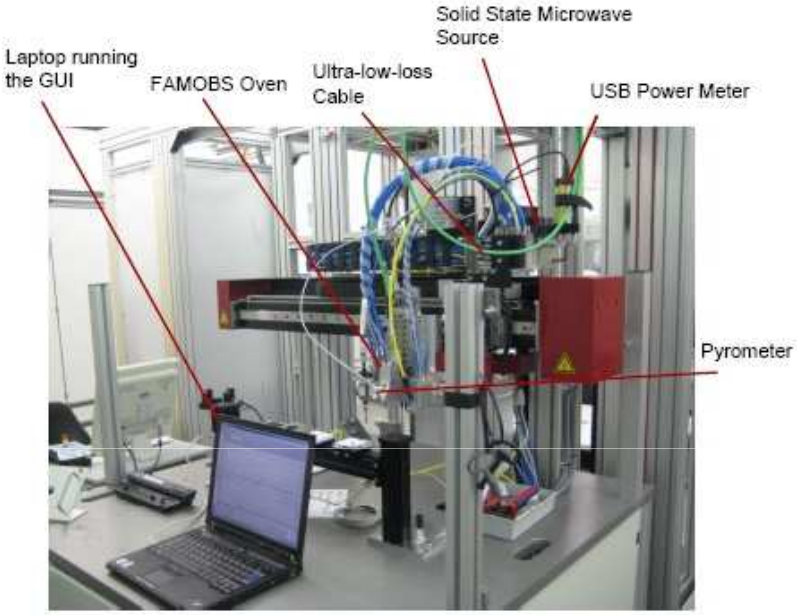
Heriot-Watt University, Edinburgh EH14 4AS, Scotland, United Kingdom

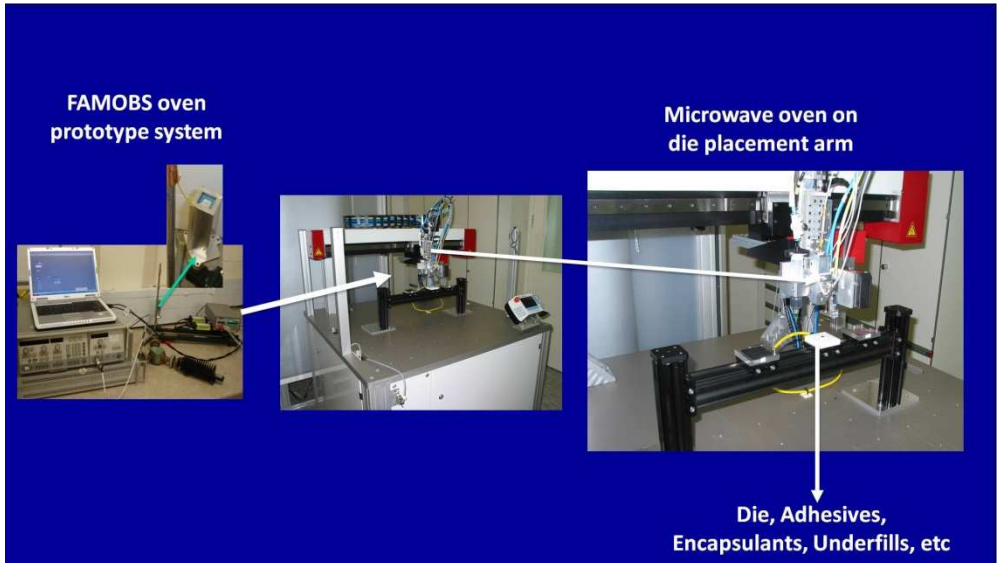
Tel: +44 (0)131-451-3774, E-mail: M.Desmulliez@hw.ac.uk

**Event: Innovative Manufacturing Research Centre Conference 2011**

Date: Friday 8 July 2011

# Open-Ended Microwave Applicator Integration




- Open ended microwave applicator designed
- Integrated with a pick and placement machine
- Achieves faster curing of encapsulant materials for packaging electronic chips in QFN packages
- Uses 1 W of microwave power for QFN packages of 8 mm * 8 mm dimensions and is thus green technology

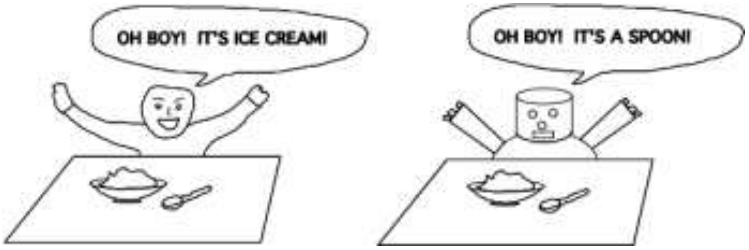
# How Mesoscale and Microscale Roughness Affect Perceived Gloss

**Lin Qi**, Heriot-Watt University, UK
**Mike J. Chantler**, Heriot-Watt University, UK
**J. Paul Siebert**, University of Glasgow, UK
**Junyu Dong**, Ocean University of China, China

**Agile Manufacturing Conference**

July 08, 2011

# Peicerved Gloss on Rough Surfaces

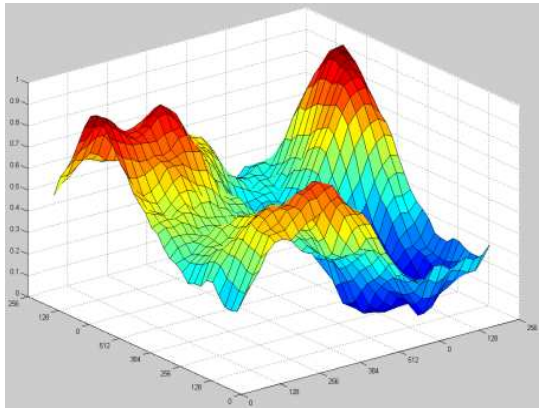



People are good at recognizing materials, while computers are not yet. (Adelson2001)

Material perception is from surface reflections. (Fleming2003)

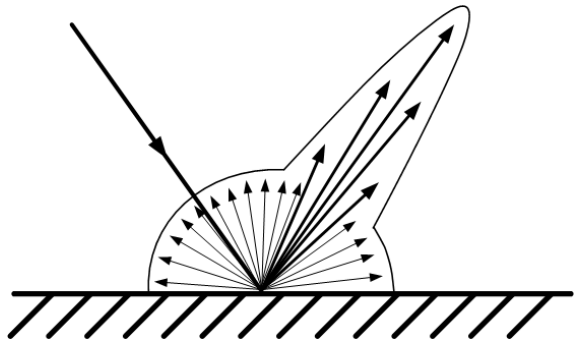
But how people perceive gloss on rough surfaces?

**MESOSCALE roughness**



$1/f^{\beta}$ noise surfaces with different mesoscale roughness levels

**MICROSCALE roughness**



Reflection models with different microscale roughness levels

# High-Energy Yb:KYW Ultrafast Laser

**C.Y. Ramirez Corral*, C.G. Leburn and D.T. Reid**,

Heriot-Watt University

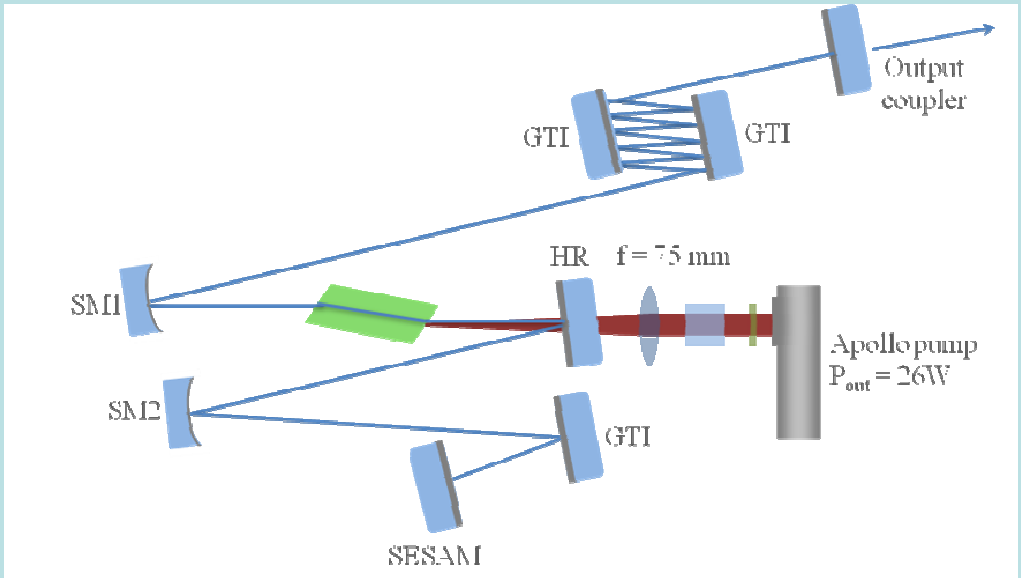
**JWI - Innovative Manufacturing Research Centre Conference**

8th july 2011

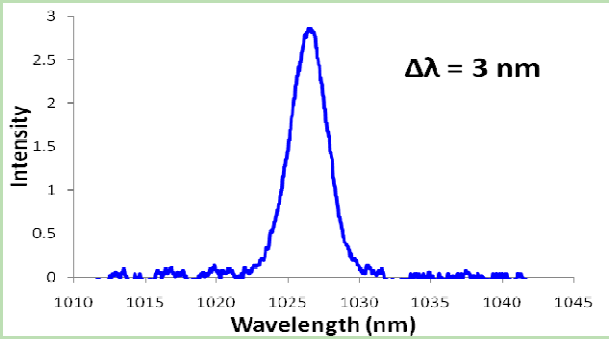
# High-Energy Yb:KYW Ultrafast Laser

**Yb:KYW laser oscillator operating at 4 W output power, 500 fs pulse duration, beam quality $M^2$ = 1.12, 53 MHz repetition rate, and time-bandwidth product of 0.39**

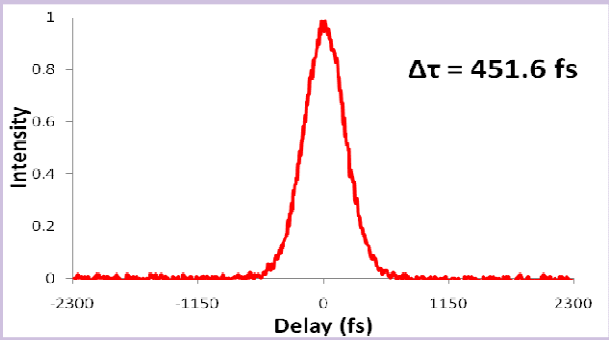
## Laser geometry




## Spectral bandwidth




## Pulse duration



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# Facial Emotions and Design Environments

**A.Sivanathan**

**Event:** Agile Manufacturing Conference

Date: Friday 8 July 2011



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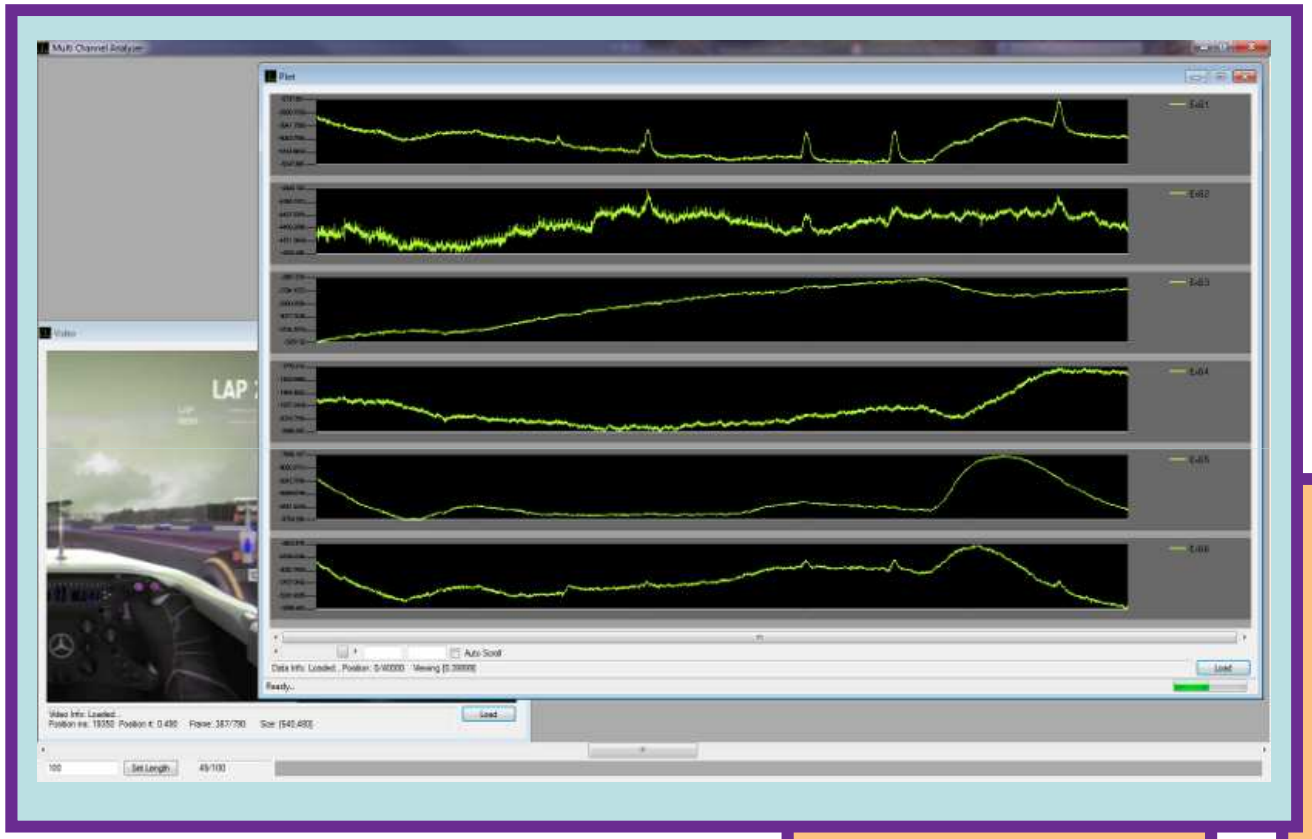
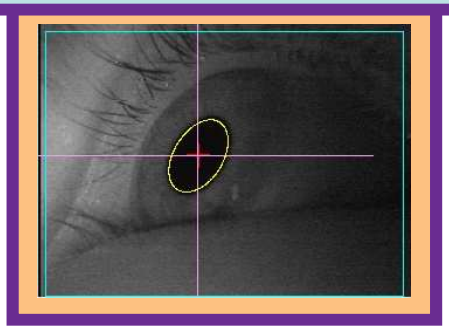
# Facial Emotions and Design Environments





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# Haptic Soldering & Knowledge Capture

**Raymond Sung**, Department of Mechanical Engineering, EPS

**JWI Conference – Agile Manufacturing**

July 8th 2011



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# Haptic Soldering & Knowledge Capture

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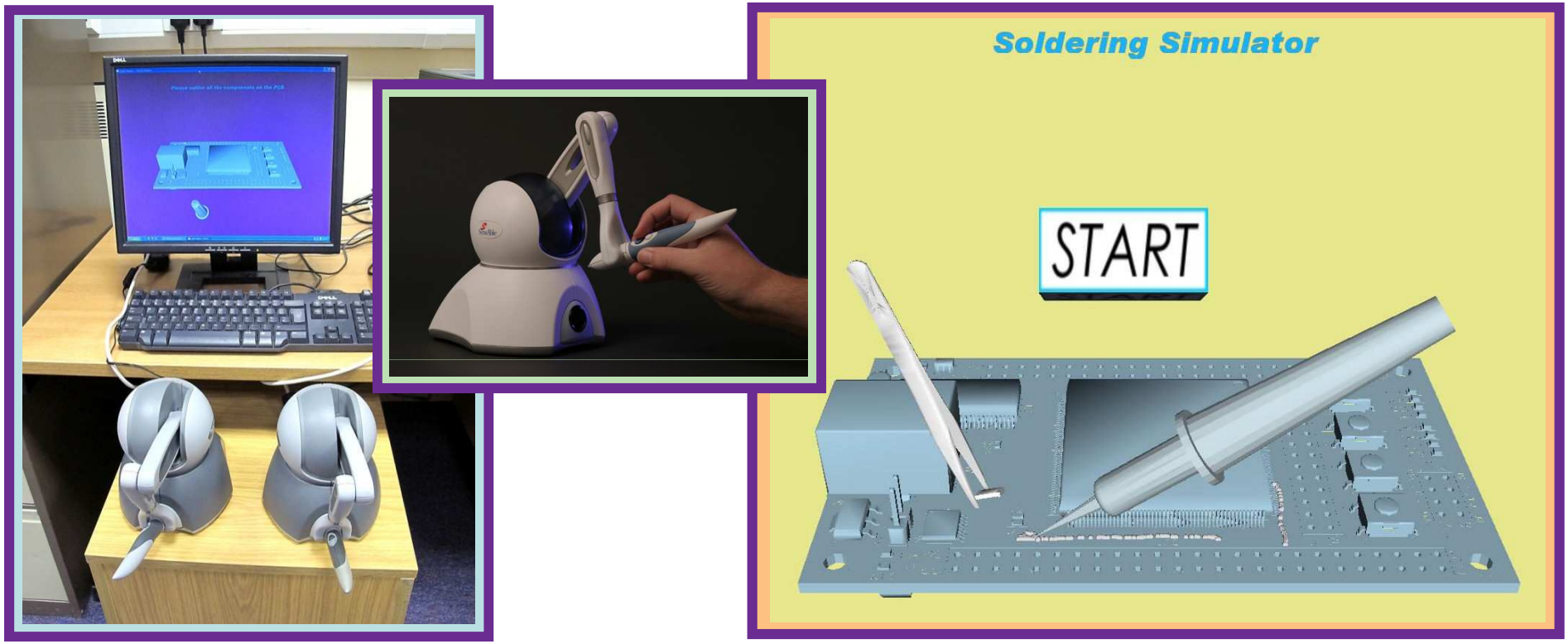



- Simulation of soldering process using haptics
- Capture & representation of soldering knowledge
- Tool to train new users

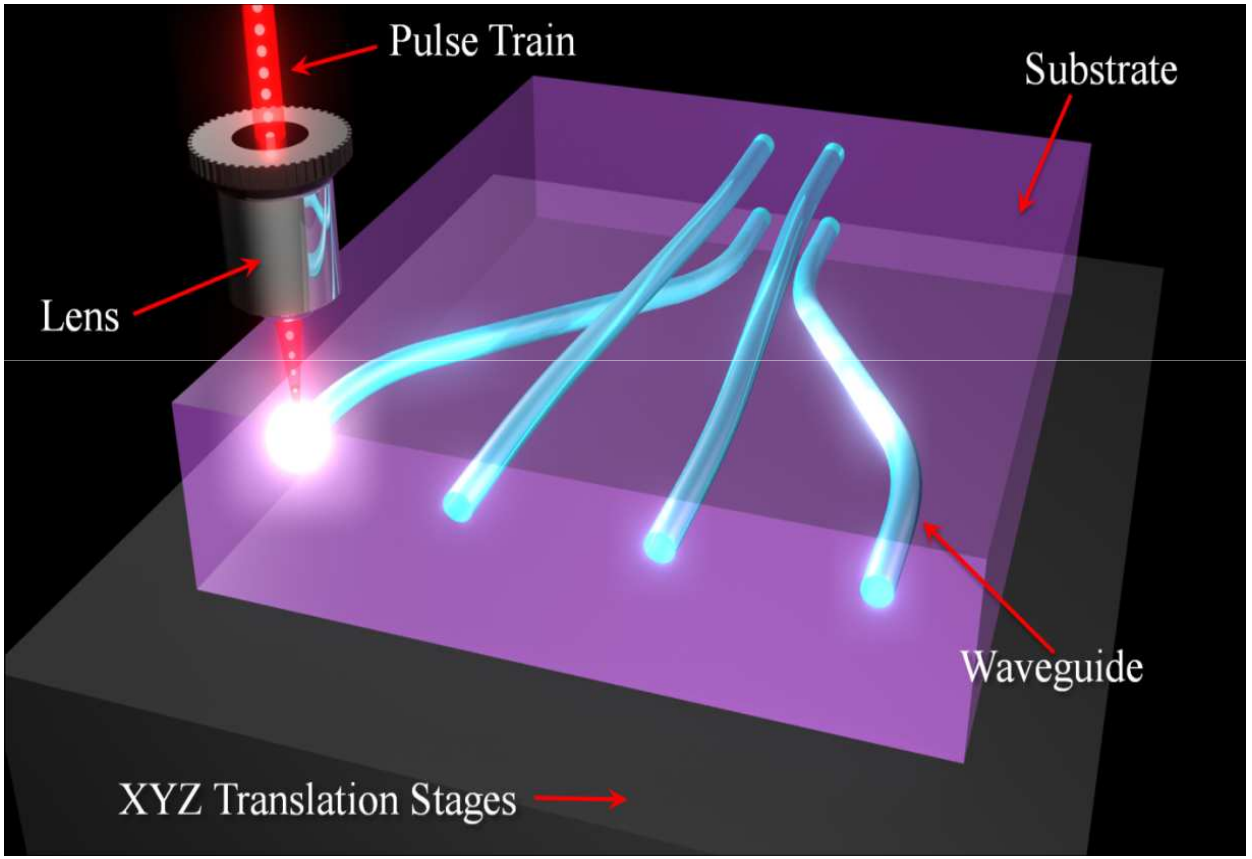
# 3D microfabrication using ultrafast lasers

**Academics involved:**

**R. R. Thomson, L. Paterson, D. T. Reid and A. K. Kar**

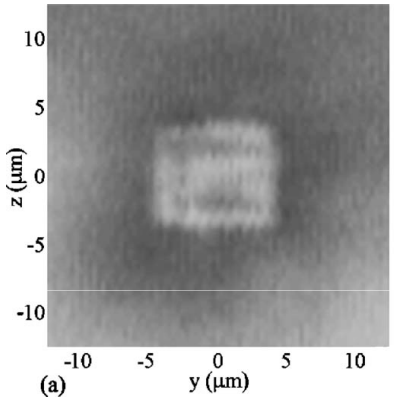
Heriot Watt University - Edinburgh

# 3D microfabrication using ultrafast lasers

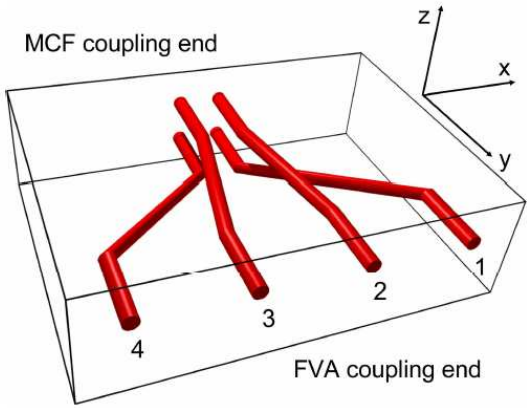



Sketch of the ultrafast laser inscription process

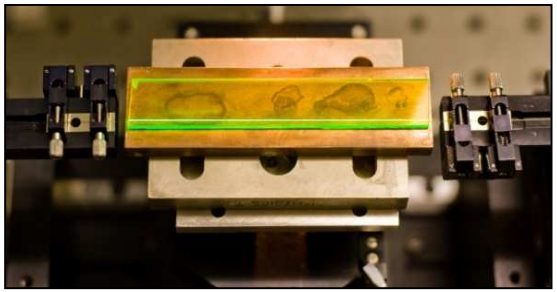
# 3D microfabrication using ultrafast lasers



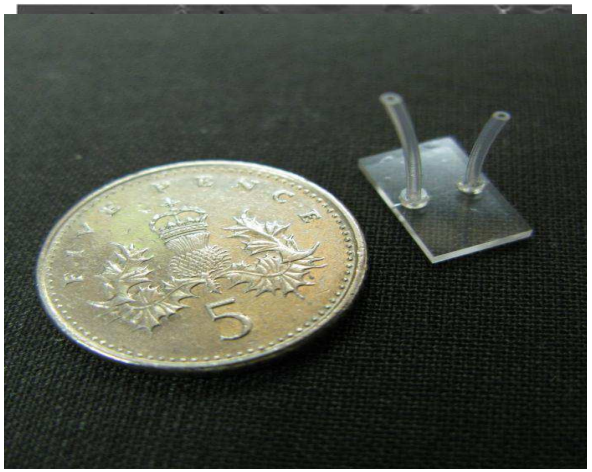

Psaila et al,
*Appl. Phys. Lett*. **90**, 131102 (2007)




Thomson et al,
*Opt. Express* **15**, 11691 (2007)



Thomson et al, *Opt. Express* **18**, 13212 (2010)



Cheng et. al., *Appl. Phys. A.* **85**, 11 (2006)

# Additive Direct Writing Based Process for Metallisation of Polyimide

**David Watson and Professor Marc P.Y. Desmulliez**

Microsystems Engineering Centre (MISEC), School of EPS

Heriot-Watt University

**JWI Conference – Agile Manufacturing**

July 8th 2011

# Additive Direct Writing Based Process for Metallisation of Polyimide

James Watt Institute *for* High Value Manufacturing

MISEC

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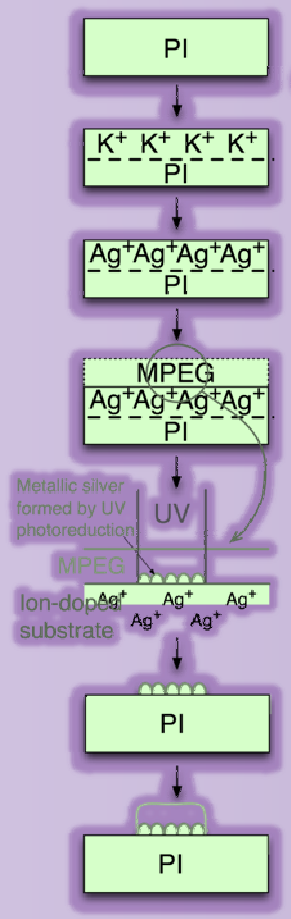
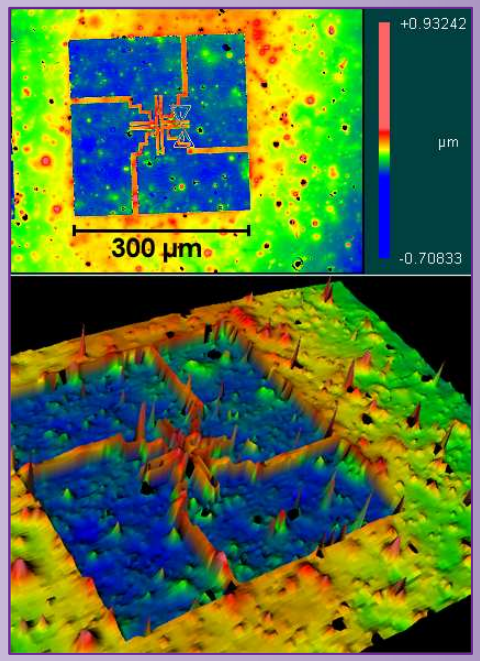
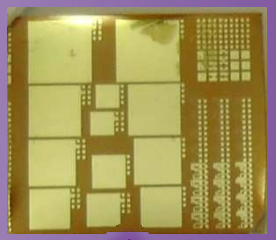
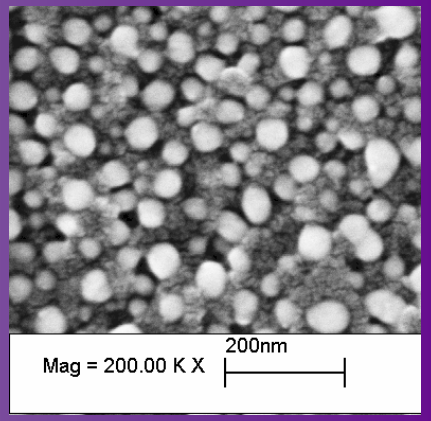
## Simple 6 step process!

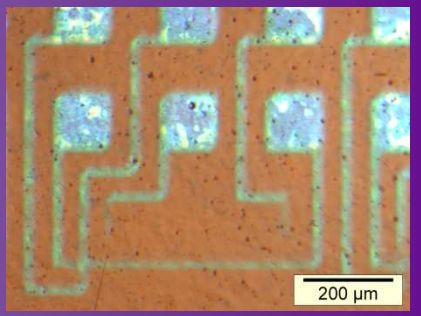





## Mindblowing results!




**David Ewan Watson,** Heriot Watt University



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