2-Minute-2-Slide Quick-Fire Project Introductions

Second and Third Year CDT Students
Running Order

- Giampaolo Ariu
- Laura Beckett
- Manu Mulakkal
- Qing Ai
- Jamie Hartley
- Xun Wu
- Evangelos Zympeloudis
The Development of Embedded Vascular Networks in FRP as Active/Passive Thermal Management Tools for Cure Processing

Giampaolo Ariu

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Ian Bond, Richard Trask, Carwyn Ward and Yusuf Mahadik
Project Outline

Aims

- Alternative cure process for thick FRPs.
- Time and cost efficiency.
- Exotherm and cure cycle control.

Experimental

- Proof-of-concept demonstrator.
- Thermal monitoring in-mould silicone oil (silicone oil through pultruded carbon fibre tube).

Numerical (ABAQUS)

- Heat transfer within in-mould silicone oil.
- Cure prediction of randomly distributed composite.
Results

Experimental
• Ramp rates comparable with oven (2 °C min⁻¹; heat losses).

<table>
<thead>
<tr>
<th>Silicone flow rate [m³ s⁻¹]</th>
<th>$T_{max}$ model [°C]</th>
<th>$T_{max}$ setup [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>4×10⁻⁷</td>
<td>29.45</td>
<td>47.5</td>
</tr>
<tr>
<td>5×10⁻⁷</td>
<td>29.85</td>
<td>47.9</td>
</tr>
<tr>
<td>7×10⁻⁷</td>
<td>30.45</td>
<td>46.8</td>
</tr>
</tbody>
</table>

Numerical
• Potential cure time reduction with higher flow rates and provided temperature (2D simplification).

Detailed Model + Experimental Setup Optimisation = Cure of Actual Composite Part
Hierarchical Complex Fibrous Architecture for Additive Layer Manufacturing

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Wuge Briscoe, Richard Trask
• Discontinuous fibrous reinforcement in natural materials (e.g. bone) achieves excellent mechanical properties.

• Use zinc oxide (ZnO) nanorods to produce hierarchical glass fibres under mild reaction conditions.

Gupta, H. S. et al. 2006
Results

- Tuneable, repeatable ZnO coverage.

- No decrease in tensile strength compared with base fibre.

Future Work - investigate effect of rods on interfacial properties.
Programmable Deployment of Origami Architectures

Manu Charles Mulakkal
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Supervisors: Dr Richard Trask (ACCIS), Dr Annela Seddon (NSQI), Dr George Whittel (Chemistry) and Prof Ian Manners (Chemistry)
Inspiration

1. Zhong You and Kaori Kuribayashi-Shigetomi
2. Nuclear Spectroscopic Telescope Array
3. Etienne Cliquet, Flotilla

Mimosa paudica

Heart stent

10 m deployable mast – NuSTAR

Flotilla
Research findings

- Porosity
- Surface free energy
- Surfactant concentration
- Temperature
- Water retention
- Hornification

Controlled by hydration and Hydrogen bonds

Towards Reversible Deployment

Using thermo-responsive polymers grafted via ATRP

Hydrophilic

Above 32°C

Hydrophobic

Paper fibres before and after polymer grafting
Analytical model of a morphing trailing edge using variable stiffness materials

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Prof. Paul Weaver

Dr. Mahdi Azarpeyvand
A novel morphing trailing edge is proposed for airfoil noise control purposes:

- a composite upper skin
- a silicone lower skin
- a bending stiffness tailored core

Advantages of the novel morphing flap design:

- reducing actuation requirement
- enabling morphing profile tailoring
- enhanced airfoil aerodynamic and noise performance
Model:

Model: a layer-wise sandwich beam model:

- tapered beam geometry
- material stiffness variation in the core
- three beam state variables
- the Ritz method
- the minimum total potential energy principle

Future work:

- Parametric studies and optimization design of the morphing trailing edge
- Demonstrator construction
Crash Simulation of Tufted Sandwich Components for Automotive Applications

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James Kratz, Carwyn Ward and Ivana Partridge

www.bris.ac.uk/composites
Automotive Composites

- Current Roadblocks:
  - Cost
  - Recyclability
  - SAFETY

- Side impact a critical design case.

- Need to be able to protect occupants, and avoid damage to battery.

- Tufted sandwich structures are a potential solution to this problem.
XP Project Work

- Aimed to understand behaviour of tufts within sandwich structures.
- Edgewise Compression of miniature, single tuft samples.

- Variation of tufting parameters and manufacturing results.
- Consistent experimental results validate process.
- No clear effect of varying tuft conditions at this stage.

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XP Project Work

- Aimed to understand behaviour of tufts within sandwich structures.
- Edgewise Compression of miniature, single tuft samples.

**Example Test Results**

<table>
<thead>
<tr>
<th>Load (N)</th>
<th>Displacement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Section</td>
<td></td>
</tr>
</tbody>
</table>

**Comparison of Stitching and Tufting processes [1]**

- Variation of tufting parameters and manufacturing results.
- Consistent experimental results validate process.
- No clear effect of varying tuft conditions at this stage.

Investigating the Feasibility of Through-thickness Tufting with Discontinuous Carbon Fibre Scraps

Xun Wu*

James Kratz, Carwyn Ward and Ivana Partridge

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Introductions

- 40 – 60% scrap volume resulted from automotive manufacturing.
- Incorporating through-thickness tufting with simplified overlap layup.
- Resin infusion process + four point bending flexural testing.

(a) Tufted on ply-drop overlap design
(b) Tufted on half-tiled overlap design
Key Results

Tufted Properties change (%)

- Strength: 4.4, 5.4, 0.2
- Modulus: -2.7, 4.0, -19.9
- Elastic strain: -11.7, -9.0
- Failure strain: 36.7, 42.0
- Energy Absorption: 3000, 1000

(a) Tufted ply-drop overlap design
(b) Tufted half-tiled overlap design
Automated High-Volume Production of Complex Composite Parts: CMTS
(Continuous Multi-Tow Shearing)

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Kevin Potter, Paul M. Weaver, B.C. Eric Kim

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Continuous Multi-Tow Shearing (CMTS)

• Tow steering:
  – Production of Variable Angle Tow Laminates.
  – Lay-up in complex doubly curved moulds.

• CMTS:
  – Material width does not affect steering capabilities.
  – High production volumes and high shape complexity can be achieved.

[1] P.M. Weaver et al, Buckling Of Variable Angle Tow Plates: From Concept To Experiment
Prototype Development

Steering Radius: 200mm
Max. shear angle: 30 deg

400 mm

CMTS (Continuous Multi-Tow Shearing)
E Zympeloudis, K Potter, BC Eric Kim, ACCIS, University of Bristol
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