Induction heating with carbon nanotube fibres

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INTRODUCTION

Carbon nanotube (CNT) fibres can exhibit high electrical and thermal conductivity within a macroscopic continuous structure. This work describes the use of CNT fibre as heating element for induction heating of both thermostet and thermoplastic composite materials.

RESEARCH QUESTIONS

• Can CNT fibre be used as susceptors for induction heating of thermostet and thermoplastic materials?
• How do CNT fibres affect the mechanical properties of the bonded joints?

MATERIALS AND METHODS

• CNT fibre properties:

<table>
<thead>
<tr>
<th></th>
<th>Diameter (μm)</th>
<th>Density (μg/cm²)</th>
<th>Conductivity (W/m-K)</th>
<th>Number of fibres in the thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread 1</td>
<td>112</td>
<td>1.3</td>
<td>2.2</td>
<td>3</td>
</tr>
<tr>
<td>Thread 2</td>
<td>157</td>
<td>1.3</td>
<td>2.1</td>
<td>6</td>
</tr>
</tbody>
</table>

• Thermoplastic material was glass fibre reinforced PPS coupons (Tgs = 280°C)
• Thermostet material was a two part epoxy resin (EC-9323-2 B/A) used to bond two GFRP coupons (bond layer of 300 μm, cure cycle of 71 minutes at 80°C)
• Dimensions of single lap shear (SLS) samples (ASTM norm 5368):

• Induction heating set-up:

INDUCTION CURING

• Oven cured samples as reference (cure cycle of 71 minutes at 80°C)
• Circuit junction made with silver loaded paste to improve junction electrical conductivity
• Use of rectangular CNT fibre circuit, entirely coated with silver paste to allow a better homogenous heating within the overlap area:

INDUCTION WELDING

• Metal mesh used as reference samples
• Four different CNT fibre based heating element (HE) configurations:

• Lap shear strengths for the different configurations and examples of fracture surfaces:

CONCLUSIONS

• Induction curing of epoxy paste adhesive with CNT fibre is a promising alternative for oven curing.
• For induction welding, hot spot development could be explained by the change of geometry/property of the CNT fibre upon heating.
• However, the proof of concept of welding GF-PPS with CNT fibre was established and the quality of the partial weld was promising.
• Further investigations should be performed in order to understand the hot spot formation along the CNT fibre.