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By

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THERMAL AND MECHANICAL PROPERTIES OF INJECTION MOULDED SHORT GLASS/SHORT CARBON HYBRID FIBRE REINFORCED POLYAMIDE 6,6 COMPOSITES

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Introduction

Hybrid fibres – to modify / tailor made the properties to suit certain application

Glass – impact properties

Carbon – tensile properties
Introduction

- Polyamide – hygroscopic, absorb moisture up to 2.5% w/w

Hybridisation

- Plasticisation – affect properties
Objectives

To study the effect of:-

• Hybridisation
• Conditioning
Materials

- Pre-compounded short carbon fibre polyamide 6,6 composites (SC), $V_f = 0.33$
- Pre-compounded short glass fibre polyamide 6,6 composites (SG), $V_f = 0.18$
Experimental

- Pre-compounded composites – physical blended, 0/100, 25/75, 50/50, 75/25 and 100/0 (SG/SC w/w %)

- Injection moulded – Boy 55 tonne injection moulding machine, single gated four cavities, two impacts and two tensile test bars
Experimental

Specimens conditioning:-

- Dry as moulded
- 50% RH
- Wet

TGA, Hot stage, ESC, Perkin Elmer, 10°C/min

DMA – Q800 TAI, three point bending, 3°C/min
Experimental

• TGA – Perkin Elmer, 10°C/min

• DSC – Hyper DSC, Perkin Elmer, 10°C/min

• DMA – Q800 TAI, three point bending, 3°C/min
Experimental

• Tensile – Instron 5569, 10 mm/min

• Impact – Instron Dynatup 9210, charpy, notched ($a/D = 0.1, 0.2, 0.3, 0.4$)
Figure 1: TGA thermographs of glass/carbon hybrid fibre composite (SG50/SC50) under different conditions
Figure 2: DSC results of hybrid fibre composites with different carbon fibre content under dry condition
Figure 3: DSC results of hybrid fibre composites with different carbon fibre content under wet condition
Table 1: Thermal properties of hybrid composite at various conditions

<table>
<thead>
<tr>
<th>Sample</th>
<th>Glass/Carbon</th>
<th>$T_m$ (°C)</th>
<th>$\Delta H_m$ (J/g)</th>
<th>$T_c$ (°C)</th>
<th>$-\Delta H_m$ (J/g)</th>
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<tbody>
<tr>
<td>SGD18</td>
<td>100/0</td>
<td>258.9</td>
<td>47.37</td>
<td>232.7</td>
<td>29.59</td>
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<td>259.4</td>
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Figure 4: The tan delta–temperature behaviour of unreinforced polyamide 6,6 matrix under different conditions
Figure 5: The storage modulus–temperature behaviour of unreinforced polyamide 6,6 matrix under different conditions
Figure 6: The tan delta–temperature behaviour of injection-moulded (SG50/C50) hybrid fibre composites under different conditions.
Figure 7: The storage modulus–temperature behaviour of injection-moulded (SG50/C50) hybrid fibre composites under different conditions.
<table>
<thead>
<tr>
<th>Glass/Carbon</th>
<th>Sample</th>
<th>$\tan \delta_{25}^A$ (x 10^-2)</th>
<th>$\tan \delta_{\text{max}}^B$ (x 10^-2)</th>
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<td>4.57</td>
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</table>
Figure 8: Tensile strength of composites subjected to dry condition
Figure 9: Tensile modulus of composites subjected to dry condition
Figure 10: Fracture strain of composites subjected to dry condition
Table 3: Tensile properties of glass/carbon hybrid fibre composites at different condition

<table>
<thead>
<tr>
<th>Sample</th>
<th>Composition of carbon fibre composites (%)</th>
<th>Fracture strain (%)</th>
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<tbody>
<tr>
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Figure 11: Variation of fracture energy with specimen geometry function of hybrid fibre composites under dry condition.
Figure 11: Variation of fracture energy with specimen geometry function of hybrid fibre composites under dry condition
Figure 12: $G_c$ values of hybrid fibre composites under dry, 50% RH and wet condition
Table 4: The critical strain energy release rate, $G_c$ values of hybrid composites under various conditions.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Composition of carbon composites (%)</th>
<th>$G_c$ (kJm$^{-2}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGD18</td>
<td>12.41</td>
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<tr>
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<td>27.72</td>
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<tr>
<td>SGW18</td>
<td>41.43</td>
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<td>SG75/C25D</td>
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<td>SG50/C50,50%RH</td>
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<td>SC50%RH33</td>
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<tr>
<td>SCW33</td>
<td>24.55</td>
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</tr>
</tbody>
</table>
Conclusion

Effect of hybridisation:-

- No sensible change in matrix properties from DSC results
- Positive effect on $E, G_c$
- Negative effect on UTS
Conclusion

Effect of moisture absorption:-

- Plasticisation effect – shown in mechanical and dynamic mechanical properties
Thank you