**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Illustrations</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Optical micrographs of Al 6063/SiCₚ (9 vol.% and of average particle size 30 μm) MMCs in (a) as-cast condition; and (b) heat treated condition</td>
<td>22</td>
</tr>
<tr>
<td>2.2</td>
<td>Optical micrographs of Al 7075/SiCₚ MMCs with reinforcement weight fractions of (a) 10%; (b) 15%; and (c) 20%</td>
<td>23</td>
</tr>
<tr>
<td>2.3</td>
<td>Variation of density with vol.% of fibre reinforcement</td>
<td>25</td>
</tr>
<tr>
<td>2.4</td>
<td>Density of Al6061-SiC and Al7075-Al₂O₃ composites as a function of % of filler content</td>
<td>25</td>
</tr>
<tr>
<td>2.5</td>
<td>Variation of hardness values of Al/10 wt.% SiCₚ MMC with artificial ageing time</td>
<td>27</td>
</tr>
<tr>
<td>2.6</td>
<td>Micro-hardness of Al6061-SiC and Al7075-Al₂O₃ composites as a function of % of filler content</td>
<td>28</td>
</tr>
<tr>
<td>2.7</td>
<td>Hardness of Al–SiC–Gr hybrid composites as a function of % of combined reinforcements</td>
<td>29</td>
</tr>
<tr>
<td>2.8</td>
<td>Profiles of ultimate tensile strength for Al 7075/SiCₚ MMCs as function of reinforcement wt.%</td>
<td>31</td>
</tr>
<tr>
<td>2.9</td>
<td>Effect of vol.% of SiC on UTS and YS of Al 6063/SiC composites in (a) as-cast condition; and (b) age-hardened condition</td>
<td>33</td>
</tr>
<tr>
<td>2.10</td>
<td>Flexural strength of as-cast and heat treated Al 7075/SiCₚ MMCs as a function of wt.% of reinforcement</td>
<td>35</td>
</tr>
<tr>
<td>2.11</td>
<td>SEM images of turned surfaces of Al/ SiC composite showing (a) voids around SiC particles; (b) pulled out SiC particles; and (c) fractured SiC particles</td>
<td>37</td>
</tr>
<tr>
<td>2.12</td>
<td>Variation of Rₘₐₓ with feed rate for different (a) cutting speed (b) depth of cut</td>
<td>38</td>
</tr>
</tbody>
</table>
2.13 Surface roughness profiles during turning Al-Cu-TiC hybrid composites with respect to (a) cutting speed; (b) feed rate; and (c) depth of cut

2.14 Chip morphology during turning Al 6061/SiC MMC at cutting speed, feed and depth of cut of 180 m/min, 0.15 mm/rev, and 0.2 mm respectively

3.1 Sliced Al 7075 bars

3.2 Optical emission spectrometer

3.3 Photographic images of SiC particulates used as reinforcement

3.4 Degassing flux (Hexachloroethane tablets)

3.5 Photographic image of vertical chamber furnace (Jay Crucible)

3.6 Schematic of vertical chamber furnace

3.7 Single-zone tube furnace (Carbolite STF 10/75 ²x)

3.8 Flow chart representing fabrication process of the Al 7075/SiCₚ MMCs

3.9 Acetone ringed Al 7075 alloy ingots

3.10 Al 7075 alloy ingots in steel crucible

3.11 Melting of Al 7075 alloy in vertical chamber furnace

3.12 Heating of SiCₚ in single zone tube furnace

3.13 Addition of preheated SiCₚ in the molten alloy

3.14 Photographic view of stirring of the composite slurry

3.15 MMC ingot in steel mold

3.16 Cast MMC ingot

3.17 Solution annealing of the MMCs

3.18 Water quenching of the solution annealed MMCs

3.19 Precipitation hardening of the MMCs

3.20 MMC ingots in the muffle furnace

3.21 Heat treated MMC ingots

4.1 Hydraulic specimen mounting press (Chennai Metco Bainmount MPH 007)
| 4.2 | EpoFix Resin and EpoFix Binder (Struers) | 70 |
| 4.3 | FixiForms (Struers) | 70 |
| 4.4 | Mounted MMC samples (a) As-cast; and (b) Heat treated | 70 |
| 4.5 | Polishing machine (Struers LaboPol-5) | 70 |
| 4.6 | Image showing drying operation of polished samples | 70 |
| 4.7 | Inverted optical microscope (Leica-DMI 3000M) | 71 |
| 4.8 | Field emission scanning electron microscope (Zeiss-Supra 55VP) | 71 |
| 4.9 | Materials research diffractometer (PANalytical’s X’Pert PRO) | 71 |
| 4.10 | Density measuring apparatus working on Archimedes principle fitted to a Mettler Toledo precision balance | 72 |
| 4.11 | Hardness test using Leco LM247AT microhardness tester | 75 |
| 4.12 | Tensile test using Instron 8801 servo-hydraulic testing machine | 75 |
| 4.13 | Compressive test using Heico HL590.15 universal testing machine | 75 |
| 4.14 | Impact test using Instron 600 MPX impact testing machine | 75 |
| 4.15 | Three point bend test using Tinius Olsen H50K-S universal testing machine | 76 |
| 4.16 | Fractured composite specimens after (a) tensile tests; (b) compressive tests; (c) impact tests; and (d) three point bend tests | 77 |
| 4.17 | Optical micrographs of Al 7075/SiC\textsubscript{p} MMC samples in as-cast and heat treated conditions | 81 |
| 4.18 | Scanning electron micrographs of heat treated Al 7075/SiC\textsubscript{p} MMC samples (a) A2; (b) B3; and (c) C1 | 83 |
| 4.19 | EDX spectrum of heat treated Al 7075/SiC\textsubscript{p} MMC samples (a) A2; (b) B3; and (c) C1 | 84 |
| 4.20 | XRD patterns of as-cast Al 7075/SiC\textsubscript{p} MMC samples (a) A1, A2, A3; (b) B1, B2, B3; and (c) C1; C2, C3 | 86 |
| 4.21 | Bar graphs for density of Al 7075 alloy and Al 7075/SiC\textsubscript{p} MMMCs | 88 |
4.22 Bar graphs for percentage of porosity in Al 7075 alloy and Al 7075/SiC\(_p\) MMCs  
4.23 Influence of heat treatment, SiC\(_p\) wt.% and their mean particle size on the microhardness of the MMCs  
4.24 Influence of heat treatment, SiC\(_p\) weight percentage and their mean particle size on yield strength of the MMCs  
4.25 Influence of heat treatment, SiC\(_p\) weight percentage and their mean particle size on ultimate tensile strength of the MMCs  
4.26 Influence of heat treatment, SiC\(_p\) weight percentage and their mean particle size on percentage of elongation (ductility) of the MMCs  
4.27 Influence of heat treatment, SiC\(_p\) weight percentage and their mean particle size on compressive strength of MMCs  
4.28 Influence of heat treatment, SiC\(_p\) weight percentage and their mean particle size on impact strength of the MMCs  
4.29 Influence of heat treatment, SiC\(_p\) weight percentage and their mean particle size on flexural strength of the MMCs  
4.30 Influence of heat treatment, SiC\(_p\) weight percentage and their mean particle size on maximum deflection of the MMCs during three point bend tests  
4.31 Normal probability plot of residuals for \(v\)  
4.32 Normal probability plot of residuals for \(\sigma_{ut}\)  
4.33 Normal probability plot of residuals for \(\sigma_c\)  
4.34 Normal probability plot of residuals for \(\sigma_i\)  
4.35 Normal probability plot of residuals for \(\sigma_{fl}\)  
4.36 Main effects plot for means of grey relational grade  
5.1 Al 7075/20 wt.% SiC\(_p\) (8.18 \(\mu\)m) MMC workpiece for preliminary turning experiments  
5.2 Schematic of SIC set-up  
5.3 SIC setup consisting (a) air compressor; and (b) water pump and pressure regulating valves  
5.4 Turning setup in SIC machining environment during preliminary experiments
5.5 Infrared thermal imager (Fluke-Ti32)  
5.6 Measurement of surface roughness using Taylor Hobson-Surtronic 25 surface roughness tester  
5.7 Main effects plots for means of grey relational grade  
5.8 Al 7075/25 wt.% SiC_p (6.18 µm) MMC workpiece for turning  
5.9 Setup for turning Al 7075/25 wt.% SiC_p (6.18 µm) MMC in (a) dry environment; (b) SIC environment  
5.10 Flank wear measurement using Nikon V10 AD profile projector  
5.11 Imaging of worn cutting edges using Radical Instrument-RSM 8 Stereo Zoom Microscope  
5.12 Infrared thermal images showing tool tip temperature during turning Al 7075/25 wt.% SiC_p (6.18 µm) MMC in dry machining environment at (a) N= 250 rpm, f= 0.05 mm/rev, d= 0.2 mm; (b) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (c) N= 1210 rpm, f= 0.1 mm/rev, d= 0.5 mm; and (d) N= 1575 rpm, f= 0.1 mm/rev, d= 0.4 mm  
5.13 Infrared thermal images showing tool tip temperature during turning Al 7075/25 wt.% SiC_p (6.18 µm) MMC in SIC machining environment at (a) N= 250 rpm, f= 0.05 mm/rev, d= 0.2 mm; (b) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (c) N= 1210 rpm, f= 0.1 mm/rev, d= 0.5 mm; and (d) N= 1575 rpm, f= 0.1 mm/rev, d= 0.4 mm  
5.14 Surface roughness profiles during turning the MMC in dry environment at (a) N= 250 rpm, f= 0.05 mm/rev, d= 0.2 mm; (b) N= 250 rpm, f= 0.16 mm/rev, d= 0.4 mm; (c) N= 250 rpm, f= 0.20 mm/rev, d= 0.5 mm; (d) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (e) N= 1210 rpm, f= 0.16 mm/rev, d= 0.2 mm; (f) N= 1210 rpm, f= 0.20 mm/rev, d= 0.3 mm; (g) N= 1575 rpm, f= 0.16 mm/rev, d= 0.3 mm; and (h) N= 1575
rpm, f= 0.20 mm/rev, d= 0.2 mm

5.15 Surface roughness profiles during turning the MMC in SIC environment at (a) N= 250 rpm, f= 0.05 mm/rev, d= 0.2 mm; (b) N= 250 rpm, f= 0.16 mm/rev, d= 0.4 mm; (c) N= 250 rpm, f= 0.20 mm/rev, d= 0.5 mm; (d) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (e) N= 1210 rpm, f= 0.16 mm/rev, d= 0.2 mm; (f) N= 1210 rpm, f= 0.20 mm/rev, d= 0.3 mm; (g) N= 1575 rpm, f= 0.16 mm/rev, d= 0.3 mm; and (h) N= 1575 rpm, f= 0.20 mm/rev, d= 0.2 mm

5.16 Optical micrographs of machined surfaces during turning the MMC at N= 1575 rpm, f= 0.20 mm/rev, d= 0.2 mm in (a) dry environment; and (b) SIC environment

5.17 Images of worn cutting edges during turning Al 7075/25 wt.% SiC_p (6.18 µm) MMC in dry machining environment at (a) N= 250 rpm, f= 0.05 mm/rev, d= 0.2 mm; (b) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (c) N= 1210 rpm, f= 0.1 mm/rev, d= 0.5 mm; and (d) N= 1575 rpm, f= 0.1 mm/rev, d= 0.4 mm

5.18 Images of worn cutting edges during turning Al 7075/25 wt.% SiC_p (6.18 µm) MMC in SIC machining environment at (a) N= 250 rpm, f= 0.05 mm/rev, d= 0.2 mm; (b) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (c) N= 1210 rpm, f= 0.1 mm/rev, d= 0.5 mm; and (d) N= 1575 rpm, f= 0.1 mm/rev, d= 0.4 mm

5.19 Chip forms during turning Al 7075/25 wt.% SiC_p (6.18 µm) MMC in dry environment at (a) N= 250 rpm, f= 0.1 mm/rev, d= 0.3 mm; (b) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (c) N= 1210 rpm, f= 0.1 mm/rev, d= 0.5 mm; and (d) N= 1575 rpm, f= 0.1 mm/rev, d= 0.4 mm

5.20 Chip forms during turning Al 7075/25 wt.% SiC_p (6.18 µm) MMC in SIC environment at (a) N= 250 rpm, f= 0.1 mm/rev, d= 0.3 mm; (b) N= 715 rpm, f= 0.16 mm/rev, d= 0.5 mm; (c) N= 1210 rpm, f= 0.1 mm/rev, d= 0.5 mm; and (d) N= 1575
rpm, f = 0.1 mm/rev, d = 0.4 mm

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.21</td>
<td>Main effects plots for (a) T; (b) Ra; and (c) VBc</td>
<td>141</td>
</tr>
<tr>
<td>5.22</td>
<td>Normal probability plots of residuals for (a) T; (b) Ra; and (c) VBc</td>
<td>147</td>
</tr>
<tr>
<td>5.23</td>
<td>Residuals versus the fitted values of (a) T; (b) Ra; and (c) VBc</td>
<td>148</td>
</tr>
<tr>
<td>5.24</td>
<td>Residuals versus observation orders of (a) T; (b) Ra; and (c) VBc</td>
<td>150</td>
</tr>
<tr>
<td>5.25</td>
<td>Surface plots for (a) T vs. f, N; (b) Ra vs. f, N; (c) VBc vs. f, N</td>
<td>152</td>
</tr>
<tr>
<td>5.26</td>
<td>Contour plots for (a) T vs. f, N; (b) Ra vs. f, N; (c) VBc vs. f, N</td>
<td>153</td>
</tr>
<tr>
<td>5.27</td>
<td>Main effects plot for grey relational grade</td>
<td>159</td>
</tr>
<tr>
<td>5.28</td>
<td>Interaction plot for grey relational grade</td>
<td>159</td>
</tr>
</tbody>
</table>