Preparation and characterization of A356 composite reinforced with SiC nano- and microparticles by stir casting method

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ABSTRACT

In this study, A356 aluminum alloy matrix composites reinforced with different weight percentages of SiC nano- and microparticles respectively with 50 nm and 5 µm average particle sizes were fabricated by stir casting method. Due to the effect of T6 heat treatment on the strength and hardness of A356 alloy, the obtained composites were subjected to the T6 heat treatment. The mechanical properties such as hardness and compressive properties of the composites were investigated. Microstructures of the samples were also investigated by an optical microscope (OM), scanning electron microscope (SEM) and field emission scanning electron microscope (FESEM). Microstructural investigation indicated that T6 heat treatment led to the change of eutectic silicon morphology and formation of the Mg2Si precipitates during age hardening stage, leading to increased hardness and compressive strength. The results showed that an increase in wt.% of nanoparticles led to increased hardness and compressive strength. The results of microstructural investigation showed the relatively uniform distribution of reinforcement particles. Also, the strength and hardness of the composites reinforced with nanoparticles were greater than those of the composite reinforced with microparticles, even with higher weight percent of reinforcement particles. Hardness and compressive strength at 35% strain for the composite reinforced with 1.5 wt.% nanoparticles were respectively obtained 62 HBN and 252MPa, which are improved compared to the base alloy.
Table 1 Chemical composition of A356 alloy

<table>
<thead>
<tr>
<th>Element</th>
<th>Si</th>
<th>Fe</th>
<th>Cu</th>
<th>Mn</th>
<th>Mg</th>
<th>Zn</th>
<th>Ti</th>
<th>Bal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>7.10</td>
<td>0.18</td>
<td>0.14</td>
<td>0.10</td>
<td>0.42</td>
<td>0.10</td>
<td>0.18</td>
<td>bal</td>
</tr>
</tbody>
</table>

A356 Alloy: A356 Al alloy is a commonly used wrought aluminum alloy in the automotive industry.

1. Chemical Composition
   - The chemical composition of A356 alloy includes Si, Fe, Cu, Mn, Mg, Zn, Ti, and Bal.
   - The content of Si is 7.10, Fe is 0.18, Cu is 0.14, Mn is 0.10, Mg is 0.42, Zn is 0.10, Ti is 0.18, and Bal is bal.

2. Tensile properties
   - The tensile strength of A356 alloy is high, making it suitable for various applications.

3. Corrosion resistance
   - A356 alloy has good corrosion resistance, especially in marine environments.

4. Forming properties
   - The forming properties of A356 alloy are excellent, allowing for various forming processes.

5. Weldability
   - The weldability of A356 alloy is good, allowing for various welding techniques.

6. Castability
   - The castability of A356 alloy is excellent, making it suitable for casting processes.

7. Heat treatment
   - A356 alloy can be heat treated to improve its mechanical properties.

8. Fabrication
   - The fabrication of A356 alloy is simple, allowing for various fabrication processes.

A356 alloy is widely used in automotive industries, where it is known for its high strength-to-weight ratio and excellent formability.
Fig. 3 View of stainless steel stirrer

Fig. 4 The stir casting system used in this study

Fig. 1 SEM micrographs of As-received SiC micro particles

Fig. 2 TEM micrographs of As-received SiC nano particles

1 Union
2 Tescan
3 Jeol
4 Santam
Fig. 5 The optical micrographs of As cast A356 alloy

Fig. 6 The SEM images of microstructures A356 alloy

Fig. 7 The optical micrographs of (a) As-cast A356 alloy and (b) 5wt.% SiC microparticle reinforced composites

Fig. 8 The SEM images of microstructures A356 alloy in T6 heat treated condition
کربن زیری در تقویت کننده در کامپوزیت‌های ذرات ماهی‌های کاربردی مورد استفاده قرار می‌گیرد. شکل 9 نشان می‌دهد که کمترین میزان تغییر در ضریب تغییر حجمی توسط شیشه‌های باارزش در میکروپویتری باعث بهبود در این صنعت می‌شود. این نتایج نشان می‌دهد که استفاده از ذرات کمک به کاهش تغییر حجمی در میکروپویتری به عنوان آنتی‌کربن‌زایی حاضر می‌شود. شکل 10 نشان می‌دهد که تغییر توانایی تغییر حجمی در میکروپویتری باعث بهبود در این صنعت می‌شود.

**شکل 9.** SEM micrograph of the 5wt. % SiC nanoparticle reinforced composites (a) and EDS composition analysis (b) of Al 2Si-Mg composite.

**شکل 10.** FESEM micrograph of the 1.5wt. % SiC nanoparticle reinforced composites.
3.3 - Assay of Fracture

In Fig. 11 (a), the SEM micrograph of the 1.5 wt. % SiC nanoparticle reinforced composites in high magnification (b) EDS composition analysis.

![Fig. 11](image-url)

**Fig. 12** The compressive stress–strain curves of samples.

![Fig. 13](image-url)

**Fig. 14** Compression results at 35% strain

### 5. مراجع


