EFFECT OF PROCESSING CONDITIONS ON SIZE AND MORPHOLOGY OF ALUMINUM POWDER PARTICLES PREPARED VIA SAMD TECHNIQUE

P. Delshad-Khatibi, F. Akhlaghi
School of Metallurgy and Materials Eng., Faculty of Eng., University of Tehran, P.O. Box 11365-4563, Tehran, Iran

Abstract
Solid Assisted Melt Disintegration (SAMD) is a relatively new technique for producing metallic powder particles. In the present paper, for the first time, a soluble media (NaCl) was used for melt disintegration. The effect of stirring speed on the size, size distribution and morphology of the Al-6%wt Si powder particles using 4 different impeller speeds was investigated. It was concluded that by increasing the stirring speed from 600 to 1400 rpm the size of the produced powder particles was decreased. However, further increase in the stirring speed up to 1900 rpm, increased the particles size. Aluminum powders fabricated by this technique, regardless of the stirring speed exhibited a near spherical morphology.

Introduction
Aluminum Powder particles can be produced by a variety of manufacturing routes. The main commercially available production routes include atomization, melt spinning and subsequent pulverization of the ribbons into flakes, and mechanical alloying. Solid Assisted Melt Disintegration (SAMD) is a relatively new technique for producing metallic powder particles [1,2]. In this process, melt disintegration is achieved by introducing a solid media into the molten alloy and stirring the slurry to produce droplets which after solidification form the powder particles. In the present paper, the effect of stirring speed on the size, size distribution and morphology of the Al-6%wt Si powder particles produced via SAMD method has been investigated.

Experimental
In the present study, Al-6wt%Si was prepared by melting commercial pure Al and LM6 (Al-12.6Si) alloy in an electrical resistance furnace. Then about 40 g of Al-6wt%Si alloy ingot was melted and superheated to 690 °C and then about 160 g of NaCl (average size D50 = 254 µm) was added to the melt. The slurry was subsequently stirred via a spiral graphite impeller (d=30mm) at 600, 1000, 1400, 1900 rpm using an electrical motor for 5 min while its temperature was kept constant at 690 °C. Then the blend was quenched in distilled water and the Al powder particles were washed, collected, dried and passed through 710 µm and 500 µm sieves. LPS (Laser Particle Size) analyses was performed on the <500 µm fraction of produced powders. The shape and surface morphology of different powders were examined by scanning electron microscope (SEM).

Results and Discussion
The results of size and size distribution of the produced powders are shown in Table 1.

<table>
<thead>
<tr>
<th>Stirring Speed(rpm)</th>
<th>D10 (µm)</th>
<th>D50 (µm)</th>
<th>D90 (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>11.20</td>
<td>373.20</td>
<td>750.19</td>
</tr>
<tr>
<td>1000</td>
<td>10.89</td>
<td>306.87</td>
<td>720.98</td>
</tr>
<tr>
<td>1400</td>
<td>7.22</td>
<td>34.48</td>
<td>329.48</td>
</tr>
<tr>
<td>1900</td>
<td>8.51</td>
<td>42.78</td>
<td>354.58</td>
</tr>
</tbody>
</table>

It can be seen that, with increasing stirring speed up to 1400 rpm, the amounts of D10, D50 and D90 are decreased. However, for higher stirring speeds (e.g. 1900 rpm), these quantities are increased. In fact, by increasing the stirring speed up to 1400 rpm, more kinetics energy is provided for fragmentation of liquid droplets and results in a decrease in the powder particles size. However, by increasing the stirring speed beyond a critical value (i.e. 1400 rpm), due to a relatively high centrifugal force, a part of the NaCl particles get accumulated at the internal surface of the crucible and cannot act as a solid for melt disintegration. Therefore the average size of the produced Al powders increases.
Fig. 1 shows the influence of stirring speed on the weight percent of large sized (>500 µm) powder particles. It can be seen that with increasing the stirring speed, this quantity decreases. In fact, the increased stirring speed provides more kinetic energy for melt disintegration resulting in a decreased wt.% of large particles.

![Fig. 1. Effect of stirring speed on the wt.% of large sized (>500 µm) powders](image)

The SEM micrographs of the SAMD particles within the size range of 106-212 µm produced at different stirring speeds are shown in Fig. 2. It can be seen that the shape of particles are near spherical and are not affected by stirring speed. Basically the morphology of produced powders by this method depends on a number of factors such as melt surface tension, degree of superheat and cooling rate which have been identical for the present set of experiments. Therefore, for any specific powder size range, identical shaped particles can be expected.

![Fig. 2. Typical SEM micrographs of the SAMD particles within the size range of 106-212 µm produced at different stirring speeds of (a) 600 rpm, (b) 1000 rpm, (c) 1400 rpm and (d) 1900 rpm.](image)

**Conclusion**

Aluminum 6 wt% Si powder particles with a wide range of size distribution can be produced by SAMD technique using NaCl particles as the solid disintegrating medium. In this process, melt disintegration is achieved by introducing a solid media into the molten alloy and stirring the slurry to produce droplets which after solidification form the powder particles. The effect of stirring speed on the size, size distribution and morphology of the Al-6%wt Si powder particles have been investigated. The present results show that increasing the stirring speed from 600 to 1400 rpm decreases the size of the powder particles. However, further increase in the stirring speed up to 1900 rpm, leads to an increase in the particles size. Also by increasing the stirring speed, the weight percent of large sized (>500 µm) powder particles decreases. Aluminum powders fabricated via different stirring speed are relatively spherical and their morphology is not affected by stirring speed.

**References**
