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Abstract

Sedimentation in the A356-Al_2O_3 Stirred Cast †

Omid Emadinia [1,*], Rui Madureira [1], Rui Soares [1], Helder Nunes [1], Inês Frada [2], Vitor Anjos [2], Carlos Silva Ribeiro [1,3], Rui Neto [1,3], Ana Reis [1,3] and Manuel Vieira [1,3]

1 LAETA/INEGI—Institute of Science and Innovation in Mechanical and Industrial Engineering, 4200-465 Porto, Portugal; rdmadureira@inegi.up.pt (R.M.); rsoares@inegi.up.pt (R.S.); hnunes@inegi.up.pt (H.N.); sribeiro@fe.up.pt (C.S.R.); rneto@inegi.up.pt (R.N.); areis@inegi.up.pt (A.R.); mvieira@fe.up.pt (M.V.)

2 Centre for Innovation and Technology N. Mahalingam, 3750-122 Águeda, Portugal; ines.frada@citnm.pt (I.F.); vitor.anjos@citnm.pt (V.A.)

3 Faculty of Engineering, University of Porto, 4200-465 Porto, Portugal

* Correspondence: oemadinia@inegi.up.pt

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The production of aluminium metal matrix composites (AlMMCs) is noteworthy for obtaining enhanced mechanical and/or physical properties such as a high strength-to-weight ratio, high stiffness, high wear resistance, and higher thermal conductivity or modified coefficient of thermal expansion. Liquid methodologies such as stir casting can be remarkable for large series production of components with semi to complex geometries. In the current study, we used the A356 Al alloy, which is frequently used for casting processes because it has an adequate flowability, due to the concentration of Si, a low cost, and a variety of industrial applications. Al_2O_3 particles (a hard, stable, and sustainable ceramic material) with a size smaller than 10 µm were added to the Al matrix.

The graphitic crucible, A356 ingot, alumina particles, and mixing blade were preheated at 350 °C for at least 1 h. The Al melt was prepared in a resistant furnace at 720 °C and then cooled down to 600 °C. The preheated Al_2O_3 particles were added to the semi-solid alloy and mechanical stirring finished at 750 rpm for 5 min. Then, specimens for microscopic observations were selected at 600, 625, 650, 675, 700, and 720 °C. Moreover, the melt temperature was kept constant, and the sampling proceeded every 10 minutes for one hour. Sample preparations involved conventional metallographic techniques; microstructural characterization was performed by scanning electron microscopy (SEM) through backscattered electron imaging. The area fraction and size of the reinforcements/agglomerates were considered to evaluate the sedimentation as the function of temperature rising, from 600 to 720 °C, and of the holding time after reaching 720 °C as well. The ImageJ software was used for the image analysis of the taken SEM images. The SEM observations revealed a typical A356 microstructure consisting of Al dendrites with eutectic Si and the alumina agglomerates in different sizes; porosities were associated with large agglomerates and reduced by rising temperature. The smallest mean agglomerate size and the tiniest area fraction were for the specimen selected at 700 °C, with almost 105 µm and 3%, respectively. The size of the porosities and agglomerates did not show a linear behaviour with the function of time. However, the reduction in the agglomerate size was highlighted after 10 min of holding time. The sedimentation increased over time, which means that losing reinforcement in the Al matrix accompanied by the increase in the remaining Al charge in the crucible left as a solidified shell. It was concluded that, after stirring, the casting temperature and the holding time can influence the sedimentation of alumina. Thus, it seems that a narrow interval should be adjusted for proceeding with mould filling by processes such as low-pressure sand casting. Tomography analysis will be helpful. The authors gratefully acknowledge the

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