A Study on the Fluidity of Hybrid Aluminum-matrix Composite (AMC/SiCp/Gr.)

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ABSTRACT

ABSTRACT The purpose of this study is to investigate the effect of process and metallurgical parameters on the hybrid aluminum matrix composites AMC/SiCp/Gr. which used three types of aluminum alloys A356.2, A413.1 and A390.1 as matrix alloys. The reinforcement materials are silicon carbides particles (SiCp) and graphite particles (Gr.) which their sizes are micrometer order. The fluidity measurements are conducted by using CO2 sand mold method and spiral fluidity test pattern. In addition, the computer-added cooling curve analysis method (CA-CCA) was utilized to evaluate the effects of solidification temperature and solidification time on the fluidity of the three types of hybrid aluminum composites. The latent heat and the solid fraction change during the flow and solidification in the cavity are also calculated by CA-CCA method. The data show significant influence on the fluidity of the composites. The results of this research indicate that the fluidity of aluminum added with graphite particles composites was firstly increased with the increase amounts of graphite for the AMC/Gr. composites and then was decreased with the increase amounts of graphite. The best fluidity occurred at four weight percent(4wt.%) graphite added amount. However, the fluidity was gradually decreased with the increase of silicon carbide amounts for the hybrid AMC/SiCp/Gr. composite. The CA-CCA analyses find that the solidification temperatures increase and latent heat decreases and the solidification time increases firstly and then decreases with the increase amounts of graphite for the AMC/Gr. composites. But, the solidification temperatures increase and latent heat and solidification time decrease with the increase amounts of silicon carbide for the AMC/SiCp/Gr. composites. Finally, the microstructure observations about the spiral fluidity test castings of AMC/Gr. and hybrid AMC/SiCp/Gr. composites indicate that the fluidity was significantly affected by the solidification modes and the solid fraction change along the spiral fluidity test castings.

Keywords : Hybrid aluminum-matrix composite(AMC/SiCp/Gr.) ; Fluidity ; Graphite(Gr.) ; Silicon carbide(SiCp) ; CA-CCA

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REFERENCES

參考文獻 1. Pradeep Rohatgi , “ Cost Metal Matix Composites:Past Present and Future, ” AFS Trans., vol.133, 2001, pp.633-656. 2. Pradeep Rohatgi , “ Foundry Processing of Metal Matrix Composites, ” Modern Casting, April, 1988, pp.47-50. 3. D. Huda, M.A. El Baradie and M. S . J. Hashmi, “ Metal-matrix Composites:Materials Aspects. Part Ⅱ, ” Journal of Materials Processing Technology, 37, 1993, pp.529-541. 4. F. M. Yarandi, P. K. Rohatgi and S. Ray, “ Casting Fluidity of Aluminum A356-SiC Cast Particulate Composite, ” AFS Trans., vol.100, 1992, pp.575-582. 5. P. Meyer, P. Hottebart, P. Malletroit, D. Massinon and F. Plumail, “ MMC Developments at Montupet:An Overview, ” AFS Trans., vol.102, 1994, pp.653-664. 6. E. F. Crawley and M. C. Van, J. Compos. Mater., 21, 1987, p.553. 7. ASM Metals Handbook, vol.15, 9th ed., (1983), pp.840-854. 8. P.B.shaffer, Handbook of Advanced Ceramic Materials. Advanced Refractory Technologies, Buffalo N.Y. 9. E. N. Pan, C. S. Lin and C. R. Loper, Jr., “ Effects of Solidification Parameters on the Feeding Efficiency of A356 Aluminum Alloy, ” AFS Trans., vol.98, (1990), pp.735-746. 10. P. K. Rohatgi, R. Asthana and S. Das, “ Solidification, Structure and Properties of Cast Metal-Ceramic Particle Composite, ” Int. Met. Rev. vol.31, (1986), pp.115. 11. T. W. Chou, A. Kelly and A. Okura, Composites, 16, (1986), p.187. 12. P. K. Rohatgi, R. Q. Cuo and T. F. Stephenson, “ Casting Characteristics of Hybrid (Al/SiC/Gr) Composites, ” AFS Trans., vol. 106, (1998), pp.191-197. 13. F. M. Yarandi, P. K. Rohatgi and S. Ray, “ Casting Fluidity of Aluminum A356-SiC Cast Particulate Composite, ” AFS Trans., vol.100, (1992), pp.575-582. 14. P. K. Ghosh and S. Ray, “ Influence of Process Parameters on the Porosity Content in Al (Mg)-Al2O3 Cast Particulate Composite Produced by Vortex Method, ” AFS Trans., vol.96, (1988), pp.775-782. 15. D. P. K. Singh and D. J. Mitchell, “ Analysis of Metal Quality in a Low Pressure Permanent Mold Foundry, ” AFS Trans., vol.028, (2001), pp.333-346. 16. 胡瑞峰，蔡俊彥，蕭毅憫，潘永寧，“ 液態鑄造鋁基碳化矽顆粒 複合材料流動性之研究 ”「中華民國八十九年論文發表會論文集」，pp.15-23. 17. M. K. Surappa and P. K. Rohatgi, “ Preparation and Properties of Cast Aluminum-Ceramic Particle Composites. ” J. of Mater. Sci., vol 16, (1981), p.983. 18. V. Laurent, D. Chatain and N. Esutathopoulos, J. of Mater. Sci., vol 22, (1987), pp.244-250. 19. G. S. Hanumanth and G. A. Irons, J. of Mater. Sci., vol 28, (1993), pp.2459-2465. 20. H. K. Moon, J. A. Cornie and M. C. Flemings, Mat. Sci. and Eng., A144, (1991), pp.253-265. 21. B. P. Krishnan, M. K. Surappa and P. K. Rohatagi, J. of Mat. Sci., vol.16, (1981), pp.1209-1216. 22. B. C. Pai and P. K. Rohatagi, Mat. Sci. and Eng., 21, (1975), pp.161-167. 23. T. F. Stephenson, A.E.M. Warner, S. Wilson, A. T. Alpas and P. K. Rohatagi, Proceedings of Materials Week, (1996), pp.337-351. 24. D. Huda, M.A. El Baradie and M. S. J. Hashmi, “ Metal-matrix Composites:Manufacturing Aspects. Part I, ” Journal of Materials Processing Technology, 37, 1993, pp.513-528. 25. ASM Metals Handbook, vol.15, 9th ed., 1983, pp.840-854. 26. A. W. Neumann, J. Szekely, E. J. Rabenda

and Jr., J. Olloid : Interface Sci., 43, 1993, p.727. 27. A. Mortensen : Materials Science and Engineering, vol.135, 1991, pp.1-11. 28. M. K. Surappa and P. K. Rohatgi,“ Preparation and Properties of Cast Aluminium-ceramic Particle Composites, ” Journal of Materials Science, 16, 1981, pp.983-993. 29. D. Nath and P. K. Rohatgi,“ Fluidity of Mica Particle Dispersed Aluminum-SiC Composites, ” Composite Science and Technology, 35, 1898, p.159. 30. P. A. Karnezis, G. Durrant and B. Cantor,“ Characterization of Reinforcement Distribution in Cast Al-Alloy/SiCp Composites, ” Elsevier, (1998), pp.97-108. 31. V. A. Ravi, D. J. Frydrych and A. S. Nagelberg,“ Effect of Particle Size, Shape and Loading on the Fluidity of SiC-Reinforced Aluminum MMCs, ” AFS Trans., vol.102, 1994, pp.891-895. 32. M. C. Fleming, F. R. Mollard, E. F. Niiyama and H. F. Taylor,“ Fluidity of Aluminum, ” AFS Trans., vol.68, 1962, pp.1029-1039. 33. D. L. Rose, B. M. Cox and M. D. Skibo,“ Degassing and Cleaning of Al-Based SiC Particulate Reinforced Composites, ” AFS Trans., vol.101, 1993, pp.619-626. 34. R. Fuoco and E. R. Correa,“ Microporosity Morphology in A356 Aluminum Alloy in Unmodified and in Sr-Modified Conditions, ” AFS Trans., vol.015, 2001, pp.259-265. 35. Nouruzi and Khorasani,“ Study of Surface Blistering Defect in Low pressure Die-Casting of Aluninum, ” AFS Trans., vol.015, 2001, pp.259-265. 36. B. C. Pai and R. M. Pillai,“ Role of magnesiumin Cast aluminum alloy matrix compostites, ” Materials Sci., 30, (1995), pp.1903-1911 37. J. M. Kim and C. R. Loper, Jr.“ Effect of Solidification Mechanism on Fluidity of Al-Si Casting Alloys, ” AFS Trans., vol.08, 1995, pp.521-529. 38. Q. G. Wang and D. Apelian,“ Solidification of Eutectic in Hypoeutectic Al-Si Casting Alloys, ” AFS Trans., vol.149, 1999, pp.249-256. 39. W. Kasprzak and C. A. Kierkus,“ Sturcture and Matrix Microhardness of the 319 Aluminum Alloy After Isothermal Holding During the Solidification Process, ” AFS Trans., vol.090, 2001, pp.529-539. 40. A.M. Samuel and F.H. Samule,“ Effect of Superheat, Cooling Rate and Impurities on the Formation of Iron Intermetallics in Al-Si Die Casting Alloys, ” AFS Trans., vol.170, 2001, pp.679-696. 41. J. Hashim, L. Looney and M. S. J. Hashmi,“ Metal Matrix composites : Production by the Stir Casting Method, ” Journal of Materials Processing Technology, vol.92, August, 1999, pp.1-7. 42. 李世欽, 楊家彰, 翁震杰,“ 融體鑄造碳化矽顆粒強化A356鋁合金製程參數探討 ”，鑄工，第87期，民國84年12月，pp.37-43. 43. M. C. Flemings, E. Niiyama and H. F. Taylor,“ Fluidity of Aluminum Alloys, ” AFS Trans., vol.69, 1961, pp.625-635. 44. 蔡俊彥, 90年,“ 砂模鑄造鋁基碳化矽複合材料流動性之探討, ” 大葉大學機械工程學研究所碩士論文