Processing of Low cost and Light Weight Al-SiC Metal Matrix Composites

T. Surya Prakash
M.Tech Student, Department of Mechanical Engineering, Osmania University, Hyderabad

Under the Guidance of Dr. A. Chennakesava Reddy, Associate Professor, Department of Mechanical Engineering, Vasavi College of Engineering Hyderabad.

ABSTRACT

This project aims at the potential of use Al-SiC metal matrix composite (MMC) with particular reference to the aerospace industry. In the present study a modest attempt has been made to develop aluminium based silicon carbide particulate MMCs with an objective to develop a conventional low cost method of producing MMCs and to obtain homogenous dispersion of ceramic material. Aluminium (98.41% C.P) and SiC (320-grit) has been chosen as matrix and reinforcement material respectively. Experiments have been conducted by varying weight fraction of SiC (5%, 10%, 15%, 20%, 25%, and 30%), while keeping all other parameters constant. An increasing trend of hardness and impact strength with increase in weight percentage of SiC has been observed. The best results (maximum hardness 45.5 BHN & maximum impact strength of 36 N-m.) have been obtained at 25% weight fraction of SiC.

Figure 1: Applications of Al-SiC metal matrix composites.

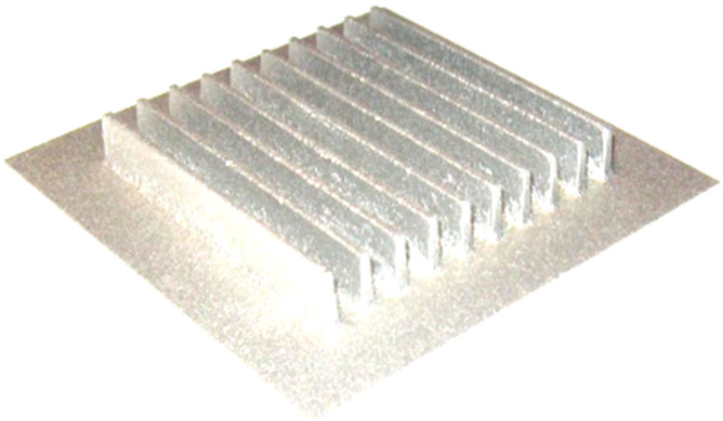

Figure 2: Test coupon of Al-SiC metal matrix composites.

References

1. P.K. Rohatgi, et al., Synthesis of Aluminum-Fly Ash Particulate Composite by Pressure Infiltration Technique, Materials Science and Engineering A, Vol. 244, pp. 22-30, 1998.

2. R. Arsenault, The Strengthening of Aluminum Alloy 6061 by Fiber and Platelet Silicon Carbide, Mater. Sci. Eng., 64 (2), pp.171-181, 1984.

3. T. Clyne and P. Withers, An Introduction to Metal Matrix Composites, Cambridge, UK: Cambridge University Press, 1993.

4. S. Sundara Rajan, A. C. Reddy, Evaluation of Tensile Behavior of Boron Carbide/AA1100 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.156-159.

5. S. Sundara Rajan, A. C. Reddy, Assessment of Tensile Behavior of Boron Carbide/AA2024 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.160-163.

6. P. Martin Jebaraj, A. C. Reddy, Prediction of Tensile Behavior of Boron Carbide/AA3003 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.164-166.

7. A. C. Reddy, Effect of Particle Loading on Microealstic Behavior and interfacial Tractions of Boron Carbide/AA4015 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.176-179.

8. B. Kotiveera Chari, A. C. Reddy, Estimation of Micro-stresses and interfacial Tractions in Boron Carbide/AA5050 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.180-182.

9. P. Martin Jebaraj, A. C. Reddy, Prediction of Micro-stresses and interfacial Tractions in Boron Carbide/AA6061 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.183-185.

10. B. Kotiveera Chari, A. C. Reddy, Computation of Micro-stresses and interfacial Tractions in Boron Carbide/AA7020 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.186-188.

11. H. B. Niranjan, A. C. Reddy, Valuation of Micro-stresses and interfacial Tractions in Boron Carbide/AA8090 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.189-191.

12. H. B. Niranjan, A. C. Reddy, Determination of Micro-stresses and interfacial Tractions in Titanium Boride/AA1100 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.192-194.

13. A. C. Reddy, Reckoning of Micro-stresses and interfacial Tractions in Titanium Boride/AA2024 Alloy Metal Matrix Composites, 1st International Conference on Composite Materials and Characterization, Bangalore, 14-15 March 1997, pp.195-197.

14. A. C. Reddy, Interfacial Debonding Analysis in Terms of Interfacial Tractions for Titanium Boride/AA3003 Alloy Metal Matrix Composites, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.124-127.

15. P. Martin Jebaraj, A. C. Reddy, Effect of Interfacial Debonding on Stiffness of Titanium Boride/AA5050 Alloy Metal Matrix Composites, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.132-135.

16. S. Sundara Rajan, A. C. Reddy, Micromechanical modeling of Titanium Boride/AA7020 Alloy Metal Matrix Composites in Finite Element Analysis using RVE Model, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.140-143.

17. P. Martin Jebaraj, A. C. Reddy, Effect of Interfacial Tractions of Rectangular Titanium Boride Particulate/AA8090 Alloy Metal Matrix Composites, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.144-147.

18. S. Sundara Rajan, A. C. Reddy, Cohesive Zone interfacial debonding of Silicon Nitride/AA1100 Alloy Metal Matrix Composites Using Finite Element Analysis, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.265-268.

19. S. Sundara Rajan, A. C. Reddy, Simulation of Micromechanics for interfacial debonding in Silicon Nitride/AA2024 Alloy Metal Matrix Composites, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.269-272.

20. P. Martin Jebaraj, A. C. Reddy, Finite Element Analysis for Assessment of Dislocation and Debonding Events in Silicon Nitride/AA3003 Alloy Metal Matrix Composites, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.273-277.

21. A. C. Reddy, Evaluation of Debonding and Dislocation Occurrences in Rhombus Silicon Nitride Particulate/AA4015 Alloy Metal Matrix Composites, 1st National Conference on Modern Materials and Manufacturing, Pune, India, 19-20 December 1997, pp.278-282.

22. A. C. Reddy, Assessment of Debonding and Particulate Fracture Occurrences in Circular Silicon Nitride Particulate/AA5050 Alloy Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.104-109.

23. B. Kotiveera Chari, A. C. Reddy, Numerical Simulation of Particulate Fracture in Round Silicon Nitride Particulate/AA6061 Alloy Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.110-114.

24. H. B. Niranjan, A. C. Reddy, Effect of Elastic Moduli Mismatch on Particulate Fracture in AA7020/Silicon Nitride Particulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.115-118.

25. P. Martin Jebaraj, A. C. Reddy, Cohesive Zone Modelling for Interface Debonding in AA8090/Silicon Nitride Nanoparticulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.119-122.

26. P. Martin Jebaraj, A. C. Reddy, Plane Strain Finite Element Modeling for Interface Debonding in AA1100/Silicon Oxide Nanoparticulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.123-126.

27. A. C. Reddy, Local Stress Differential for Particulate Fracture in AA2024/Titanium Carbide Nanoparticulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.127-131.

28. B. Kotiveera Chari, A. C. Reddy, Interface Debonding and Particulate Facture based on Strain Energy Density in AA3003/MgO Nanoparticulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.132-136.

29. H. B. Niranjan, A. C. Reddy, Numerical and Analytical Prediction of Interface Debonding in AA4015/Boron Nitride Nanoparticulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.137-140.

30. S. Sundara Rajan, A. C. Reddy, Effect of Particulate Volume Fraction on Particulate Cracking in AA5050/Zirconium Oxide Nanoparticulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.156-159.

31. S. Sundara Rajan, A. C. Reddy, Cohesive Zone Analysis for Interface Debonding in AA6061/Titanium Nitride Nanoparticulate Metal Matrix Composites, National Conference on Materials and Manufacturing Processes, Hyderabad, India, 27-28 February 1998, pp.160-164.

32. A. C. Reddy, Cohesive Zone Finite Element Analysis to Envisage Interface Debonding in AA7020/Titanium Oxide Nanoparticulate Metal Matrix Composites, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.204-209.

33. B. Kotiveera Chari, A. C. Reddy, Interfacial Debonding Analysis in Nanoparticulate Reinforced Metal Matrix Composites of AA8090/Zirconium Carbide, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.210-214.

34. H. B. Niranjan, A. C. Reddy, Debonding Failure and Volume Fraction Effects in Nano-reinforced Composites of AA2024/Silicon Oxide, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.215-219.

35. B. Kotiveera Chari, A. C. Reddy, Effect of Debonding on Overall Behavior of AA3003/Titanium Carbide Nanoparticulate Reinforced Metal Matrix Composites, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.220-224.

36. P. M. Jebaraj, A. C. Reddy, Analysis of Debonding along Interface of AA4015/Magnesium Oxide Nanoparticulate Reinforced Metal Matrix Composites, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.225-229.

37. T. Iseki, T. Kameda and T. Maruyama, Interfacial reactions between SiC and aluminium during joining, Journal of Materials Science, Vol. 19 (5), pp.1692-1698, 1984.

38. R. Lin and K. Kannikeswaran, Interfacial reaction kinetics of Al/SiC composite during casting, In: Interfaces in Metal-Ceramic Composites, Proceedings of the International Conference, R. Lin, R. Arsenault, G. Martins and S. Fishman (eds.), Warrendale, PA: TMS, pp.153-164, 1990.