Fracture Behavior of Boron Nitride/Aluminum Metal Matrix Composites

B. Krishna Murthy

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

Boron nitride (BN) reinforced aluminum based composites are manufactured by stir casting route. The volume fraction of BN is varied as 10, 15 and 20 vol.% in the aluminum matrix. BN play an active role in strengthening Al matrix through effective load bearing and transfer by crack bridging.



Figure 1: Fractographs of BN/AL metal matrix composites (a) 10% BN (b) 15% BN and (c) 20% BN

References

- 1. 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.
- 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.
- 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.

- 4. 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.
- 5. 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.
- 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.
- 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.
- 8. 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.
- 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.
- B. Kotiveerachari, 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.
- 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.
- 12. 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.
- 13. 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.
- 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.
- 15. B. Kotiveerachari, 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.
- 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.
- 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.

- 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.
- 19. 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.
- B. Kotiveerachari, 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.
- 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.
- 22. B. Kotiveerachari, 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.
- 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.
- H. B. Niranjan, A. C. Reddy, Effect of Particulate Debonding in AA5050/Boron Nitride Nanoparticulate Reinforced Metal Matrix Composites, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.230-234.
- P. M. Jebaraj, A. C. Reddy, Interface Debonding Prediction Technique for Tensile Loaded AA6061/Zirconium Oxide Nanoparticulate MMC, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.235-239.
- 26. S. Sundara Rajan, A. C. Reddy, FEM Model for Volume Fraction Dependent Interface Debonding in TiN Nanoparticle Reinforced AA7020 Metal Matrix Composites, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.240-244.
- S. Sundara Rajan, A. C. Reddy, Deformation Behavior of AA8090/TiO2 Nanoparticulate Reinforced Metal Matrix Composites with Debonding Interfaces, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.245-248.
- A. C.Reddy, Micromechanical Modelling of Interfacial Debonding in AA1100/Graphite Nanoparticulate Reinforced Metal Matrix Composites, 2nd International Conference on Composite Materials and Characterization, Nagpur, India, 9-10 April 1999, pp.249-253.
- 29. B. Kotiveerachari, A. C. Reddy, Interfacial effect on the fracture mechanism in GFRP composites, CEMILAC Conference, Ministry of Defence, India, 20-21st August 1999, B85-87.
- A. C. Reddy, Micromechanical and fracture behaviors of Ellipsoidal Graphite Reinforced AA2024 Alloy Matrix Composites, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.96-103.
- B. Kotiveerachari, A. C. Reddy, Debonding Microprocess and interfacial strength in ZrC Nanoparticle-Filled AA1100 Alloy Matrix Composites using RVE approach, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.104-109.

- 32. S. Sundara Rajan, A. C. Reddy, Micromechanical Modeling of Interfacial Debonding in Silicon Dioxide/AA3003 Alloy Particle-Reinforced Metal Matrix Composites, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.110-115.
- 33. S. Sundara Rajan, A. C. Reddy, Role of Volume Fraction of Reinforcement on Interfacial Debonding and Matrix Fracture in Titanium Carbide/AA4015 Alloy Particle-Reinforced Metal Matrix Composites, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.116-120.
- 34. A. C. Reddy, Constitutive Behavior of AA5050/MgO Metal Matrix Composites with Interface Debonding: the Finite Element Method for Uniaxial Tension, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.121-127.
- 35. B. Kotiveerachari, A. C. Reddy, Interfacial Debonding of Boron Nitride Nanoparticle Reinforced 6061 Aluminum Alloy Matrix Composites, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.128-133.
- 36. P. M. Jebaraj, A. C. Reddy, Simulation and Microstructural Characterization of Zirconia/AA7020 Alloy Particle-Reinforced Metal Matrix Composites, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.134-140.
- 37. P. M. Jebaraj, A. C. Reddy, Continuum Micromechanical modeling for Interfacial Debonding of TiN/AA8090 Alloy Particulate Composites, 2nd National Conference on Materials and Manufacturing Processes, Hyderabad, India, 10-11 March 2000, pp.141-145.
- Ch. Rajana, A. C. Reddy, Interfacial Reaction between Zirconium Alloy and Zirconia Ceramic Shell Mold, National Conference on Advanced Materials and Manufacturing Technologies, Hyderabad, 18-20 March 2000, pp.212-217.
- S. Madhav Reddy, A. C. Reddy, Interfacial Reaction between Magnesium Alloy and magnesia Ceramic Shell Mold, National Conference on Advanced Materials and Manufacturing Technologies, Hyderabad, 18-20 March 2000, pp.218-222.
- 40. H. B. Niranjan, A. C. Reddy, Computational Modeling of Interfacial Debonding in Fused Silica/AA7020 Alloy Particle-Reinforced Metal Matrix Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.222-227.
- 41. H. B. Niranjan, A. C. Reddy, Nanoscale Characterization of Interfacial Debonding and Matrix Damage in Titanium Carbide/AA8090 Alloy Particle-Reinforced Metal Matrix Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.228-233.
- 42. S. Sundara Rajan, A. C. Reddy, Assessment of Temperature Induced Fracture in Boron Nitride/AA1100 Alloy Particle-Reinforced Metal Matrix Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.234-239.
- 43. S. Sundara Rajan, A. C. Reddy, Estimation of Fracture in Zirconia/AA2024 Alloy Particle-Reinforced Composites Subjected to Thermo-Mechanical Loading, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.240-245.
- 44. P. M. Jebaraj, A. C. Reddy, Finite Element Predictions for the Thermoelastic Properties and Interphase Fracture of Titanium Nitride /AA3003 Alloy Particle-Reinforced Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.246-251.

M. Tech Thesis

Department of Mechanical Engineering, University College of Engineering, Osmania University, Hyderabad

- 45. P. M. Jebaraj, A. C. Reddy, Effect of Thermo-Mechanical Loading on Interphase and Particle Fractures of Titanium Oxide /AA4015 Alloy Particle-Reinforced Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.252-256.
- 46. A. C. Reddy, Effect of CTE and Stiffness Mismatches on Interphase and Particle Fractures of Zirconium Carbide/AA5050 Alloy Particle-Reinforced Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.257-262.
- 47. A. C. Reddy, Behavioral Characteristics of Graphite /AA6061 Alloy Particle-Reinforced Metal Matrix Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.263-269.
- 48. A. C. Reddy, Prediction of CTE of Al/TiB2 Metal Matrix Composites, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.270-275.
- 49. A. C. Reddy, Significance of Testing Parameters on the Wear Behavior of AA1100/B4C Metal Matrix Composites based on the Taguchi Method, 3rd International Conference on Composite Materials and Characterization, Chennai, India, 11-12 May 2001, pp.276-280.
- A. C. Reddy, Mechanisms of Load Transfer in Tension to Estimate Interfacial Behaviour of Kevlar 29 / Epoxy Composites by Laser Raman Spectroscopy, National Conference on Advances in Manufacturing Technologies (AMT-2001), Pune, 9-10 March 2001, pp.205-207.
- 51. J. Kaneko, D.G. Kim and M. Sugumata, Proceedings of 2nd International Conference on Structural Application of Mechanical Alloying, Vancouver, British Columbia, Canada, 20-22 Sept., (1993) 261.
- 52. I.A. Ibrahim, F.A. Mohamed, and E.J. Lavernia, Particulate Reinforced Metal Matrix Composites—A Review, J. Mater. Sci., 1991, 26(5), p 1137–1156.
- 53. P.K. Rohatgi, D. Nath, S.S. Singh, and B.N. Keshavaram, Factors Affecting the Damping Capacity of Cast Aluminum-Matrix Composites, J. Mater. Sci., 1994, 29, p 5975–5984.
- 54. B.S. Majumdar, A.H. Yegneswaran, and P.K. Rohatgi, Strength and Fracture Behaviour of Metal Matrix Particulate Composites, Mater. Sci. Eng., 1984, 68, p 85–96.
- 55. A. Sato and R. Mehrabian, Aluminum Matrix Composites: Fabrication and Properties, Metall. Mater. Trans. B, 1976, 7(3), p 443–451.
- 56. H. Rumpf, The Strength of Granules and Agglomerates, Agglomeration, W.A. Knepper, Ed., Interscience Publishers, New York, 1962, p 379–418.
- 57. N. Harnby, M.F. Edward, and A.W. Nienow, Mixing in the Process Industries, 2nd ed., Butterworths-Heinemann Ltd., Oxford, 1985, 106 p.
- K.K. Chawla, Composite Materials, 2nd ed., Springer, New York, 1998, p 3–5 2. T.W. Clyne and P.J. Withers, An Introduction to Metal Matrix Composites, 1st ed., Cambridge University Press, Cambridge, 1993, p 1–10.
- S. Biswas, A. Shantharam, N.A.P. Rao, K. Narayana Swamy, P.K. Rohatgi, and S.K. Biswas, Bearing Performance of Graphitic Aluminum Particulate Composite Materials, Tribol. Int., 1980, 13, p 171– 176.