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Role of fine size zircon sand ceramic particle on controlling the cell morphology of aluminum composite foams

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ABSTRACT

Composite foams exhibit unique properties such as light weight, blast palliation, sound absorption, high energy absorption, and flame resistance. In the present investigation, role of fine size zircon sand ceramic particle on controlling the cell morphology of LM13 alloy-composite foams has been studied. For this purpose LM13 piston alloy of near eutectic composition is used as foaming matrix material and zircon sand ceramic particles as reinforcement. Composite foam was developed by stir casting route at different temperatures. Variation in microstructures of the composite foam is observed with the addition of zircon sand ceramic particles and also with varying foaming temperatures. The results show that the cell morphology parameters such as cell size, node and ligament length increases with increasing foaming temperature. However, the addition of zircon sand ceramic particles leads to decrement in the ligament length with increasing foaming temperature.

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1. Introduction

Metallic foams, as a new class of engineering materials, offer a unique combination of properties such as low density, energy absorption capability, high stiffness and strength. These improved properties of the metallic foams make them highly desirable materials for different engineering applications [1–4]. Recent improvements in the production methods for metallic foams have offered a variety of applications in different fields such as the automobile, railway and aerospace industries [5]. In these applications, the composite foam is subjected to high-velocity deformations. Miyoshi et al. [3] have shown the application of aluminum composite foam as a functional material for sound and impact energy absorption. Metallic foams are excellent impact energy absorber, and they can convert impact energy into deformation energy and absorb more energy than bulk metals at low stresses [4,6]. Main application of particle reinforced metallic composite foams is in defence and is used as passive safety systems due to energy absorption and dissipation properties of the foams. Both physical and mechanical properties of aluminum composite foams are not only controlled by composition of matrix and reinforcement but are also significantly affected by cell structure of foam [6]. Ma and Song [5] found that the Cell structure of aluminum foams can be

controlled by the foaming process where viscosity of the aluminum melt has be controlled by addition of Ca and continuous stirring of the melt. The average cell diameter of aluminum foams decreases with increasing viscosity of the melt. Many studies have been carried out to optimize the microstructural properties of aluminum foams as it influences the above said properties which are of at most importance. This includes the cell wall thickness, node size, ligament length and interdependent relationship of foam density with cell size [4–6]. Since all these microstructural properties are believed to originate from manufacturing condition of metallic foams [3,7], it is of interest to modify the processing conditions in order to achieve more uniform cell size distribution with reduced morphological defects for better performance. The blowing agent used for foaming decomposes in molten aluminum and generates gas bubbles therein. However, to have a uniformity in structure, it should generate the desired amount of gas bubbles of desired sizes during the foaming process. Apart from this the molten aluminum must possess a certain viscosity which is affected by the addition of ceramics particles so that the generated gas bubbles are retained in the aluminum matrix during solidification [8]. In this entire process, temperature plays an important role.

Role of reinforcement of SiC on foam stability has been studied by Prakash et al. [1] and also by Deqing and Ziquan [9]. They have controlled the stability of aluminum foam with the distribution of SiC particles and the addition of higher content of SiC, increase the brittleness nature of foam [9]. Mukherjee et al. [10] have studied the effect of SiC on the microstructure, density, and strength of closed

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Journal of Manufacturing Processes Society of Manufacturing Engineers (Dearborn, Mich.),1999 **Advanced Materials and Manufacturing Processes** Amar Patnaik,Malay Kumar Banerjee,Ernst Kozeschnik,Albano Cavaleiro,J. Paulo Davim,Vikas Kukshal,2021-10-14 This book discusses advanced materials and manufacturing processes with insights and overviews on tribology automation mechanical biomedical and aerospace engineering as well as the optimization of industrial applications The book explores the different types of composite materials while reporting on the design considerations and applications of each Offering an overview of futuristic research areas the book examines various engineering optimization and multi criteria decision making techniques and introduces a specific control framework used in analyzing processes The book includes problem analyses and solving skills and covers different types of composite materials their design considerations and applications This book is an informational resource for advanced undergraduate and graduate students researchers scholars and field professionals providing an update on the current advancements in the field of manufacturing processes **Nanomaterials in Manufacturing Processes** Dhiraj Sud,Anil Kumar Singla,Munish Kumar Gupta,2022-08-02 In the manufacturing sector nanomaterials offer promising outcomes for cost reduction in production quality improvement and minimization of environmental hazards This book focuses on the application of nanomaterials across a wide range of manufacturing areas including in paint and coatings petroleum refining textile and leather industries electronics energy storage devices electrochemical sensors as well as in industrial waste treatment This book Examines nanofluids and nanocoatings in manufacturing and their characterization Discusses nanomaterial applications in fabricating lightweight structural components oil refining smart leather processing and textile industries and the construction industry Highlights the role of 3D printing in realizing the full potential of nanotechnology Considers synthetic strategies with a focus on greener protocols for the fabrication of nanostructured materials with enhanced properties and better control including these materials characterization and significant properties for ensuring smart outputs Offers a unique perspective on applications in industrial waste recycling and treatment along with challenges in terms of safety economics and sustainability in industrial processes This work is written for researchers and industry professionals across a variety of engineering disciplines including materials manufacturing process and industrial engineering *Advanced Manufacturing Processes* Hitesh Vasudev,Chander Prakash,Mohammad Khalid,Kavindra Kesari,2025-01-31 The increasing demand for advanced manufacturing processes is making an impact on the Earth s resources and its industrial practices are producing negative impacts on the environment such as carbon footprints energy resources waste etc The trend of advanced manufacturing coincides with the acceleration of innovations in sustainable techniques **Advanced Manufacturing Processes Integration of Sustainable Approaches** focuses on sustainability materials the 6 Rs reuse recycle redesign remanufacture reduce and recover lifecycle engineering and life cycle assessment It discusses sustainability in manufacturing and the impact on plant

performance while keeping in mind IR 4.0 and highlights issues related to materials recovery and a circular economy. The book also presents the use of new sustainable materials in processes and their impact on the environment and plant performance. Case studies are offered to enable the reader to get a comparison of the manufacturing processes based on individual sustainability. All aspects related to the implementation and adoption of sustainable advanced manufacturing approaches are encapsulated in this book along with their applications which makes this a useful book for industry, academic, teaching, research, scholars and experts dealing with sustainability related issues.

Sustainable Manufacturing Processes R. Ganesh Narayanan, Jay S. Gunasekera, 2022-10-08. Sustainable Manufacturing Processes provides best practice advice on sustainable manufacturing methods with examples from industry as well as important supporting theory. In the current manufacturing industry processes and materials are developed with close reference to sustainability issues with an outward look to optimum production efficiency and reduced environmental impact. Important topics such as the use of renewable energy, reduction of material waste and recycling, reduction in energy and water consumption and reduction in emissions are all discussed along with broad coverage of deformation and joining technologies, computational techniques and computer aided engineering. In addition, a wide range of traditional and innovative manufacturing technologies are covered including friction stir welding, incremental forming, abrasive water jet machining, laser beam machining, sustainable foundry, porous material fabrication by powder metallurgy, laser and additive manufacturing and thermoelectric and thermomagnetic energy harvesting. Features practical case studies from industry experts. Explains methods for reducing waste in additive manufacturing. Provides a detailed examination on how sustainability is measured in manufacturing.

Advances in Sustainable Machining and Manufacturing Processes Kishor Kumar Gajrani, Arbind Prasad, Ashwani Kumar, 2022-05-18. This text provides an in depth overview of sustainability in machining processes, challenges during machining of difficult to cut materials and different ways of green machining in achieving sustainability. It discusses important topics including green and sustainable machining, dry machining, textured cutting, coated tools for machining, solid lubricants based machining, gas cooled machining, cryogenic cooling for intelligent machining, artificial neural network for machining, big data based machining and hybrid intelligent machining. This book covers advances in sustainable machining such as gas cooled machining, near dry machining and minimum quantity lubrication. Explores use of big data, machine learning and artificial intelligence for machining processes. Provides case studies and experimental design as well as results with analysis focusing on achieving sustainability. Discusses artificial intelligence and machine learning based machining processes. Cover the latest applications of sustainable manufacturing for a better understanding of the concepts. The text is primarily written for senior undergraduate, graduate students and researchers in the fields of mechanical manufacturing, industrial production, engineering and materials science.

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Table of Contents Journal Of Manufacturing Processes

1. Understanding the eBook Journal Of Manufacturing Processes
 - The Rise of Digital Reading Journal Of Manufacturing Processes
 - Advantages of eBooks Over Traditional Books
2. Identifying Journal Of Manufacturing Processes
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Journal Of Manufacturing Processes
 - User-Friendly Interface
4. Exploring eBook Recommendations from Journal Of Manufacturing Processes
 - Personalized Recommendations
 - Journal Of Manufacturing Processes User Reviews and Ratings
 - Journal Of Manufacturing Processes and Bestseller Lists
5. Accessing Journal Of Manufacturing Processes Free and Paid eBooks
 - Journal Of Manufacturing Processes Public Domain eBooks
 - Journal Of Manufacturing Processes eBook Subscription Services
 - Journal Of Manufacturing Processes Budget-Friendly Options
6. Navigating Journal Of Manufacturing Processes eBook Formats

- ePub, PDF, MOBI, and More
- Journal Of Manufacturing Processes Compatibility with Devices
- Journal Of Manufacturing Processes Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Journal Of Manufacturing Processes
 - Highlighting and Note-Taking Journal Of Manufacturing Processes
 - Interactive Elements Journal Of Manufacturing Processes
- 8. Staying Engaged with Journal Of Manufacturing Processes
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Journal Of Manufacturing Processes
- 9. Balancing eBooks and Physical Books Journal Of Manufacturing Processes
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Journal Of Manufacturing Processes
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Journal Of Manufacturing Processes
 - Setting Reading Goals Journal Of Manufacturing Processes
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Journal Of Manufacturing Processes
 - Fact-Checking eBook Content of Journal Of Manufacturing Processes
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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