



# Chapter 4

## Mechanical Alloying of Aluminium Alloys

**Rayappa Shrinivas Mahale**

 <https://orcid.org/0000-0002-0508-9871>  
REVA University, India

**P. C. Sharath**

 <https://orcid.org/0000-0003-2939-5889>  
Jain University, India

**Krishnamurthy P. Goggi**

Jain College of Engineering and Research, India

**Rajendrachari Shashanka**

Bartın University, Turkey


**Shamanth Vasanth**

REVA University, India


**Prashant Kakkamari**

KLS Gogte Institute of Technology, India

**Gangadhar M. Kanaginahal**

 <https://orcid.org/0000-0002-0823-6507>  
Jain College of Engineering and Research, India

**Adarsh Patil**

 <https://orcid.org/0000-0002-6917-6245>  
KLE Technological University, India

**Vaibhav S. Raibole**

Jain College of Engineering and Research, India

### ABSTRACT

*Mechanical alloying is a solid-state powder processing technique that has revolutionized the development of advanced materials, including aluminium alloys. This chapter provides a concise overview of the key aspects of mechanical alloying applied to aluminium alloys, exploring its principles, advantages, and potential applications. The process of mechanical alloying involves subjecting aluminium powder and alloying elements to intense mechanical deformation using a high-energy ball mill. This results in repeated welding, fracturing, and cold welding of particles, leading to the creation of a homogenous and fine-grained microstructure. The alloying mechanisms encompass solid-state diffusion and deformation-induced mixing, facilitating the uniform dispersion of alloying elements within the aluminium matrix. Mechanical alloying has several distinct advantages over conventional alloying methods.*

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## **1. INTRODUCTION**

### **1.1 Background and Significance**

In the field of materials science and engineering, mechanical alloying has emerged as a pioneering technique that allows the synthesis of novel materials with exceptional properties. Specifically, the application of mechanical alloying to aluminium alloys has garnered substantial attention due to the versatile range of properties these materials can exhibit (Zhang, Guo, Chen et al, 2019). Conventional methods of alloying aluminium, such as melting and casting, often result in limited control over microstructures and may lead to the segregation of alloying elements. In contrast, mechanical alloying offers a solid-state processing route, enabling the creation of homogeneous and finely dispersed alloy compositions, which in turn, yield superior mechanical and chemical characteristics (Mao et al., 2019). The increasing demand for lightweight, high-performance materials in industries like aerospace, automotive, and electronics has spurred the interest in developing advanced aluminium alloys through mechanical alloying (Zheng et al., 2019).

### **1.2 Objectives of the Chapter**

The primary objectives of this chapter are to provide a comprehensive overview of the principles, techniques, and applications of mechanical alloying in the context of aluminium alloys. The chapter aims to delve into the fundamental aspects of the mechanical alloying process, including the mechanisms behind alloy formation and microstructural evolution. Additionally, it seeks to explore the influence of process parameters on the properties of mechanically alloyed aluminium alloys. Through a detailed examination of mechanical properties, corrosion behavior, and potential applications, this chapter aims to showcase the superior performance of these materials in comparison to conventionally alloyed counterparts. Furthermore, the chapter intends to identify the challenges faced in the mechanical alloying process and potential solutions to overcome them, making it a valuable resource for researchers, engineers, and students working in the field of materials science.

### **1.3 Scope and Limitations**

While mechanical alloying has demonstrated significant promise in enhancing the properties of aluminium alloys, it is essential to recognize the scope and limitations of this technique. The chapter will focus on the fundamental principles and theoretical aspects of mechanical alloying as applied to aluminium alloys (Affolter et al., 2019).

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