



## ALUMINIUM-TITANIUM DIBORIDE (AL-TIB2) IN-SITU MATRIX COMPOSITE SYNTHESIS AND CHARACTERIZATION, AND STUDY OF TRIBOLOGICAL AND MECHANICAL PROPERTIES

Mangirish Deshpande<sup>1</sup>, Chaitali S P. Tendulkar<sup>2</sup>, Sujit K Nagare<sup>3</sup>,  
Shruti rathore<sup>4</sup>, Avani Sharma<sup>5</sup>, Pearl Dighe<sup>6\*</sup>

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### Abstract

Situ matrix composite can more be expensive than other materials. It is less cost effective for certain applications. Situ matrix composite knows the high strength to weight ratio. It may be prone to cracking, delimitation of other forms of damage over time. Situ matrix composite can be more difficult in process than other materials. It is requiring for the specialized requirements and expertise in the situ matrix composite. This can make it more challenging and more consuming to manufacture products using these materials. Overall the situ matrix composite typically out weight the potential side effects for many applications. High cost situ matrix composite can be more expensive to produce than traditional materials due to the complexity of the manufacturing process and the need for specialized equipment. The manufacturing process for the situ matrix composites can be complex and difficult to control, leading to variations in the material properties. Limited of the design flexibility for the situ matrix composites are typical made in specific shape. This is why, which can limit their design flexibility compare to other materials that can be easily molded or form.

**Keywords:** Matrix, Aluminum, Titanium, Reinforcement, Composite, Dioxide

<sup>1</sup>Department of Pharmacology, PES Rajaram and Tarabai Bandekar College of Pharmacy, Farmagudi Ponda, Goa, India

<sup>2</sup>Department of Pharmaceutical Chemistry, PES Rajaram and Tarabai Bandekar College of Pharmacy, Farmagudi Ponda, Goa, India

<sup>3</sup>Department of Pharmacognosy, Dnyandeep College of Pharmacy, Boraj-Khed Ratnagiri, Maharashtra, India

<sup>4</sup>LCIT School of Pharmacy, Near High Court, Bodri, Bilaspur Chhattisgarh, India

<sup>5</sup>Bharat Institute of Technology School of Pharmacy, NH58 Bypass, Partapur, Meerut, Uttar Pradesh 250103

<sup>6\*</sup>Department of Pharmaceutics, PES Rajaram and Tarabai Bandekar College of Pharmacy, Farmagudi Ponda, Goa, India

Email: <sup>6\*</sup>pirespearl@gmail.com

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### Corresponding Author

Pearl Dighe<sup>6\*</sup>

<sup>6\*</sup>Department of Pharmaceutics, PES Rajaram and Tarabai Bandekar College of Pharmacy, Farmagudi Ponda, Goa, India

## 1. Introduction

The Synthesis and characterization of Al-TiB<sub>2</sub> In-situ matrix composites involves the creation of a composite material consisting of aluminum. Al as the matrix and titanium dioxide as the reinforcement phase [1]. The in situ synthesis process involves the simultaneous formation of the matrix and the reinforcement phases within the

composite material. The synthesis process involves the preparation of the starting materials and their making in the appropriate ratios [2]. The mixture of then subjected to a high energy milling process to promote the formation of the desired composite structure. The resulting powder is the consolidated into a solid composite material using techniques. Such as hot pressing in or spark plasma sintering.

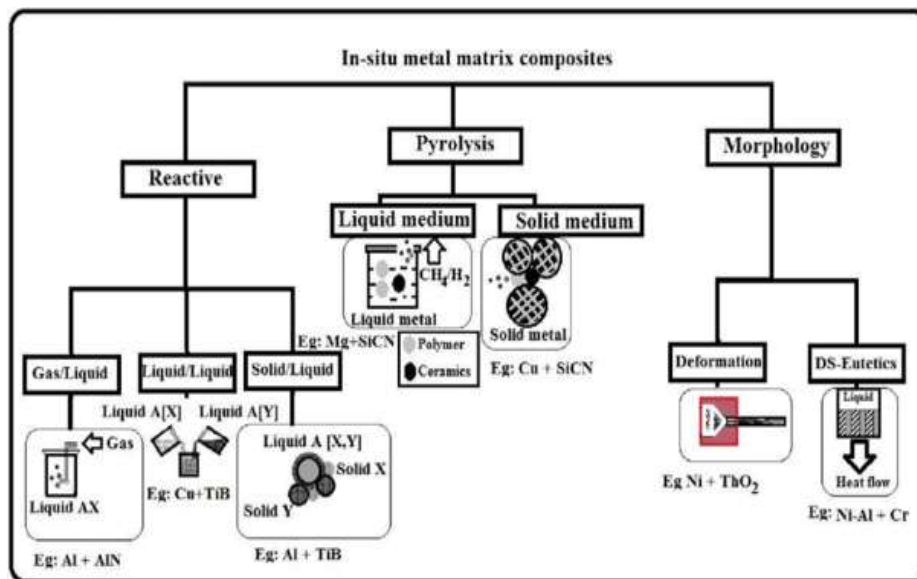


Figure 1: Situ matrix complex

The characterization of Al-TiB<sub>2</sub> In-situ matrix composites involves the analysis of the microstructure. Mechanical properties are the tribological behavior of the material [4]. The situ matrix composites techniques are such as scanning electron microscopy, x-ray diffraction, and energy dispersive spectroscopy. It can be use to analyze the microstructure and phase composition of the composite material. Mechanical testing such as hardness, tensile and compressive strength can be performed in determine the mechanical properties of the composite material. The study of tribological and mechanical properties is the Ai Tib2 in situ matrix [6]. It can composites of help in understanding the behavior of the material under different loading and environmental conditions.

### Objectives

- To composite a aluminum metal of a with a high strength and high specific stiffness
- To use in saving weight for long term application in the Al-TiB<sub>2</sub> In-situ matrix composites
- To the use of side effects in Al-TiB<sub>2</sub> In-situ matrix composites

- To specialized application in such areas like cutting tools, wear resistant of coatings, crucibles, neutron absorbers resistant armor
- To use vapor coating aluminum for the evaporate boat
- To analyze the disadvantage of the use of Al-TiB<sub>2</sub> In-situ matrix composites
- To use the structural titanium metal for the increase of oxidation resistance

## 2. Methodology

In situ matrix composites are form by the creation of a metal matrix with a ceramic reinforcement material. In the case of Al Tib2 in situ matrix composites aluminum is the metal matrix and titanium dioxide [8]. It is the ceramic reinforcement material in the AI Tib2 in situ matrix composition. The synthesis of Al Tibu 2 in the matrix composite involves the following steps. Preparation of tibu powder is the synthesized by a reaction between titanium and boron in a furnace under an inert atmosphere.

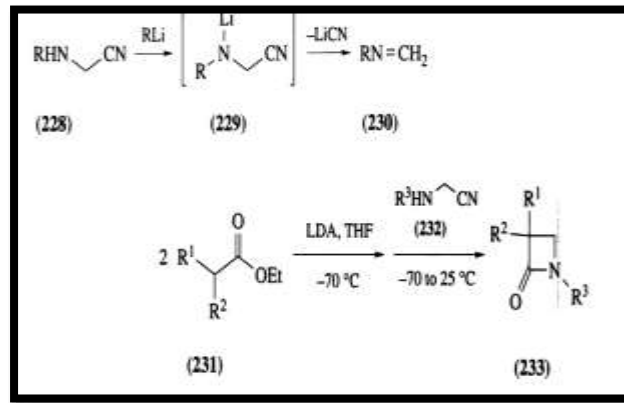


Figure 2: Composite of situ matrix complex

(Source: 5)

Matrix of the tib2 powder is with molten aluminum. The tib2 powder is mix with molten aluminum in form a homogeneous mixture. Reaction between tib2 and molten aluminum the mixture was heat to a temperature above the melting point of the aluminum [11]. This reaction occurs between tib2 and aluminum to form Al. Tib2 situ matrix composites are casting of the composites in a desired shape. The characteristics in Al tib2 composites are following in such techniques. Scanning electronic microscopy is use to observe the microstructure of the composites [12]. X-ray diffraction is use to identify the phases present in the composites. Transmission electron is use in study the crystal structure and morphology of the composites. Hardness and wear tests are perform to evaluate the mechanical and tribological properties of the composites.

### Composite A aluminum metal of a with a high strength and high specific stiffness

Composite material made with aluminum matrix can offer superior properties compared to pure aluminum. One example in aluminum reinforced with ceramic particles or fibers [9]. This is the can strength, stiffness and wears resistance of the material. Others types of composites include aluminum reinforce with carbon fibers, glass fibers, or other material such as titanium. These composites can also improve the mechanical properties of aluminum [12]. Such as strength, durability, and resistance to corrosion. Aluminum matrix composite can be manufacture using various techniques. Such as casting, powder metallurgy and infiltration.

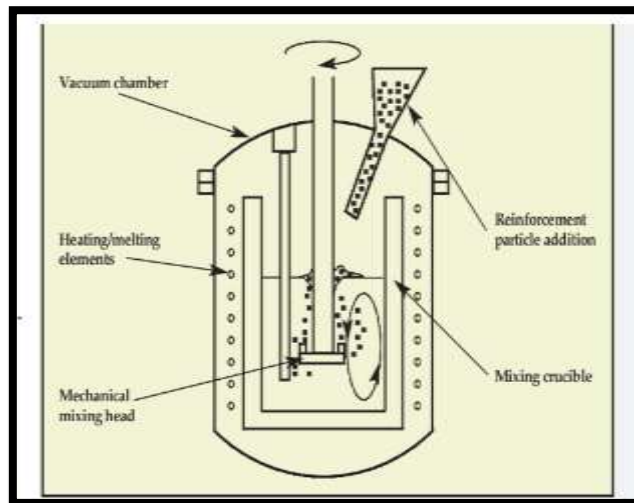


Figure 3: Composite of aluminum metal

The specific manufacturing process used depends on the desired properties and the intended applications of the composite materials. Overall aluminum matrixes composites are promising class

of materials that can offered improve performance. There are various industry such as aerospace, automobile and electronics in the situ matrix complex [15]. Aluminum metal is a chemical

element with the symbol of Al and its atomic number is 13. It is a lightweight, silvery white, soft, ductile metal[12]. However, pure aluminum is not commonly used in construction or other applications due to its low strength and hardness. Instead, composite materials made of aluminum are often used to provide strength and durability. One popular composite material made of aluminum is aluminum composite panel, which is used extensively in the construction [14]. In industry aluminum is the lightweight, durable and fire resistance properties.

**Use the Side Effects in Al-Tib2 in-Situ Matrix Composites**

Situ matrix composite is a type of composite material made by combining a matrix material. Such as epoxy or thermoplastic with reinforce fibers. The materials used in the situ matrix composites such as resin and fibers can release hazardous chemicals [12]. During the manufacturing process or when the composite is damaged.

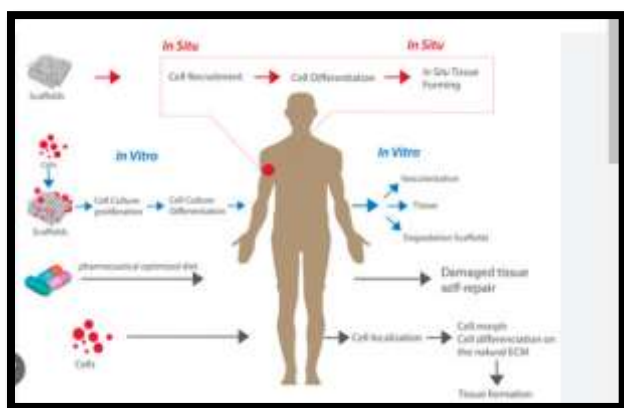


Figure 3: Side effect on situ matrix composite in human body

These can pose a health risk to the workers who handle the materials or people who meet it. The production of the situ matrix composite can have an environmental impact due to the use of non-renewable resources and the release of pollutants into the air and water.

**Disadvantage of the Use of Al-Tib2 in-Situ Matrix Composites**

situ matrix composite have several advantages , including high strength to weight ratio, corrosion resistance and low thermal expansion coefficient. However, there are also some disadvantages

associated with their use. One major advantage is their high cost use of situ matrix [8]. Situ matrix composite involves complex and specialized techniques, which can drive up cost of production. Additionally the cost of raw materials used in the production the situ matrix complex. The composites of situ matrix can be expensive, particularly advanced materials such as ceramic matrix composites [7]. Another advantage is there susceptibility to damage from impact and mechanical stresses. While situ matrix composites are strong and stiff.

Synthesis method	Filler content	Advantages	Disadvantages
Spray winding	50-80 wt%	-Large scale production -Good alignment	Relatively complex apparatus
Shear press	60-70 wt%	Good alignment	Small scale production
Capillary rise infiltration	40-60 wt%	Simple apparatus	Limited to thermoplastic polymer
In-situ	5-70 wt%	-Polymerisation and	Limited to certain type

Figure 4: Advantage and disadvantage of situ matrix composite

They can be brittle and prone to cracking or fracture when subjected to impact and high stresses [11]. This can limit their high use in application where they may be exposing to such conditions. Furthermore, the properties of situ matrix composite can also be affecting by temperature and environmental conditions.

### Vapor Coating Use of Aluminum

Vapor coating also known as physical vapor deposition. A thin film is deposit on a substrate

material by evaporating a solid metal or alloy in a vacuumed chamber [5] in proceeds. Aluminum is a commonly used in a material to vapor coating due to is unique properties. Such as being lightweight, corposant resistance, and having a high thermal conductivity. Aluminum vapor coating often used to in various industry, including aerospace, Automobile and electronic industry [9]. Aluminum coated components are used in spacecraft and satellite application due to their ability withstand harsh environment and extreme temperature.

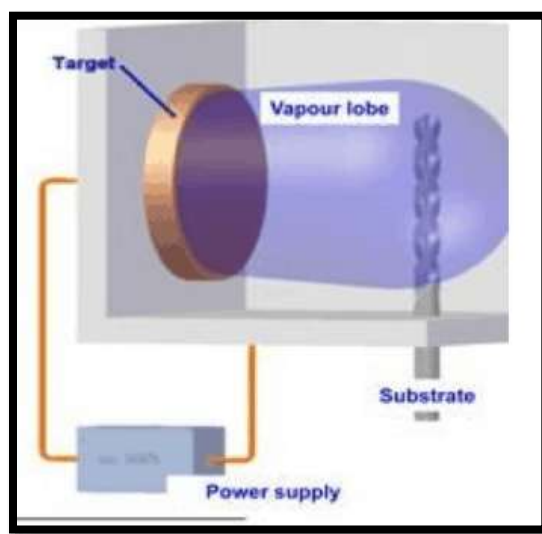


Figure 5: Vapor coating of aluminium

In the automobile industry aluminum, vapor coating is use on engine components. Such as pistons and cylinder are heads to improve their wear resistance and durability. In the electronics industry aluminum, coated components are use in electronic devices. Such as smart phones and laptops to improve there thermal management and reduce heat buildup [8]. Overall vapor coating of aluminum is a versatile process that can be use to improve the performance and durability of various materials in a range of industry.

### Problem Statement

Situ matrix composites are a type of composite materials that consists of a ceramic or material reinforce with fabrics and particles. These components offer several problems over conventional materials [15]. It is including high materials, stiffness, and wear resistance. It is as well as good thermal and chemical resistance.

### 3. Conclusion

The properties of the situ matrix composites depend on the type and volume. Fraction of the reinforcement of materials is the properties of the matrix material. Generally, these composites

exhibit superior mechanical, thermal, and chemical properties compared to their constituent material. The fabrication situ composite can be complex. It is often involving the multiple steps such as infiltration, sintering and hot pressing. However, the new processing such as additive manufacturing and infiltration casting have made the process easier, simpler, and most cost effective.

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