INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Research Article

ALU-ALU Packaging Vs ALU-PVC Blister Packaging: Waste to Value - A Comparative Analysis

Charmi Patel[1], Hitesh Dani[2], Maitreyi N. Zaveri[3], Zuki Patel*[4]

[1]*B. Pharm, M. Pharm, K.B. Institute of Pharmaceutical Education and Research, Gandhinagar.*
[2]*Director, Saviour Pharmaceuticals, Ahmedabad.*
[3]*M. Pharm, Ph.D., Professor & Head of Department of Regulatory Affairs, K.B. Institute of Pharmaceutical Education and Research, Gandhinagar.*
[4]*M. Pharm, Department of Regulatory Affairs, K.B. Institute of Pharmaceutical Education and Research, Gandhinagar.*

ARTICLE INFO

Published: 28 Mar. 2025
Keywords:
Packaging Materials, Aluminium Packaging, Polyvinyl Chloride and Polyvinyl Dichloride Packaging Materials.
DOI:
10.5281/zenodo.15100484

ABSTRACT

To ensure the safety and effectiveness of oral solid medications, pharmaceutical packaging is crucial for shielding them from mechanical, chemical, and environmental risks. The function of various packaging technologies, in particular ALU-ALU and ALU-PVC blister packs, in preserving product stability is examined in this article. While ALU-PVC adds a plastic layer for flexibility, ALU-ALU offers better protection without plastic. The primary, secondary, and tertiary systems of packaging each have specific functions in distributing and protecting the product. The study emphasizes how crucial it is to select suitable packaging to satisfy legal requirements and encourage patient adherence.

INTRODUCTION

Especially when referred to as ALU-ALU Packaging, typically does not contain plastic within the layers of aluminium used. However, in other types of Blister Packaging, Such as Alu-PVC a layer of Plastic (Polyvinyl Chloride or PVC) is used along with aluminium. Understanding the composition of different blister packaging types is crucial for discerning their protective capabilities and appropriate application in the pharmaceutical industry.

Introduction of Oral Solids

In the pharmaceutical sector, packaging plays a critical role in preserving the quality of drug goods

***Corresponding Author:** Zuki Patel
Address: M. Pharm, Department of Regulatory Affairs, K.B. Institute of Pharmaceutical Education and Research, Gandhinagar.
Email ✉: zuki.patel@kbiper.ac.in
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

during distribution as well as ensuring their safety and effectiveness. The packaging serves as an essential barrier, shielding the medication from external influences and guaranteeing its stability from manufacturing to the final consumer, even though the drug itself has a set shelf life. In addition to providing protection, packaging is essential for increasing customer attractiveness. A well-designed packaging with eye-catching artwork and useful design can have a big impact on customer loyalty and perception. For example, medications packaged in premium, laminated blisters or cartons protect the substance and encourage proper dose, both of which contribute to improved health results. To ensure the quality of pharmaceutical items during storage, transportation, delivery, sale, and usage, pharmaceutical packaging is essential. To guarantee that the medications reach the patient safely, the packaging is designed to encapsulate or protect the pharmaceutical items. The process of properly positioning pharmaceuticals to maintain their therapeutic efficacy from the moment of packaging till consumption is known as packaging.

"Packaging Is the Art and Science Which Involves Preparing the Articles for Transport, Storage, Display and Use."

There are 3 types of packaging systems available for pharmaceutical industries which are

I. **Primary Packaging:** The container that is directly in contact with the medication formulation. The primary objective of this packaging is to protect the product from environmental, chemical, mechanical, and other hazards. The stability of the product largely depends on the material used for the packaging.

II. **Secondary Packaging:** The package outside the primary container is referred to as the secondary packaging system, which includes plastic crates, cardboard, and show boxes, also known as cartons. This system provides additional protection during warehousing and delivers detailed information about the product, such as leaflets. The two main functions of these systems are to protect the flexible containers and to safeguard them from rough handling during transportation.

III. **Tertiary Packaging:** The tertiary packaging system is the outer package of the secondary packaging which is supposed to prevent the products from damage. Common types of tertiary packaging in pharmaceutical industry are cardboard boxes, Pallets and Shrink films. It needs to be robust enough to withstand the environmental challenges during transport. Packaging plays a critical role in preserving the purity and quality of pharmaceutical products, safeguarding them from spoilage, contamination, and manipulation. This ensures that a safe and effective dosage form is available to patients up until the product's expiration. In an industry as highly regulated as healthcare, it is imperative for healthcare organizations and pharmacies to utilize packaging that complies with the stringent requirements set forth by regulatory authorities, such as the U.S. Food and Drug Administration (FDA).

The ideal requirements for the container or package should be such as:

1. Protection from Environmental Hazards.
2. Protection from Mechanical Hazards.
3. Prevention of Leaching.
4. Appealing Appearance.
5. Ease of Access.
6. Tamper-Resistant and Child-Resistant Features.
7. Cost-Effectiveness and Sustainability

Aluminium As a Packaging Material in Medicinal Industry:

The medical field is an important but sometimes dangerous one. The type of goods and services it offers patients is the cause. Aluminium is an incredibly flexible material that is used extensively in many different industries, but it is most commonly used in the healthcare sector. Its distinct combination of chemical and physical qualities has made it an appealing choice for pill, capsule and medicine packaging. Its outstanding durability and lightweight nature stand out among its many benefits for pharmaceutical packaging, making it convenient to handle and deal with.

Figure 1. ALU-ALU Blister Packaging

Superior protection against environmental elements that can jeopardize the stability or potency of medications is offered by aluminum foil. Additionally, these barrier qualities contribute to the product's longer shelf life, which is important for pharmaceutical organizations that need to handle their sensitive medications with precision. Nevertheless, there are worries about the possible health hazards connected to the use of aluminium in pharmaceutical packaging, despite its many benefits. It is commonly known that certain drugs and aluminium might interact chemically, compromising the treatment's safety and effectiveness. In severe cases, aluminium may even gradually infiltrate into the medication, causing an accumulation of aluminium in the body. The aluminium foil is used to create a push-through closure with lid film or blister film where tablets and capsules are protected perfectly and hygienically. These blister packs are compact and easy to port and handle. The integration of aluminum foil has made aluminum blister foil manufacturers keep every tablet well protected from the effects of the external environment and hence keep the effectiveness of all the tablets intact.

Types of Aluminium Foil Packaging:

1. **Blister Packs:** These are the most common form of pharmaceutical packaging. They consist of a cavity or pocket made from a formable material, usually plastic and a lidding material made from aluminium foil. Blister packs are used for tablets and capsules, providing a secure environment and easy access for patients.
2. **Strip Packs:** In strip packs, tablets or capsules are enclosed between two layers of aluminium foil. This type of packaging offers excellent protection but can be less convenient for patients to open compared to blister packs.
3. **Child-Resistant Foil**: Safety is a key concern in pharmaceutical packaging. Aluminium foil can be designed to be child-resistant, ensuring

that children cannot easily access the medications, thereby preventing accidental ingestion.

PVC/PVDC As a Packaging Material in Medicinal Industry:

Two blister packaging materials that are frequently used in the pharmaceutical business are PVC (polyvinyl chloride) and PVDC (polyvinylidene chloride), although they can be hazardous to people and the environment. Pharmaceutical firms are therefore searching for fresh substitutes. Although polypropylene is a good option, processing it can be challenging. This article offers several coping mechanisms and performs a quick examination in this area.

Figure 2. PVC/PVDC Blisters Packaging

In medical blister packaging, PVC, either by itself or in conjunction with polyvinylidene chloride (PVDC), aluminum chlorotrifluoroethylene (CTFE), or oriented polyamide nylon (OPA), accounts for nearly all of the market. PVC is an inexpensive, transparent polymer that has a low permeability index to air humidity, good thermoforming, physical, and chemical resistance, and low permeability to oils, fats, and aromatic compounds. PVC is the most used material for blister packing, yet it provides the least amount of protection of any material. The pharmaceutical industry typically uses PVDC film, which is 0.2 mm to 0.8 mm thick and more rigid than PVC. Because the greater the thickness, the less likely it is that light will travel through the film, thickness has a profound effect on light barrier qualities. PVC and PVDC materials come in a variety of colors, including blue, red, amber, white opaque, clear translucent, and more. Since clear transparency has a lower barrier, it is mostly utilized for medications that remain stable when exposed to light and moisture. PVDC is used in PVC Laminated or coated packaging, reducing the permeability of PVC to oxygen and moisture by 5-10 times. PVDC cannot be used as a sole material due to its relatively high cost and mechanical properties. For items like multivitamin pills or capsules that have a long shelf life and are not very sensitive to external conditions, PVDC combined with a PVC base coat yields the best results. PVC has good chemical resistance and low permeability to oils, fats, and flavouring ingredients. When combined with PVDC, gas and moisture permeability is reduced significantly compared to uncoated PVC. This coating is critical for maintaining the integrity and shelf life of Pharmaceutical Products. Other Coatings like PVC/CTFE, Offer even lower water-Vapour permeability. For medications requiring the utmost

protection, a combination of OPA/ Aluminium/PVC is chosen. PVC is a non-toxic, inert substance. Its formulation for pharmaceutical applications ensures the safety and effectiveness of drugs by not interacting with them. used in pharmaceutical packaging for many years. PVC satisfies several international regulatory requirements for medicine packaging and has a demonstrated safety profile. PVC is extremely versatile for a variety of drug forms due to its ease of processing into diverse shapes. PVC is made without plasticizers when it comes to blisters. The plastic is very flexible even without softening additives. To improve its barrier qualities or for other practical purposes, PVC is easily laminated or coated with various materials. For example, to strengthen the barrier against gases and moisture, a layer of PVDC can be applied. Unlike other polymers, PVC is mainly composed of table salt-derived chlorine. As a result, PVC is more economical than alternatives and uses less primary energy derived from fossil fuels. Unlike other polymers, PVC is mainly composed of table salt-derived chlorine. As a result, PVC is more economical than alternatives and uses less primary energy derived from fossil fuels.

Reasons for selecting PVC/PVDC:

1) Low Permeability:
2) Increased Safety:
3) Excellent Thermo Formability:
4) Compatibility with other materials:
5) Cost-efficiency:
6) Enables radiation sterilization
7) Available in varied sizes and color shades
8) Finest organoleptic properties so the taste and odor is neutral
9) High dimension stability
10) Remarkable heat-sealing Properties
11) High dimension stability
12) Gas transmission and moisture rates are low
13) Appreciable vacuum formation, toughness and durability.

Alu-Alu Blister Packaging:

1. Composition:

- ALU-ALU blister packaging consists entirely of Aluminium Layers that creates a robust barrier against moisture, Light and Oxygen. In this type, Both the base and lidding materials are made from aluminium films. This structure provides a very high level of protection making it ideal for sensitive pharmaceutical products. ALU-ALU comes in a multiple layered structure and used as aluminium based materials for both the base and lidding of the blister packs. Aluminium foil layers play a vital role in protecting the content inside the blister cavity. Additionally, it also serves as a shield against moisture, air and UV rays and also enhance shelf life and tamper resistance.

2. Manufacture:

- Typically, the ALU-ALU blister packs are produced by the following steps:

A. **Blister Formation:** Due to the characteristics of the materials, ALU-ALU packaging is made by cold forming. The aluminium foil is sandwiched between layers of plastic film during the process. The laminate is pressed into a mold cavity using a stamp without applying heat.

B. **Product Filling:** The formed blister pack is then transferred to the filling station, where the cavities are filled with the required products.

C. **Sealing:** After filling, another layer of aluminum foil is applied on top of the filled blister cavities by sealing.

D. **Perforation and Cutting:** The sealed blisters are then perforated if necessary and cut into individual packs.

3. Advantages:

- Aluminium foil offers exceptional protection for the medication from humidity, oxygen and UV radiation. These external elements could degrade its quality or efficacy.
- The robust design of the ALU-ALU pack safeguards against physical damage or impact during handling, transportation, and storage.
- Superior barrier properties of ALU-ALU packaging contribute to an extended shelf life for pharmaceutical products.
- ALU-ALU Packaging features tamper resistance. For example, blister perforation or tear-off tabs can provide visible indications of tampering. This ensures the integrity of the products inside.

4. Disadvantages:

- ALU-ALU is generally more expensive than other packaging solutions due to aluminum-based materials. It can lead to increased production costs.
- Though the aluminum foil itself is recyclable the blisters in ALU-ALU Packaging are not made from this single material.
- Also, Aluminium foil is not biodegradable, so it has environmental implications to some extent.
- The aluminum-based materials used in the packaging make it difficult to visually inspect the contents of each blister cavity without opening the package.
- Aluminium foil is not that flexible compared to plastic material. It can't be simply molded into any shape.

Alu-Pvc Blister Packaging:

1. Composition:

- ALU-PVC integrates a layer of Plastic along with aluminium specially, it uses a clear PVC film as the base, which is coated with aluminium foil. This combination allows for better visibility of the product but generally offers less barrier protection compared to the ALU-ALU packaging. The choice between ALU-ALU and ALU-PVC packaging hinges on the sensitivity of the products being packaged. ALU-ALU's full aluminium composition serves to protect hygroscopic medications from environmental factors which is critical for their stability and efficacy. ALU-PVC blister packaging incorporates a plastic layer along with aluminium, serving to provide different levels of protection based on the needs of the product being packaged.
- ALU-PVC is a combination of 2 materials which utilizes a clear PVC film as its base coated with a layer of Aluminium foil to create the blister pack. It also offers a robust and flexible base for securely holding the medication. Aluminium foil layer is sealed to the PVC film providing a protective barrier to prevent moisture, oxygen and light from degradation.

2. Manufacture:

- The ALU-PVC packaging process is quite similar to the ALU-ALU process. The major difference lies in the blister forming step.

A. **Blister Formation:** ALU-PVC packaging utilizes thermoforming. The plastic film is heated to a specific temperature to be soft and pliable. It is then placed on a mold and subjected to vacuum or pressure to shape the blister cavity.

B. **Product Filling:** After being formed, the blister pack is taken to the filling station, where the products are placed into each cavity.

C. **Sealing:** A layer of aluminium foil is heat-sealed to the preformed PVC blister pack. All cavities are securely covered and sealed.
D. **Perforation and cutting:** This step is the same as the one during the ALU-ALU packaging process.

3. Advantage:

- ALU-PVC blister packs are made of plastic based materials. This results in lower production costs, making it a more cost-effective option for pharmaceutical packaging.
- It allows for easy visibility of medications inside the blister cavities. This enables end consumers to check the product integrity and verify the dosage before consumption.
- Packaging is more flexible and versatile in customization. The PVC blister cavities can be easily molded to accommodate different product shapes and sizes.

4. Disadvantage:

- While Alu-PVC packaging provides reasonable protection, it may not offer the same barrier performance level as Alu-Alu packaging.
- The plastic material makes Alu-PVC blister cavities more susceptible to impact damage during handling, transportation, or storage.
- PVC material has poor thermal stability. It's crucial to carefully control the temperature during the blister formation and heat-sealing stages.
- The transparency of the PVC material is a two-edged sword. While it allows for excellent product visibility, it may not be suitable for light-sensitive medications.
- PVC is not readily biodegradable. Improper disposal of PVC blister packs can cause environmental concerns.

Summary

Table 1. Material Comparison between ALU-ALU and ALU-PVC

	ALU-ALU Packaging	ALU-PVC Packaging
Composition	Aluminium Foil Layer sandwiched between plastic film layers.	Aluminum foil layer with a layer of polyvinyl chloride (PVC)
Barrier Properties	Exceptional shield against humidity, oxygen, and UV rays.	Good barrier against moisture and light.
Visibility	No visibility for the contents inside the blister cavities.	Transparent PVC film for excellent product visibility.
Tamper Resistance	Enhanced tamper resistance with features like blister perforations or tear lines.	Can be made tamper-resistant with appropriate blister designs.
Flexibility	Less flexible, suitable for standard-sized blisters.	More flexible, and suitable for various blister shapes and sizes.
Cost	Generally, more expensive	Generally, more economical
Heat Resistance	Aluminum-based materials with good resistance to temperature changes.	Plastic-based materials with limited heat resistance.
Recyclability	Less recyclable due to a combination of materials.	More recyclable with separate PVC and aluminium recycling.
Shelf Life	Extended shelf life due to excellent barrier properties.	Good protection but slightly inferior barrier properties.

Table 2. Material Comparison between PVC and PVDC

	PVC	PVDC
Composition	Polyvinyl Chloride is created through the polymerization of the vinyl chloride monomer and is known for its strength and resistance to environmental factors.	Polyvinylidene Chloride is a synthetic thermoplastic produced by the polymerization of vinylidene chloride,
Barrier Properties	Offers moderate barrier protection against moisture and gases. This makes it suitable for general consumer goods and non-sensitive pharmaceutical products	Provides superior barrier properties compared to PVC. It is highly effective in protecting products from moisture, oxygen, and other gases, making it ideal for moisture-sensitive and perishable products.
Mechanical Properties	Has good mechanical strength and is resistant to abrasion and impact. This makes it a durable choice for a wide range of products.	While also strong, the primary focus of PVDC is on barrier properties rather than mechanical strength.
Cost consideration	Generally, less expensive than PVDC, making it a cost-effective option for many applications.	More expensive due to its enhanced barrier properties. The cost is justified for products that require extended shelf life or are highly sensitive to moisture and gases.
Flexibility and Formability	High Flexible and easy to form into different shapes.	While it can be formed into blisters, it is typically less flexible than PVC and is often used as a coating over PVC to enhance barrier properties.
Applications	Used in non-sensitive pharmaceutical packaging and preferred for products that do not require high barrier protection against moisture and gases .	Ideal for packaging moisture-sensitive pharmaceuticals, food products and perishable items. Often used in combination with PVC, where PVDC acts as a coating to enhance barrier properties.
Regulatory and Health Aspects	Concerned about the release of harmful substances from PVC, especially when it contains certain plasticizers.	Generally considered safe for food and pharmaceutical packaging, but its use is regulated to ensure that no harmful substances leach into the packaged products.

CONCLUSION:

The comparison between ALU-ALU and ALU-PVC blister packaging reveals distinct advantages and limitations for each material. ALU-ALU offers superior protection against environmental factors like moisture, light, and oxygen, making it ideal for sensitive drugs, though it is costlier and less flexible in design. ALU-PVC, while providing slightly lower barrier protection, is more cost-effective and versatile, with the added benefit of transparency for visual inspection. The choice of packaging should be based on the drug's stability needs, environmental conditions, and cost considerations. As environmental concerns rise, there is a growing need for sustainable packaging alternatives that balance protection with ecological impact.

ACKNOWLEDGMENT

I would like to take this opportunity to extend my heartfelt thanks to everyone who has supported and guided me throughout my research project, "ALU-ALU Packaging Vs ALU-PVC Blister Packaging: Waste to Value - A Comparative Analysis." First and foremost, I would like to express my sincere appreciation to my academic mentor, Mrs. Zuki Patel, Assistant Professor of Regulatory Affairs, for her invaluable guidance, unwavering support, and insightful recommendations during this project. Her expertise and constant assistance have been instrumental in shaping the direction of my work. I am also deeply grateful to my industrial mentors, Mr. Hitesh Dani, Director of Saviour Pharmaceuticals, their professional insights and guidance on the regulatory landscape have significantly enhanced my understanding of the subject. I would also like to thank my colleagues and the entire faculty of the Department of Regulatory Affairs at K.B.I.P.E.R. for their continuous support and constructive feedback. Their encouragement has been essential in the successful completion of this work. I am especially thankful to my family for their unwavering support, patience, and belief in me, which has been my greatest strength throughout this journey. Lastly, I wish to express my deep gratitude to everyone who has contributed to the completion of my thesis, whether directly or indirectly.

Conflict of Interest Statement

The authors declare no conflicts of interest related to this study, "ALU-ALU Packaging Vs ALU-PVC Blister Packaging: Waste to Value - A Comparative Analysis." The research was conducted independently, and there are no financial, personal, or professional relationships that could have influenced the study's outcomes.

REFERENCES

1. 20northanalytics@gmail.com. Development of the Pharmaceutical Packaging Industry [Internet]. Medical Packaging Inc., LLC. 2022. Available from: https://medpak.com/pharmaceutical-packaging-development/
2. admin. Why Do Pharmaceuticals Need Aluminium Packaging? - Accupack [Internet]. Accupack. 2022. Available from: https://www.accupackengineering.com/post/why-do-pharmaceuticals-need-aluminium-packaging/
3. Aluminum Foil Manufacturer, Supplier & Exporter in India [Internet]. Ravirajfoils.com. 2015. Available from: https://www.ravirajfoils.com/blog/aluminum-foil%E2%80%93for-pharmaceutical-packaging
4. Pharmaceutical Packaging - European Aluminium Foil Association [Internet]. www.alufoil.org. Available from: https://www.alufoil.org/pharmaceutical-packaging
5. Uniworth Enterprises LL – Uniworth Enterprises LL [Internet]. Uniworthllp.com. 2016. Available from: https://www.uniworthllp.com/

HOW TO CITE: Charmi Patel, Hitesh Dani, Maitreyi N. Zaveri, Zuki Patel*, ALU-ALU Packaging Vs ALU-PVC Blister Packaging: Waste to Value - A Comparative Analysis, Int. J. of Pharm. Sci., 2025, Vol 3, Issue 3, 2810-2818 https://doi.org/10.5281/zenodo.15100484