

PHARMACUTICAL PACKAGING TECHNOLOGY

*Rana Hani

M-Pharm QA, Laxminarayan Dev College of Pharmacy.

Article Info: Received: 20 August 2026, Revised: 10 September 2026, Accepted: 30 September 2026

*Corresponding Author: Rana Hani

M-Pharm QA, Laxminarayan Dev College of Pharmacy.

DOI: <https://doi.org/10.5281/zenodo.23245595>



Citation:

*Rana Hani. (2026). Pharmaceutical Packaging Technology. International Journal of Clinical and Pharmaceutical Innovations, 1(7), 145-158.

ABSTRACT

Packaging is Designed to contain a product so that it is unable to interact with the environment. Packaging must provide the protection, identification, information against the physical damage, loss of content or ingredients and intrusion of unwanted component of the environment such as water vapor, oxygen and light. An important role of pharmaceutical packaging is to transform the formulation into an attractive and marketable product. So many issues regarding the pharmaceutical product like stability, sale, patient compliance etc. are related with the packaging and in regard to this; present review is done on the various advancement in the packaging material, machinery & labelling. The present article reviews the various packaging materials, types of packaging in pharmaceutical industry.

KEYWORDS: Packaging, protection, Materials, Machinery, Labeling.

INTRODUCTION^{[1][2][22]}

A Pharmaceutical Package container is an article or device which contains the Pharmaceutical product and the container may or may not in direct contact with the product. The container which is designed for pharmaceutical purpose must be stable.

IDEAL QUALITIES OF A PHARMACUTICAL PACKAGE^{[1][6][20]}

1. It should have sufficient mechanical strength so as to withstand handling, filling, closing and transportation.
2. It should not react with the contents stored in it.
3. It should be of such shape that can be elegant and also the contents can be easily drawn from it.
4. It should not leach alkali in the contents.
5. The container should not support mould growth.
6. The container must bear the heat when it is to be sterilized.
7. The contents of container should not be absorbed by the container.
8. The material used for making the container should be neutral or inter.
9. Any part of the container or closure should not react with each other.

10. Clouser should be of non-toxic nature and chemically stable with container contents.

Function of Package^{[20][21]}

A. Protective Function

A good package products the container from static and dynamic force during transportation and storage. Vibration is mainly responsible for cracking of emulsion which can be inhibited by using good package. It also protects the contents for biological hazards. It protect the container from moisture, temp, environmental gases, humidity etc. light sensitive material can be protected from light by using primary packing of amber colored bottle.

B. Identification Function

A packaging provide information regarding product such as date of manufacturing, expiry date, use, batch no., warning if any etc. It also provide an ease of identify the product for e.g colored fluted bottles are used for packaging external preparation.

c. Storage and transport Function

Packaging plays an important role in storage and transportation of product. Package shape should be such

that it can be handled easily. It must be so designed that they can be stored in efficient manner i.e safely one above the other. The dimensions of package should be according to the pellets.

TYPES OF PACKAGE

1. Primary packaging^{[1][18]}

Primary packaging are those package which are in direct contact with the Pharmaceutical formulation. The main aim of primary package is to protect the formulation from environment, chemical, mechanical, and other hazards.

Types of container which are used in primary package follow

1. Well Closed containers^{[2][3][34]}

These types of containers provide the protection from foreign particles and loss during transportation, sale etc.



Figure 1: well closed container.

2. Air tight containers^{[2][3][34]}

These types of containers protect the container from environmental hazards. If these containers are intended

to be opened on more the one occasion, then they remain airtight after reclosure. These are also known as hermetic containers.



Figure 2: Air tight container.

3. Singal Dose Containers^{[2][3][34]}

This types of containers contain single dose of medicament example are: Glass ampoules, Vials etc.



Fig.3: Single dose containers

4. Multi Dose Containers^{[2][3][34]}

As the name indicates these types of containers holds more than single dose and their contents are withdrawn at various intervals. For e.g Vials etc.



Figure 4: Multi dose container.

5. Light Resistance Containers^{[2][3][34]}

These containers protect the contents from light. These are made up of the materials which do not allow the UV

light to pass from them to containers. For e.g Amber colored glass containers.



Figure 5: Light resistance container.

Primary package for solid dosage Forms**1. Strip Package^[27]**

In this the contents are sealed in a packet. The package is made up of two layers of film. A strip containing may

pockets and each pocket contains single dose of medicament.



Figure 6: Strip packaging.

2. Blister package^{[27][28]}

It is made up of base layer with cavities which contain Pharmaceutical product. This type of package provides greater protection than strip package. This lid is made up

of aluminium or paper foil. The package is sealed by combining lid and base with the application of heat and pressure.



Figure 7: Blister packaging.

3. Primary Package for semi solid dosage forms^[29]

Semi-solid dosage forms include creams, pastes, ointments etc. the containers used for semi-solid dosage forms includes collapsible tubes etc. Plastic containers are also very popular now a days. Another types of

products are also available in market for e.g Pressurized products. For these types of products the package made up of stainless steel, aluminum etc., is used. The package used must be strong enough to withstand pressure built up in the container.



Figure 8: Collapsible Tube.

Materials used for Packaging Glass^{[1][8][12]}

Glass containers are very commonly used for storing pharmaceutical products. These containers are intended to come into direct contact with pharmaceutical products. Glass containers are used because of their following:

Advantages

1. They are impermeable to water vapors, air etc.
2. They are available in various sizes and shapes.
3. They have efficient mechanical strength and rigidity.
4. They are transparent so the contents can be easily seen from outside for e.g in case of parental products.
5. They can be converted into light resistant glass by mixing with metal oxides.
6. They have elegant appearance than plastic containers.
7. They are able to withstand temperature and pressure during sterilization.
8. They can be easily labeled.

9. They can be easily sealed which can provide hermetic sealing.

Disadvantages

1. They have heavy weight which increase their transportation cost.
2. They are breakable.
3. They can easily leach alkali to aqueous solutions if not properly treated with chemical.

Types of Glass^{[23][25][28]}**Type 1 Glass: Borosilicate Glass (Pyrex)**

This type of glass is composed of boric oxide, aluminium oxide and alkali and/or alkaline earth oxides. Except for types 1 glass container, Glass containers for pharmaceutical preparations are not be re-used. It has a high hydrolytic and thermal shock resistance. It is chemically more inert than soda lime glass. It is mainly used in preparation of laboratory glass apparatus and containers for injection and water for injections.



Figure 9: Borosilicate Glass.

Type 2 Glass: De alkalized soda lime glass

It has higher level of sodium and calcium oxide. It is less resistance to leaching property as compare to type 1 glass

but more resistance than type 3. It is used to store infusion fluids, plasma and alkali sensitive products.



Figure 10: De alkalized soda like glass.

Type 3: Regular soda lime Glass

This type of glass contains metal oxides, sodium oxides, aluminium, earth oxides mainly calcium oxides. The main disadvantage is that it can leach alkali in the

preparation, so it is used to store liquid formulation which are not alkali sensitive. It is also used to store all types of solid dosage forms.



Figure 11: Regular soda lime glass.

Plastics^{[10][12][32]}

Plastics are very commonly used for packaging Pharmaceutical products. These continue about 20% of

weight of all pharmaceutical packaging. Plastics can be easily molded to required shape.



Figure 12: Plastic containers.

Advantages

1. They are unbreakable.
2. They have less wt. than glass and so their transport cost is also very less.
3. They are available in various size and shapes.
4. They can be easily molded into desired shape.
5. They provide good protection power against chemical hazard.
6. They do not have alkali leaching property as in glass containers^{[1][8][12]}
7. They also have stuck back feature.

Disadvantages

1. The main disadvantage is permeation. The atmospheric gases, vapors or liquid from surrounding environment can easily migrate into plastic containers.
2. Permeation causes problem of oxidation and can degrade the product which is sensitive to oxidation.
3. They also have leaching problem, for e.g dyes which are used as coloring agent may migrate into product from the container.

4. Another problem is sorption is the process of removal of one or more constituents from the product by packaging material. This can affect the therapeutic efficiency of the product.
5. Preservative can also be absorbed by the container material. This may change the flexibility of the containers.

Materials used for making plastic Containers

1. Polyethylene^{[10][32]}

Polyethylene is very commonly used polymer. It is available in high density, medium density and low

density grades. Mainly high density polyethylene is used for pharmaceuticals. It provides protection against moisture but poor protection against oxygen & other environmental gases. The containers prepared from polyethylene cannot be sterilized by heat but can be easily sterilized by autoclave. Polyethylene's have melting point range of 120-150°C. It has an excellent chemical resistance, it means it provides protection against strong acid & alkali. It is used to prepare plastic bag, plastic films, bottles etc.



Figure 13: Polyethylene.

2. Polypropylene^{[32][34]}

It is very popularly used in pharmaceutical containers. It has many qualities of polyethylene. It has mpt. Of 170°C which is higher than polyethylene and make it suitable for sterilization at high temp. It has very good resistance power to almost all types of chemicals. It is superior to

low density polyethylene. The main drawback of polypropylene is its less clarity which can be improved by making thin walls containers. Other drawback is its brittleness at low temp. which can also be improved by mixing it with some proportion of polyethylene.



Figure 14: Polypropylene.

3. Polyvinylchloride^{[10][12][43]}

It has high clarity and good oxygen barrier. It is third most widely produced after polyethylene & polypropylene. It can be made softer flexible by incorporation of plasticizers. The heat stability of PVC is very poor and its mpt. Is 160°C. It has good insulation

properties but inferior than polyethylene & polypropylene. PVC can be used for making containers used for blood & blood components, catheters, bypass sets, hemodialysis sets etc. The main advantages of PVC include its transparency, light wt., softness, suitability for sterilization and biocompatibility.



Figure 15: Polyvinylchloride.

4. Polyamide(NYLON)^{[32][33][36]}

It is macromolecules having repeated units linked by amide bonds. Nylon is mainly artificially made. It can be produced by interaction of a diamine and a dicarboxylic acid. It has main advantage of good chemical resistance,

high strength, good toughness, high heat resistance, good water resistance etc. it can be autoclaved easily. The main disadvantages is high moisture absorbitivity, attacked by oxidizing agents, strong acids & alkalis etc.



Figure 16: Polyamide.

5. Polystyrene^{[20][22][29]}

It is made from petroleum. It is non biodegradable, light and rigid. Its main advantages are that it is inexpensive, resistance to acids, strong alkalis & strong oxidizing

agents, high heat resistance, expandable etc. The main disadvantages is that it can leach styrene & benzene when come in contact with warm food, oils, alcohols etc. which causes contamination of product.



Figure 17: Polystyrene.

6. Polycarbonate^{[34][38][40]}

Polycarbonate is resistance to dilute acids, oxidizing or reducing agents, salts, oils, greases, and aliphatic hydrocarbons. It is attacked by strong acids, reducing agents, amines, ketones, aromatic hydrocarbons, and

some alcohols. It has highest impact strength and inexpensive. It is clear and very good heat resistance power. It is mainly used for manufacturing of surgical equipment.



Figure 18: polycarbonate.

Closures^{[1][15][18]}

This is the most critical component a containers. An effective closure system prevents the loss of material from the container, prevent the environmental contamination of the product, prevent the microbes to enter inside the containers.

Ideal properties of a closure^{[1][15]}

1. It should be inert.
2. It should be compatible with product and container.
3. It should have a property of resealable.
4. It should be economical.
5. It should provide an effective seal.

6. It should be easily handlable.

Design of Closures

Closures are available in five main designs. Their details are as follows.

1. Threaded screw type^{[17][18][19]}

These are made up of aluminium, tin, or plastic. As the name indicates they contain threads which gets engaged with the threads present on the neck of containers. These type of closures provide the effective seal which protect the product from physical and chemical reaction. Plastic caps are more popular than metal because plastics are resistance to corrosion.



Figure 19: Threaded screw cap.

2. Lug cap^{[17][18][19]}

The difference in lug cap and thread cap is that in thread cap, continuous threads are present but in lug cap threads

are present in intermittent fashion. Another difference is that lug cap requires only a quarter turn. Lug cap are mainly used in storage of foods products.



Figure 20: Lug cap.

3. Crown caps^{[17][18][19]}

These caps are made up of metal and commonly used for beverages bottles. These also provides an effective seal

and cannot be open with hands. These cannot be seal again.



Figure 21: Crown cap.

4. Roll on Closures^{[17][18][19]}

Roll on closure contains the aluminium roll on cap which can be easily sealed, opened and closed. These are available in re sealable, non-sealable & pilfer proof type

forms. These are available for use on glass or plastic bottles & jar for food, beverages, chemicals and pharmaceuticals.



Figure 22: Roll on cap.

5. Pilfer Proof closure^{[17][18][19]}

In this additional length extends below to threaded portion which forms a bridge. When the closure is

removed then the bridge break and the additional portion remains place on neck of container which show its opening.



Figure 23: Pilfer Proof Closures.

Material used for construction of closures^{[8][9][12]}

Rubber^[8]



Figure 24: Rubber.

It is used for construction of closures for vials, transfusion bottle fluids etc. many types of rubbers are used for this purpose for e.g butyl rubber, nitrile rubber, silicon rubber etc. butyl rubber is very commonly used because of its low absorption property and also they are cheaper than other synthetic rubber but it decompose above 130 c. nitrile rubber has oil resistant and heat resistant property but it can absorb the preservative from the preparation. silicon rubbers have very low absorption and permeability of water and are stable for long time. But they are very expensive.

A rubber is prepared by mixing a base polymer with additives. The selection of base polymer and additives

depends upon the type of rubber properties to be desired. The resultant rubber is non vulcanized compound.

MACHINERY FOR PACKAGING^{[25][27]}

The machinery is an important technique for packaging the any medicines or other materials.

1. Strip packing machine^[27]

This model is applied for the packing of tablets, candy and pills in medicine, healthcare, chemical, and foodstuff industry etc with automatic double-aluminium foil hot sealing. Meeting the requirement of sealing for avoiding light, and also it is for double plastic hot sealing packing.



Figure 25: Strip packing machine.

2. Blister Packing Machine^{[27][28]}

It is high quality machine, which are suitable for handling automatic loading, filling, or non-stop feeding. Blister packaging machines are used by pharmaceutical

industry to pack capsules and tablets. The packaging and then in to and feeder which in turn can either be linear feeder or a brush box feeder depending on the shape of the product and also the material to be used.



Figure 26: Blister packing machine.

3. Cartooning Machine^{[28][29]}

This machine is applied to automatically box packing for medicine board, medicine bottle, soft box with palletized granule and ointment, Such as automatically boxing

package of medicine, cosmetics. This machine features stable performance, compact structure and beautiful appearance. And its can automatically print stainless steel stamp.



Figure 27: Cartooning machine.

4. Ampoule Filling machine^{[27][28]}

These high precision machines completely encase the product in the inert glass & don not have a rubber stopper or any other material in direct contact with the

drug. The line can be applied to fill 1-20ML ampoule with washing. Three times air sparging, drying, and sterilization, colling, liquid filling and protection gaseous filling.



Figure 28: Ampoule Filling machine.

Recent Packaging Technologies^{[15][26][38][39][40]}

1. Blow-filled-seal packaging^{[15][38]}

Plastic containers are made, filled with sterile filtered product, and sealed in an uninterrupted sequence of activities using aseptic blow-fill-seal technology, all within the controlled sterile environment of a single machine.

A reliable, cutting-edge aseptic processing technique known for its inherent operational benefits over traditional aseptic production is the Blow- fill-seal procedure. A special mix of packaging design flexibility,

cheap operating costs, and high sterility assurance is provided by blow-fill-seal systems. The devices are relatively space-efficient and only require a minimal number of operates.

2. Eco-Friendly pharmaceutical Packaging^{[39][40]}

The term “eco-friendly”. Often referred to as “environmental friendly”, “nature-friendly,” refers to packaging that use materials that are safe foe the environment in its creation in order to cause little to no harm to the environment. Eco-labels are frequently used to identify these environmentally friendly pharmaceutical

packaging materials. The usage of biodegradable and environmentally friendly packaging materials is being introduced through a number of research and development initiatives. The development biodegradable and environmentally friendly packaging materials is necessary in the morden era and must be used to replace or supplement currently available packaging materials.

Qualities of Eco-friendly Pharmaceutical packaging Material

Reduce^{[39][40]}

One of the qualities of eco-friendly pharmaceutical packaging material is that it minimises the amount of packaging needed. This lowers the amount of degradation products that are needlessly dumped. Additionally, some statutory requirements forbid the overpackaging of some formulas. Use several dosage containers rather than single-use ones, for instance, and one large bottle of formulation rather than several tiny ones. The following are the top three factors for minimising pharmaceutical packaging material.

Recycle^{[39][40]}

Eco-friendly packaging materials have the ability to be recycled into newer packaging. Examples of recyclable, environmentally friendly packaging materials include glass, metal, thermoplastic, paper, and paperboard. Additionally, materials recovered through glass and metal recycling are much less dangerous for microorganisms used in formulations.

Reuse^{[39][40]}

The ability to environmentally friendly packaging materials to be used repeatedly is referred to as reuse. The utilization of packaging material in its original state is a feature of this attribute. For instance, the body shop sells a verity of toiletries and cleaning products in resealable or returnable containers.

Renew^{[39][40]}

Eco-friendly packaging materials made of renewable natural resources have the ability to be processed again to create new packaging, such as thermoplastic.

Repurpose^{[39][40]}

Eco-friendly packaging materials have the ability to be mould into unique shapes for various pharmaceutical applications.

CONCLUSION

In conclusion, pharmaceutical packaging technology plays a vital role in protecting medicines from environmental, chemical, and physical damage while ensuring safety, stability, identification, storage, and patient convenience. Different types of packaging materials such as glass and plastics, along with suitable closures and advanced packaging machinery, help maintain the quality and effectiveness of pharmaceutical products. Modern packaging technologies like blow-fill-seal systems and eco-friendly packaging have further

improved sterility, efficiency, and environmental sustainability. Therefore, proper selection of packaging materials, containers, and packaging methods is essential for delivering safe, effective, and high-quality pharmaceutical products to patients.

REFERENCES

1. Dean DA, Evans ER, Hall IH, editors. Pharmaceutical packaging technology. Boca Raton: CRC Press, 2005.
2. Zadbuke N, Shahi S, Gulecha B, Padalkar A, Thube M. Recent trends and future of pharmaceutical packaging technology. *Journal of Pharmacy and Bioallied Sciences*, 2013; 5(2): 98-110.
3. Das PS, Saha P, Das R. Pharmaceutical packaging technology: a brief outline. *Research Journal of Pharmaceutical Dosage Forms and Technology*, 2018; 10(1): 23-28.
4. Pareek VI, Khunteta AL. Pharmaceutical packaging: current trends and future. *International Journal of Pharmacy and Pharmaceutical Sciences*, 2014; 6(6): 480-485.
5. Sah SK, Kaity S. Pharmaceutical packaging: recent trends and challenges. In: *Dosage Forms, Formulation Developments and Regulations*, 2024; 663-684.
6. Sarkar DK. Packaging technology and engineering: pharmaceutical, medical and food applications. Hoboken: John Wiley & Sons, 2020.
7. Emblem A, editor. Packaging technology: fundamentals, materials and processes. Elsevier, 2012.
8. Yam KL, editor. The Wiley encyclopedia of packaging technology. Hoboken: John Wiley & Sons, 2010.
9. Debeaufort F, Kurek M, Benbettaieb N, Scetar M, editors. Packaging materials and processing for food, pharmaceuticals and cosmetics. Hoboken: John Wiley & Sons, 2021.
10. Selke SE, Cutler JD, Auras RA, Rabnawaz M. Plastics packaging: properties, processing, applications, and regulations. Carl Hanser Verlag GmbH Co KG, 2021.
11. Ali F, Khan I. Pharmaceutical packaging. In: *Essentials of Industrial Pharmacy*. Cham: Springer International Publishing, 2022; 55-66.
12. Piringir OG, Baner AL, editors. Plastic packaging: interactions with food and pharmaceuticals. Hoboken: John Wiley & Sons, 2008.
13. Risch SJ. New developments in packaging materials.
14. Goodwin D, Young D. Protective packaging for distribution: design and development. DEStech Publications, 2011.
15. Akram A, Khanna A, Shukla VK, Sharma N. Recent advancements in pharmaceutical packaging and regulatory aspects. *Journal of Packaging Technology and Research*, 2025; 9(1): 1-7.
16. Fellows P. Packaging materials.
17. Shete NA, Mohan RS, Kotame RN, Gore SJ, Tagad RR. Changing scenario of packaging in

- pharmaceutical industry. *World Journal of Pharmaceutical Research*, 2020; 9(1): 178-190.
18. Lockhart H, Paine FA, Paine FA. Packaging of pharmaceuticals and healthcare products. Springer Science & Business Media, 1996.
 19. Baner A, Piringer O. Preservation of quality through packaging. In: *Plastic Packaging: Interactions with Food and Pharmaceuticals*, 2008; 13.
 20. Emblem A. Packaging functions. In: *Packaging technology*. Woodhead Publishing, 2012; 24-49.
 21. Brennan JG, Day BP. Packaging.
 22. Natarajan S, Govindarajan M, Kumar B. Fundamentals of packaging technology. PHI Learning Pvt. Ltd., 2014.
 23. Ellicott C, Roncarelli S. Packaging essentials: 100 design principles for creating packages. Rockport Publishers, 2010.
 24. Berger KR. A brief history of packaging. *EDIS.*, 2003; 2003(17).
 25. Mahalik NP. Advances in packaging methods, processes and systems. *Challenges*, 2014; 5(2): 374-389.
 26. Kerry JP. New packaging technologies, materials and formats for fast-moving consumer products. In: *Innovations in Food Packaging*. Academic Press, 2014; 549-584.
 27. Kumar S. Pharmaceutical packaging technology – A review. *International Journal of Research in Pharmaceutical and Biomedical Sciences*, 2013; 4(4): 1400-1414.
 28. Kunal CM, Akhilesh D, Kumar BS. Recent trends in pharmaceutical packaging: A review. *International Journal of Pharmaceutical and Chemical Sciences*, 2012; 1(3): 1282-1292.
 29. Anthony S Jr. Packaging and materials handling. In: *Materials Handling Handbook*, 1985; 717-728.
 30. Lechevalier V. Packaging: principles and technology. In: *Handbook of Food Science and Technology 2: Food Process Engineering and Packaging*, 2016; 269-315.
 31. Kumar G. Pharmaceutical drug packaging and traceability: A comprehensive review. *Universal Journal of Pharmacy and Pharmacology*, 2023; 2(1): 19-25.
 32. Emblem A. Plastics properties for packaging materials. In: *Packaging technology*, 2012; 287-309.
 33. Lv Y, Liu N, Chen C, Cai Z, Li J. Pharmaceutical packaging materials and medication safety: a mini-review. *Safety*, 2025; 11(3): 69.
 34. Pal R, Pandey P, Thakur SK, Khadam VK, Dutta P, Chawra DH, Singh DR. The significance of pharmaceutical packaging and materials in addressing challenges related to unpacking pharmaceutical products. *International Journal of Pharmaceutical and Healthcare Innovation*, 2024; 1(3): 149-173.
 35. Bix L, de La Fuente J, Sundar R, Lockhart H. Packaging design and development.
 36. Deore SD, Gajmal GK, Jadhav SP, Patil DM, Sonawane DD. Study of different methods of pharmaceutical packaging. *Journal of Interdisciplinary Cycle Research*, 2023.
 37. Mitali P, Murnali P, Rashmin P. Pharmaceutical packaging and packaging technology: A brief overview. *The Pharma Review*, 2012; 41-54.
 38. Pharmacy TK, Mohammed B, Donyai P, McCrindle R, Sherratt RS. Enhancing pharmaceutical packaging through a technology ecosystem to facilitate the reuse of medicines and reduce medicinal waste. *Pharmacy*, 2020 Mar 31; 8(2): 58.
 39. Sikaria K, Sreedevi A, Srivastava N, Ligade VS, Muragundi P. A review on emerging technologies in pharmaceutical packaging: From anti-counterfeiting to green solutions. *AAPS PharmSciTech.*, 2025 Nov 11; 27(1): 22.
 40. Pathak A, Rao NR, Grover P, Sharma V, Malik A, Rawat AP, Singh S, Maurya A. Ecofriendly pharmaceutical packaging material: A review. *Materials Today: Proceedings*. 2024 Jan 11.