POLYMERS IN COSMETICS FILM FORMERS

INTRODUCTION

Drug product administered via topically through skin fall into two general categories-
1) For local action, to stratum corneum and
2) For systemic effect to epidermis and dermis of skin. Drug release and absorption mainly depends on skin physiology and drug properties.

First barrier for the drug absorption through skin is Stratum corneum. Only small amount of drug reaches at the target site. Conventional topical formulations includes gels, cream, ointment, patches, lotions, etc. have several limitations.

Film Forming System (FFS) is alternative to these systems and acts as a novel approach of drug delivery through skin. FFS is defined as non-solid doses form which produces film on the evaporation of vehicle, excipients in the formulations form film on skin. This is the drug and film forming polymer system, formed film acts as a matrix for sustained release of drug. FFS is created by using physical process in which polymer particle coalescence and then solvent evaporation causes particle deformation. Plasticizers are added for the softening of film. Release profile of drugs from film depends on the rate of solvent evaporation. Film formation facilitates the prolonged administration to the skin and drying of film improves its skin retention ability, it improves the treatment of skin infection. It also improves the patient compliance. FFs have great application in topical therapy as it is easily applied to skin and also overcome the troubles with the other topical and oral doses form.

SKIN

The Skin is a function as the main physical barrier which protects us from external environment. It is generally described in terms of three tissue layers as depicted in Figure.

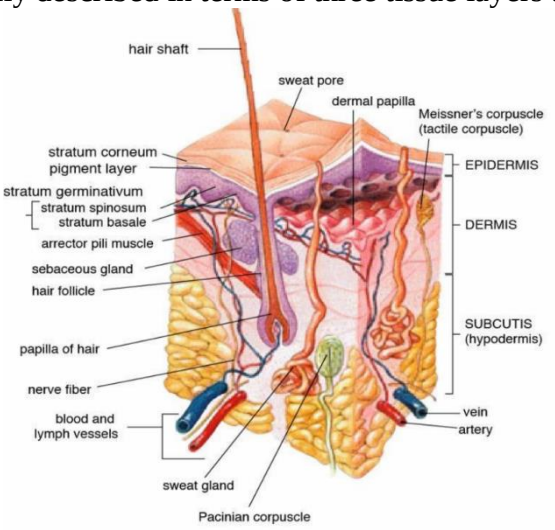

Fig. 1: Structure of skin One of the best biological barrier and it is largest organ of human body and contributes to 16%-18% to normal body weight and total area about 2 m.
One of the best biological barrier and it is largest organ of human body and contributes to 16%-18% to normal body weight and total area about 2 m. Skin composed of 3 main layers:

- Epidermis

- Dermis
- Subcutaneous

Epidermis

It is the squamous, stratified, keratinized epithelial layer **(20-200 µm thick)**. It can produce yellow and brown black pigment melanin which contributes color and absorb UV light. Microscopic sections of the epidermis show two main parts: **the Stratum Corneum (SC) and the stratum germinativum**. The stratum corneum is the outer most Horney, very thin layer and consists of compacted flattened, dehydrated, keratinized cells in stratified layer. It can resist over 80% of skin permeability. It also consists of nearly non-permeable cornified cells called corneocytes. Keratinized layer of skin is responsible for keeping water in the body and other harmful chemicals out which making skin natural barrier for infection6 (Figure 2).

- Stratum Lucidum is the additional thin layer of keratinized cells which are located beneath the stratum corneum. Mainly present on the palm of hand and on feet soles.
- Stratum Granulosum is a layer where keratinization begins. In this layer, lamellar granules appear and merge with the cell membrane, and these cells release glycophospholipids into intercellular space that forms the main constitute of the water permeability barrier.
- Stratum Spinosum the spinous cell layer of the skin composed of keratinocytes with a characteristic 'prickly' appearance due to the presence of desmosomes, important structural filament called cytokeratin.
- Stratum Basaleis a continuous single layer consists of columnar epithelial cells also called basal layer or stratum germinativum. It consist of Melanocytes, Langerhan and Merked cells.

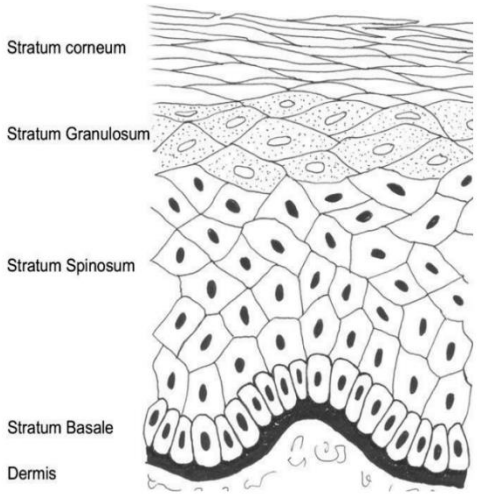

Fig. 2: Section of epidermis showing main layers Dermis

It is composed of connective tissues connected tightly to epidermis by a basement membrane. It consists of hair follicles, sweat glands, sebaceous gland, lymphatic vessels, and blood vessels. The blood vessel in dermis provides nourishment and waste removal from its own cells. It is responsible for biochemical and biological degradation of material transported across skin. Beneath the dermis, the fibrous tissue opens out and merges with the fat-containing subcutaneous tissue.

Subcutaneous

Subcutaneous fat layer serves as a cushion for the dermis and epidermis. It also provides a thermal barrier. It consists of loose connective tissue, adipose tissue and elastin. It serves as a fat storage area; regulate temperature, nutritional support and mechanical protection. It carries main blood vessels and nerves to skin and may contain sensory organs.

FILM FORMING SYSTEM

Mechanism of film formation and permeation Film forming system is applied directly to the skin and it forms a thin, transparent film in situ upon solvent evaporation as shown in Figure 3. After application of the formulation to the skin, the composition of the film forming system changes significantly due to the loss of the volatile components of the vehicle which results in formation of residual film on the skin surface. In this process the concentration of drug increases, reaching saturation level and with the possibility of reaching super saturation level on the skin surface. Super saturation results in the enhanced drug flux through the skin by increasing the thermodynamic activity of the formulation without affecting the skin's barrier, thereby reducing the side effects or irritation. The concept of super saturation can be explained by the modified form of Fick's law of diffusion.

The Fick's law of diffusion given by Eq., Where J=Rate of drug permeation per unit area of skin per unit time (flux) D=Diffusion coefficient of drug Cv=Concentration of drug h=Thickness of barrier to diffusion From this equation, it is clear that the rate of drug permeation across the skin is proportional to the concentration of the drug.

However this is true when the entire drug is dissolved in the vehicle. Equation describes the modified form of Fick's law of diffusion: $J=\alpha D/\gamma h$

Where, a=thermodynamic activity of drug within formulation γ=thermodynamic activity of drug within membrane

According to this equation, the flux of the drug is directly proportional to the thermodynamic activity of the system, which is related to saturation. However increasing the super saturation increases thermodynamic instability.

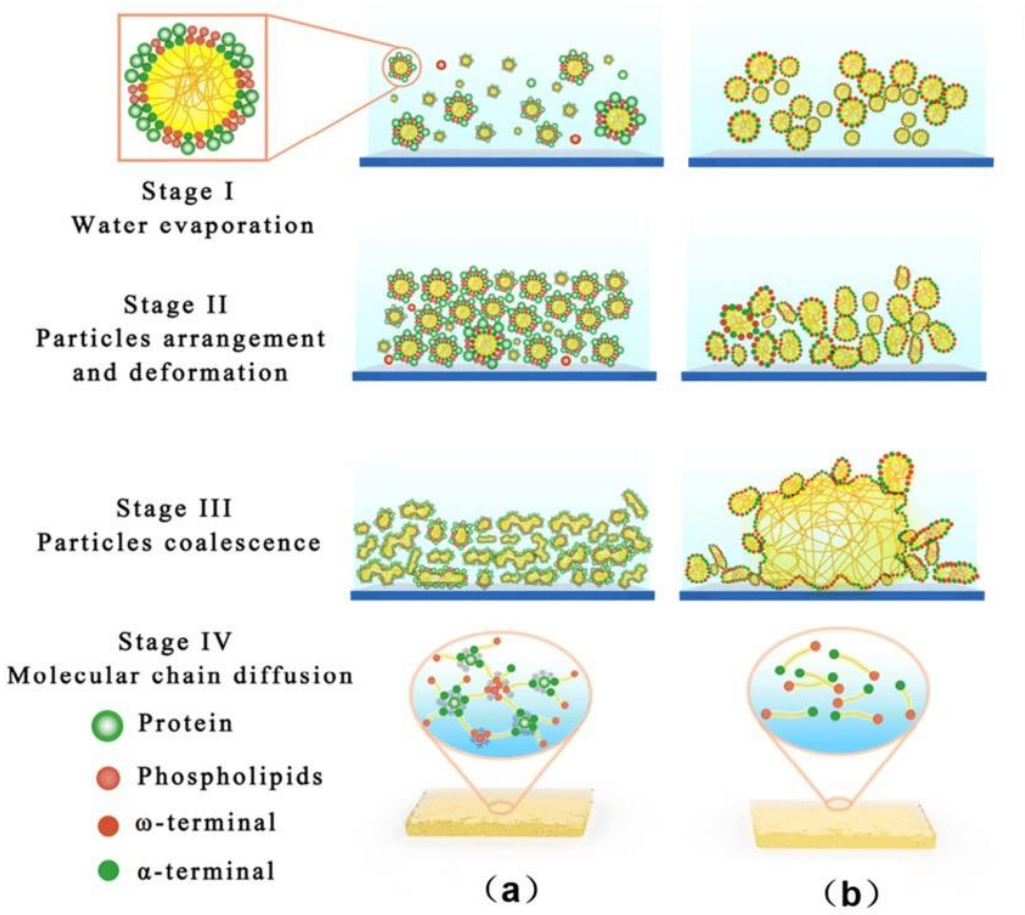

Fig. 3: Mechanism of film formation

Film forming application

- Film forming systems offer a number of advantages over more conventional formulation.
- They can provide a unit dose and reduced dose frequency.
- Improved drug delivery.
- Easily applied to large application areas and the rapidly drying/absorbing nature can help to minimize losses of product onto cloths or other people.
- Fast dissolving and also we can make from it sustained drug delivery.
- Good patient compliance, reduced dose frequency.
- Hepatic first pass effect is omitted and GIT is avoided.
- Used in the wound care, as a tissue glues for closing of operative wound.

In the application active ingredient through beauty product, e.g. Silicone film forming technology used as peel off mask for skin hydration treatment, acne problems etc.

As a barrier membrane to protect workers in industry from strong acids, bases, IR rays, UV rays, hazardous chemicals etc. e.g.: UV protective creams, hydrophilic and hydrophobic ointments and creams.

PROPERTIES OF FILM

Almost all desirable properties of a coating film strongly depend upon the quality and integrity of the coating film which in turn depends upon the polymer chemistry, formulation variables, and the glass transition temperature of the dry film and the surface characteristics of the substrate among other factors.
Film Formation depends upon the Chemical and Physical Property, Molecular weight, Cross-linking, Density, Glass Transition Temperature, Viscosity of polymeric solution.

Formulation variables

- At the early stages of drying, the rate of solvent evaporation is essentially independent of the presence of polymer.
- The rate of evaporation depends upon-
- The vapor pressure
- The ratio of surface area to volume of the film
- The rate of air flow.

The film forming preparation can be applied to the site regardless of shape and area, and can be retained for a long time as compared to conventional semi-solid preparations.
Fig A) shows that FFS forms an almost completely transparent fast drying film on application. Fig B) shows that after drying, a non-tacky, flexible and easily peelable film is formed (Figure 4). There is an excellent adhesion of the formed film to the skin, hence wipe off resistance. Therefore the risk of transfer of active other people or clothes is reduced

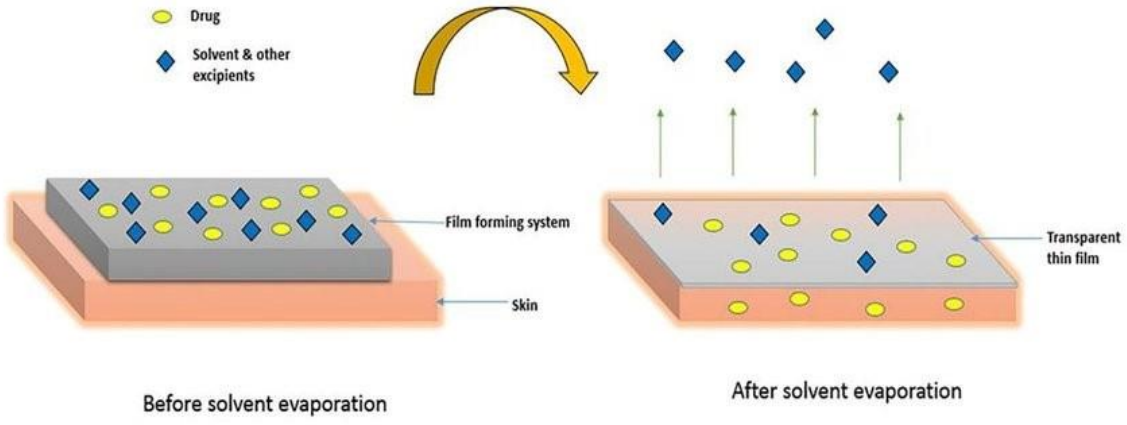

Fig. 4: (A) Before drying (B) After drying

Disadvantages of other topical preparations

Following are the disadvantages of other topical preparations which are overcome by film forming system:

- They are greasy and sticky preparations that can adhere to cloths, others skin and difficult to remove from skin, cloths and hair hence low patient compliance.
- Uncomfortable in hot climate.
- Wool fat and wool alcohol may cause sensitization in some people.

- Feasible for a less number of drugs.
- Slow onset of action, there is no rapid, bolus type drug administered by this route.
- Drugs incorporated into semisolids show penetrate into skin layers to reach the site of action but systemic delivery of drugs is limited due to various factors.
- These preparations can easily wipe off and hence repeated administration is required in chronic disease (Table 1).

Table 1: Comparison of topical drug delivery system

	Patch	Film Forming	Semisolid form
Visual Form	Very visible	Almost invisible	Visible
Skin feel	Non-sticky, non-greasy	Non-sticky, non-greasy	Sometimes sticky, greasy
Applications	Easy	Easy	Sometimes messy
Dose Adjustment	Low	High	High
Dosage Frequency	1-7 days	1-2 days	1 day or less
Sustained release	Yes	Yes	No
Occlusive Properties	Yes	No	No
Wipe off resistance	Yes	Yes	No
Residual residue	Possible	No	No

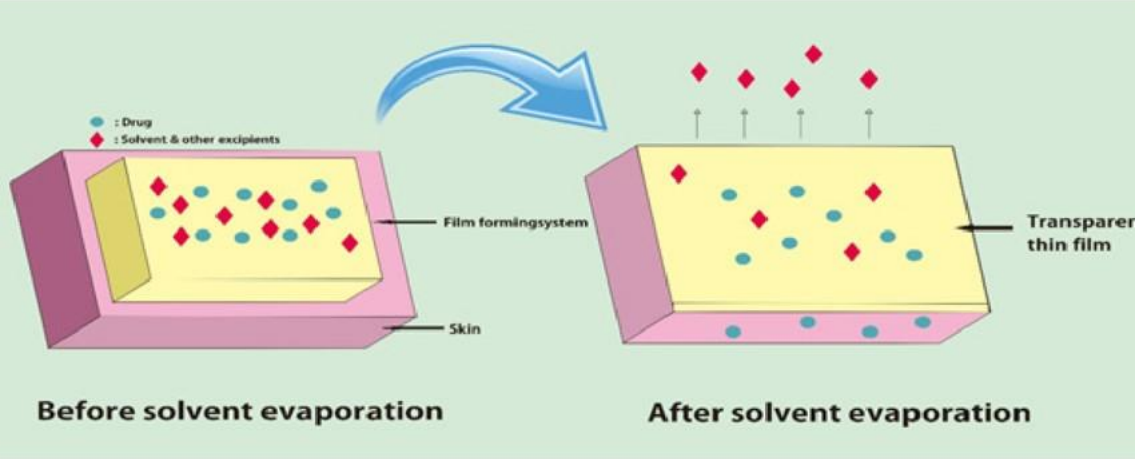

Fig. 3. Mechanism of film formation

Features Patches Film forming system Visual appearance Highly visible Almost invisible Skin feel Non-sticky, non-greasy Non-sticky, non-greasy Administer Convenient Convenient Dose adjustment Low High Dosing frequency 1-7 day 1-2 day Sustained release Yes Yes Occlusive properties Yes No Wipe off resistance Yes Yes Residual remaining Possible No

COMPONENTS OF FFS

Drug For transdermal application of film forming system, the drugs required to have suitable properties which are independent of the dosage form. Generally the drugs which are applicable to these systems are highly potent which permeate the skin rapidly, which cause no skin irritation and which are relatively stable to enzymes present in the epidermis. Choice of the drug incorporated within the preparation depends on its solubility, lipophilicity and molecular weight.

Stratum corneum is as a barrier for drug permeability across the skin, skin permeability increases with increasing lipophilicity, an octanol-water partition coefficient (log P=1-3), drugs oil and water solubility are ideal characteristics for good skin penetration. Nature of the polymer used in the FFS also has impact on the release and absorption of active components. Due to formation of skin reservoir, for rapid penetration through skin barriers drug would be more lipophilic, which will more suitable for achieving the sustained delivery profile (Table 2).

	Patches	**Film forming system**	**Semisolids**
Visual Appearance	Highly Visible	Almost invisible	visible
Skin feel	Non-sticky, non-greasy	Non-sticky, non-greasy	Sometimes sticky, greasy
Administration	Convenient	Convenient	Sometimes messy
Dose adjustment	Low	High	High
Dosing frequency	1 – 7 days	1 – 2 days	1 day or less
Sustained release	Yes	Yes	No
Occlusive properties	Yes	No	No
Wipe off resistance	Yes	Yes	No
Residual remains	Possible	No	No

Table 2: Ideal properties of drug for transdermal and topical delivery Parameters Properties Dose.