# Polymersome : Stabilization of Amphiphilic Block Copolymer Nanoparticles

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## Introduction:

The skin is composed of several layers of cells, protecting it from external microorganisms and harmful substances. In order to permeate the cosmetic to the skin, a component similar to the cell membrane is brought into contact with the skin [2]. The double layer of cell membrane is then assimilated, opening the barrier of the skin membrane. When the skin membrane is opened, cosmetics that can penetrate the skin can enter the skin. In general, skin active ingredients used in cosmetics are easily denatured by light, temperature and air, so their application to products requiring long-term preservation such as cosmetics is limited [3]. Drug delivery technology that delivers effective ingredients to the skin is being developed in combination with nanotechnology [4]. Liposomes, a typical nano-sized drug delivery system in cosmetics, are composed of phospholipids, which are the main components of biological membranes and have a structure composed of two components, hydrophilic and lipophilic, such as hydrogenated lecithin, ceramide and cholesterol. Due to this structure, polar and non-polar substances can be captured and transported into cells [5]. However, there are problems such as material instability due to oxidative degradation of phospholipids, low emulsion stability and low capture efficiency of active ingredients. Also, since the skin penetration of the active material is not achieved, the effect applied to the skin is limited [6]. In this study, hydrogenated lecithin, a representative component of liposomes, is combined with a polymer to increase skin absorption. This is a new drug delivery system called polymersome, which increases stability and skin permeability. Polymersomes are self-assembled polymer-based bilayer vesicles made of block copolymers [7]. It is composed of a copolymer including a hydrophilic block, which is a hydrophilic polymer, and hydrophobic block, which is a conductive polymer, and has biocompatibility and biodegradability properties similar to lipids [8]. Depending on the characteristics of the block copolymer, various types of polymersomes can be produced, and the particle shape can penetrate the stratum corneum well, thereby maximizing the effect on the skin. In this study, we focused on the application of biocompatible polymers to the cosmetic industry by using the self-assembling, tunable physicochemical properties of film-forming copolymers.

## Materials & Methods:

1) Preparation of polymersome according to the ratio of hydrogenated lecithin

The amphiphilic agent used to prepare polymersomes is a PEG-PCL based copolymer. First, a polymer and hydrogenated lecithin are mixed in an appropriate ratio. (Table 1) Polymersomes are prepared using a microfluidizer, a high-pressure micro-emulsification process. The particle size and surface charge (zeta potential) of the synthesized block polymer are measured.

Table-1. Prescription of polymersomes formulation

| Phase | Ingredient | % by weight | | | | | |
|---|---|---|---|---|---|---|---|
| A | Hydrogenated Lecithin | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| | PEG-PCL | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| B | Water | 95.5 | 95.0 | 94.5 | 94.0 | 93.5 | 93.0 |
| | 1,2-Hexanediol | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |

2) Preparation of polymersome according to the ratio of various oils

Oil is applied to a proportion of the six polymersomes that does not change significantly in particle size over time. There are three types of oil used for polymersome produciton: vegetable oil(Caprylic/Capric Triglyceride), ester oil(Cetyl Ethylhexanoate) and hydrocabon-based oil(Squalane). (Table 2)

Table-2. Prescription of polymersomes containing oils formulation

| Phase | Ingredient | % by weight | | | | |
|---|---|---|---|---|---|---|
| A | Hydrogenated Lecithin | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | PEG-PCL | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | Water | 93.0 | 91.0 | 89.0 | 87.0 | 84.0 |
| | 1,2-Hexanediol | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| B | Oils | 1.0 | 3.0 | 5.0 | 7.0 | 10.0 |

After measuring the particle size of the polymersome to which the three oils are applied, the ratio of the oil that does not change the most over time is selected to finally prepare a polymer-hybrid that captures retinol. Using vegetable oil with the most compatibility with retinol, retinol was included in liposomes and polymer-hybrids, respectively, and comparative analysis was performed. All polymer hybrids are manufactured by high pressure emulsification process.

## Results & Discussion:

The particle sizes increases as the ratio of hydrogenated lecithin and the amount of oils increase as shown in Fig.1. The zeta oitential is on a stable state at -30mV.

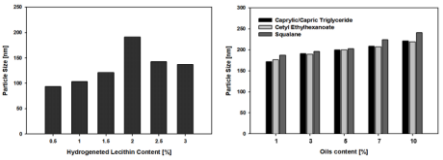


Figure 1. Particle sizes of Polymersomes

Through this, it can be seen that the polymer-hybrid including retinol and the liposome are produced differently as a result of analyzing the structure.(Fig.2) Generally, the higher the TSI index, the more unstable the sample is. Comparing the two samples, it can be determined that the polymer-hybrid is relatively stable because the TSI value is smaller than that of the liposome. Also, When the MSD curve is overlaid from 20 hours, which is a section where the analysis point of the sample is parallel, it can be seen that both samples decrease and the viscous aspect decreases over time, and the polymer-hybrid has higher viscous properties than the liposome.(Fig.3,4.)

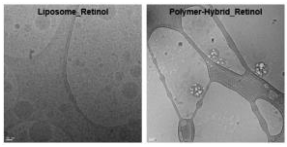


Figure 2. Electron Microscopic Images

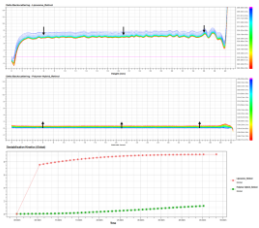

Figure 3. Tutbiscan data

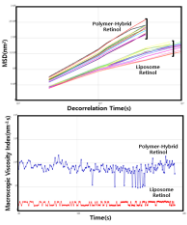


Figure 4. Rheology data

A comparison of dispersion stability through rheology with terbiscan shows that the polymer-hybrid containing retinol is much more stavle than the liposome.

## Conclusions:

In this study, we found the optimal ratio to form a stable structure of polymersomes. It can be confirmed that the polymersome has excellent emulsifying power with oil due to its compatibility with various oils, and based on this, retinol, an active material that is unstable in the external environment, was collected. When compared to liposome, structural differences of the polymer-hybrid containing retinol were confirmed under an electron microscope. The particle size of the polymer-hybrid was also relatively small. Through dispersion stability and rheology analysis, the polymer-hybrid was able to obtain much more stable data than liposome. Therefore, it is expected that polymer-hybrid can increase skin permeability than liposome when applied to cosmetic formulations. In summary, a polymer-hybrid was developed as a system that can stably capture retinol from the external environment, and it is expected that other active ingredients as well as retinol can be grafted..

## Acknowledgements:

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