

Novel second skin technology by Direct-Electrospinning method with adhesive primer to achieve superior makeup appearance and longevity

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Introduction

Second skin tech.

- Form a single film on skin [1,2,3]
- **Have high barrier function**
e.g. anti-pollution & moisturizing effects

Challenges of second skin

- **Applicability on makeup is limited**
- Noticeable film deterioration
e.g. wrinkles during application
e.g. peeled edge by a mask after time

The aim of this study

Develop a second skin technology suitable for makeup for the first time

Conclusions

(1) How?

No defects during application by **D-ES**

&

Sufficient durability by **Adhesive Primer**

(2) What?

Smoother appearance

Lasting color

Easy makeup removal

+Anti-pollution / Moisturization

(3) Why?

Bridging structure

Network structure

Layered structure

A second skin technology for makeup was developed, leading to epoch-making effects with precise film structure control

Materials

Direct-Electrospinning (D-ES) method

Application steps

Foundation (FD)
D-ES film
Primer
Skin care
Skin

- Spin fine fibers from a polymer solution with a portable device [4].
- Form an ultra-thin film directly on skin.
- Polymer solution consisted of polyvinyl butyral and additives [5].

Adhesive primer formulation

- Contain polymer emulsion of acrylates copolymer.
- Increase adhesion between skin & film.

Methods

(1) Evaluation on applicability

1-1: Observation of the film

- In vivo test: The primer (half face) and D-ES film (whole face) were applied on Asian females (N=8) without using FD. To visualize the film, a UV absorbent was added to the polymer solution. Photograph and UV image were taken.
- In vitro test: Height images of the films on a silicon wafer were obtained by laser microscope.

1-2: Durability confirmation

- Subsequently to the in-vivo test in 1-1, they wore a non-woven face mask for 8h. Photographs and UV image were taken at 8h.

(3) Mechanism understanding

SEM observation

- The film structures on substrates were observed with SEM. A cryostat cross-section polisher was used for creating a cross-section.

(2) Cosmetic effects evaluation

2-1 Evaluation on appearance

- FD was applied on full face Asian females (N=8) with & without the primer and film.
- Standard deviation (SD) of pixel values of the photograph of 1cm x 1cm on cheek was calculated.

2-2 Evaluation on lasting performance

- The primer & film were applied only on half face of Asian female (N=8), and FD was applied on their whole face. Then, they wore a mask for 8h.

2-3 Evaluation on makeup removability

- Subsequently to the test in 2-2, microscopic image was obtained after peeling off the film.
- The a* value of green artificial skin plate was measured before/after peeling off the film.

2-4 Anti-pollution effect

- Removability of graphite was calculated by microscopic image.

2-5 Moisturizing effect

- TEWL was measured on the primer & film as well as on bare skin.

Results & Discussion

(1) How to achieve second skin technology applicable to makeup?

1-1: No defects of the film by D-ES application

In vivo test

Photograph Visualized film

No wrinkles or peeled edges were found

In vitro test

Pasted electrospun film D-ES Film

Noticeable edges and wrinkles **No noticeable defects**

No noticeable defects were found after D-ES application

1-2: Durability improvement of the film by the primer

In vivo test (8h)

D-ES film alone **Primer + D-ES film**

Peeled edge Remaining rate: 85% **No noticeable defects Remaining rate: 95%**

Remaining rate

Significant increase of film remaining rate by the primer

Primer increased the durability of D-ES film to practical level even under a mask

(2) What cosmetic effects were achieved?

2-1: Smoother appearance

Five-point questionnaire (Absolute assessment)

Panelists perceived the smoother appearance by the primer and film than foundation alone.

OA of a panel
"Foundation doesn't fall into pores and looks even."

AI analysis (Smoothness score)

Smoothness score was higher with the primer and film than the foundation alone, especially in the high parts of the cheeks.

Optical analysis

The primer and film decreased SD from a wide range of incidence angles, especially around the specular angle, indicating the primer and film increased the smoothness of skin.

The primer and film achieved smoother appearance than conventional cosmetics

2-2: Lasting color

Seven-point questionnaire (Comparative assessment)

100% panelists perceived longer lasting color of foundation with the primer and film than foundation alone.

OA of a panel
"I was so surprised that the foundation didn't come off at all!"

AI analysis (Makeup smudge score at 8h)

Makeup smudge score decreased with the primer and film especially from the side of the nose to the cheek area, as well as the forehead.

Color transfer to mask (8h)

The color transfer to the mask was significantly suppressed with the primer and film.

The primer and film improved the lasting performance of foundation

2-3: Easy makeup removal

In vivo test

FD alone (Wipe off) **This tech. (Peel off)**

Colorants remained **Almost no colorants remained**

In vitro test

Removal rate / %

Before peeling After peeling

Almost all foundation colorants removed by peeling off the film

2-4: Anti-pollution effect

In vitro test

Removal rate / %

Before peeling After peeling

Almost all pollutants removed by peeling off

2-5: Moisturizing effect

In vivo test

TEWL / g/m²/h

Before 30min 6h

The primer and film decreased TEWL

(3) Why were the cosmetic effects achieved?

3-1: Bridging structure

Cross section image

D-ES film bridging skin groove can prevent foundation particles from falling into skin grooves like a "hammock".

Bridging structure resulting in smoother appearance

3-2: Fine fiber network structure

Top view

Fine fiber network retained foundation particles.

Network structure resulting in lasting performance of FD

3-3: Layered structure inside the film

Cross section image

Foundation particles distributed in the upper layer of D-ES film.

Layered structure resulting in easy makeup removal