Novel technique for preventing make up deterioration using performance materials

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ABSTRUCT

MFD (Make up Film Deterioration) is a gradual deterioration of applied make up and is a common problem experienced by most foundation users. Our investigation revealed that for 64% of all make up users MFD is their greatest consern is using foundations.

Known that the primary cause of MFD is sebum secretion. We observed that the length of time prior to onset of MFD in people who produce high level of sebum varies significantly from person to person. This suggests that other factors besides quantity of sebum production can affect MFD. Control over this factor would, we believe, be key to developing longer-lasting makeups.

We studied the relationship between MFD and skin surface conditions. Our study revealed that furrows on the skin surface affect MFD significantly. Sebum reaches the skin surface from sebaceous glands and flows along furrow on the skin. If there are many deep furrows, it takes longer for sebum to overflow. But if the furrows are few or shallow, sebum quickly overflows and spreads over the skin surface where it can degrade the make up film. Therefore even when the volume of sebum produced is the same, the rate of MFD will be different depending on the number and shape of the furrows. A longer-lasting foundation could be produced by matching personal skin condition, but this would be very difficult because individual variations in texture are very large. Therefore we approached the problem by attempting to impose sebum resistance in under make up and foundation. We have developed two new materials and make up products based on our theory. A new fluoroalkyl acrylate-methacrylates copolymer designed for incorporation in under make up is extremely sebum resistant and sweat proof. Another new acrylate polymer designed for inclusion in foundation absorbs sebum and changes to a solid. Usage tests confirm it is possible to reduce MFD by using under make up and foundation which incorporate our new materials to cover where skin furrows are few or shallow

1. INTRODUCTION

According to our investigation, revealed that 76% of women in their 40's feel MFD (Make up Film Deterioration) occurs easily now than when they were in their 20's.On the other hand sebum

production long thought to be the main cause of MFD, besides decreases in women in their 40's. [1] These two facts suggest other factor besides to sebum quantity can affect MFD. The purpose of this study is to;

1) Clarify the relationship between MFD and skin surface conditions.

2) Develop a new effective material for preventing MFD, which is unaffected by skin surface condition.

3) Develop long lasting make up products.

2.MATERIALS AND METHOD

2.1 Measurement of skin surface condition

We conducted microscopic examination of 106,138 replicas taken from the cheeks of women ranging in age from 20 to 54 years. All replicas were classfied into three grades by uniformity of skin surface relief pattern as shown in Fig.1. Then we investigated possible relationship between relief pattern of skin surface and skin oiliness.

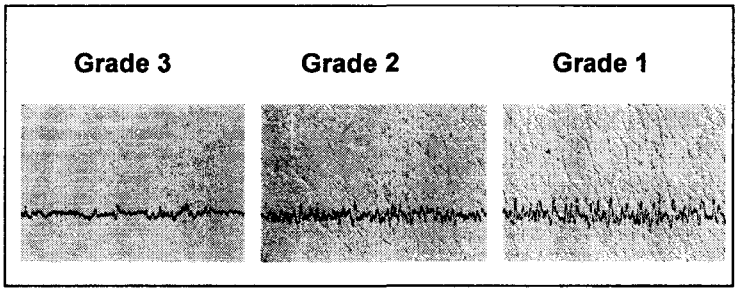


Fig.1 Typical examples showing uniformity of relief patterns

2.2 Study of MFD by micro video scope

Twenty female subjects (ranging in age from 25 to 55) were asked to wash their face and then apply toner, milk lotion ,under make up and foundation while in an air conditioned room (temp 20C° humidity 80%) cheek skin was examined by micro video scope (x50 KEYENCE VH-6300). A blue foundation was used to permit easy observation of MFD.

2.3 Synthesis of a new polymer and evaluation of it's absorption capacity of sebum

We synthesized new polymer by using one or more kinds of alkylacrylates copolymer and

di(meta)acrylates as cross linking agent to carry out radical suspension polymerization. We then measured weight to determine absorption capacity by dipping the polymer in artificial sebum.

2.4 Surface treatment

We dispersed sericite and the new polymer in organic solvent and spray-dried at 120℃ to obtain sericite coated with the new polymer. The ratio of new polymer on the surface of sericite was measured by TG/DTA and absorption capacity of artificial sebum was determined by measuring fluidity point.

2.5 In-vitro test of MFD

We applied 0.2mg/cm2 of foundation on dried pigskin and sprayed ethanol solution of artificial sebum on to the powdery foundation. Filter paper was used to cover the foundation and 100g pressure was applied to the filter paper for 30 seconds. We then measured the weight of foundation transferred to the filter paper from the dried pigskin.

2.6 Usage tests

34 female subjects who had been classified with the worst skin uniformity participated in the tests. Under make up including fluoroalkyl acrylates-metacrylates copolymer which was developed by Iyanagi [(2)] and a powdery foundation including polymer coated sericite described earlier were applied to one side of their faces. To the other side was applied contemporary under make up and powdery foundation. The subjects were then asked to assess MFD themselves.

3. Results and Discussion

3.1 Association between relief patterns and awareness of skin oiliness

In order to elucidate the major causes of make up film deterioration (MFD) experienced by persons in their 40s, a morphologic evaluation of the skin and an awareness survey on skin oiliness were conducted among 106,138 female subjects between the ages of 20 and 54. Compared with subjects whose skin had uniform relief patterns, those with non-uniform relief patterns responded more frequently that their skin was oily. As can be seen in Fig-2.

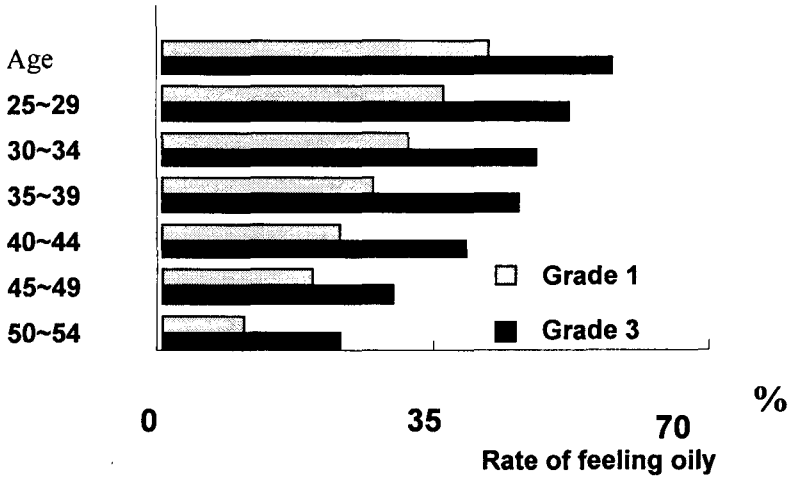
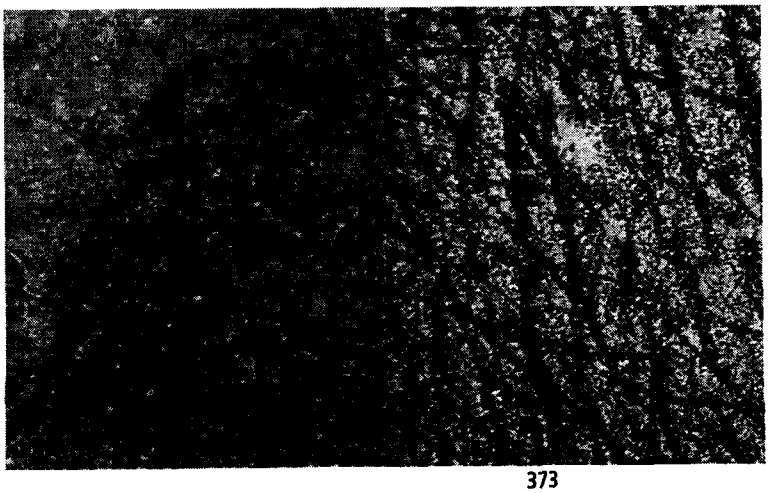


Fig.2 Relationship between relief patterns and awareness of skin oiliness

3.2 Evaluation of the magnified images of MFD conditions

To examine the association between relief patterns and awareness of skin oiliness, we evaluated the MFD and measured morphologic parameters of 20 female subjects (aged 25 – 55), using a powder foundation. In observing how MFD occurred in various relief patterns, we discovered a distinct difference in MFD. Sebum from the sebaceous glands flows along the furrows. In skin with uniform relief patterns, furrows are abundant and deep, and able to hold large amounts of sebum. It thus takes the sebum a long time to overflow the ridges. On the other hand, in a skin with non-uniform relief patterns, furrows are shallow and scarce, allowing sebum to flow from the furrows to the ridges in a relatively short time. Because make up films exist mainly on the ridges, skin with few and shallow furrows tend to develop MFD even with smaller amounts of sebum present. Typical cases are shown in Fig.3. From this experiment, it was also discovered that those subjects with greater sebum production and poor relief patterns were more likely to develop MFD, involving phenomena such as creasing and flaking. From this investigation, we were able to ascertain the characteristics of an optimally MFD-resistant material. This information guided our MFD-resistant material described below.



Hypothesis

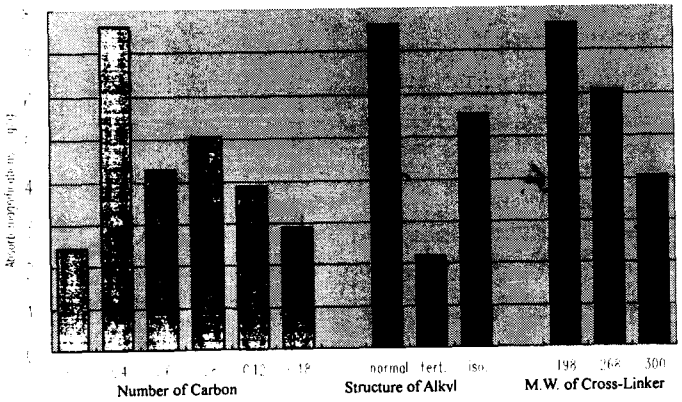
Improving sebum resistance of under make up bases and foundations would lead to an excellent long-lasting make up.

2) Requirements for developing materials to increase oil resistance of foundations against the sebum are to: a) absorb and solidify sebum in order to prevent make up film flowing with sebum, and b) insoluble in sweat.

Proceeding with our research with the above characteristics in mind, we discovered which a certain type of acrylate polymers, with a long-lasting effect, absorbs the MFD-causing sebum and swells, and solidifies itself as a whole system.

3.3 Evaluation of the synthesized polymers and monomers

Fig. 4 shows measurements of the amount of absorbed artificial sebum by the polymers synthesized through suspension polymerization. After screening many monomers, alkyl acrylates, particularly n-butyl acrylate polymers were found to absorb sebum well. We found that sebum selectivity was improved by a very small amount of EGDM added to the monomers as a cross-linking agent. The fatty acid compositions of human sebum are well known to be mostly C16, C18f1, and C18f2 and the polarity of their n-butyl side chains appears to affect the selective absorbency. The existence of cross-linking agents seems necessary to gain the physical space within the polymer networks to contain the sebum.



3.4 Surface-treated powder and sebum absorbency

With a proper solvent, polymers swelled formed a sufficiently, became clear slurry, and could easily cover the clay minerals commonly used in cosmetics. However, when the amount of the polymer exceeded 20wt%, the physical property of the polymers dominated, resulting in a material difficult to blend with cosmetics. For this series of experiments, we measured the amount of artificial sebum absorbed, using 10% covered powder. With a mere 10% covering, the amount of absorbed sebum increased by approximately 50%. The value of the absorbed sebum amount prior to covering was due to the capillary effect of the powder; the remainder is the amount absorbed by the polymers, and is consistent with the sebum amount absorbed by the monomers in the previous section.

3.5 Evaluation of MFD prevention

Fig. 5 and 6 show the results of an *in vitro* study using dried pigskin. The amount of foundation attached to a piece of pressured filter paper clearly tended to decrease when the polymer-covered powder was used. Two factors seemed to contribute to this phenomenon. One is that, by selectively absorbing the sebum only, the powder prevented the foundation film from being deteriorated by the sebum (floating in the sebum film). The other is that the polymers themselves swelled after absorbing the sebum and strengthened the foundation film as a result. Considering MFD as a physical phenomenon, it seemed difficult to achieve MFD prevention without control of either of the above two factors.

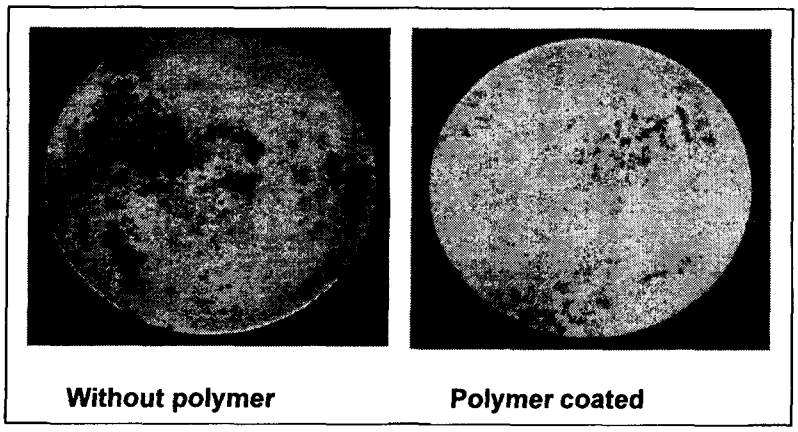


Fig. 5 Measurement of the ability to prevent MFD in an *in vitro* study

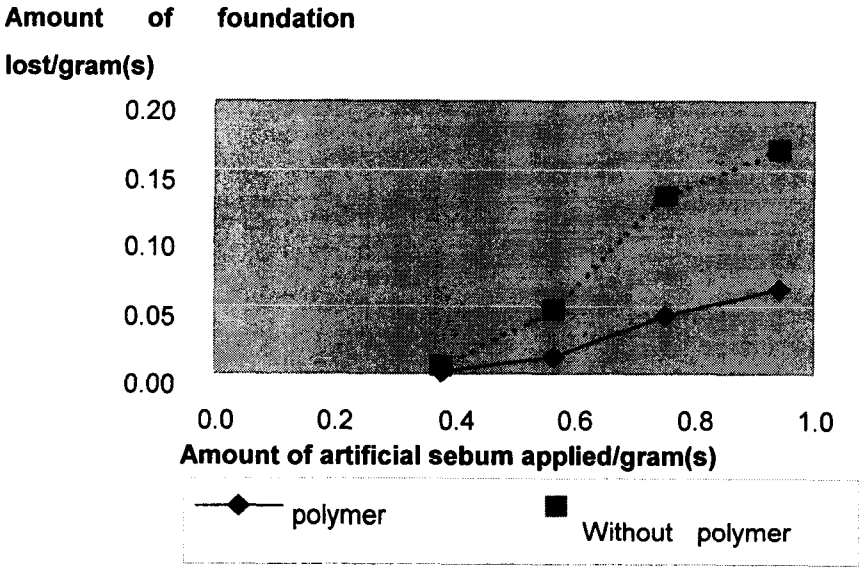


Fig. 6 Measurement of the ability to prevent MFD in an *in vitro* study

3.6 Actual usage testing

In a study involving 34 female volunteer panelists using the new foundation, we asked them to record the time when they started experiencing MFD and compare it with the control using ordinary under make up base and ordinary foundation. As shown in Fig. 7, the length of time until MFD on average increased by 25%, which was statistically significant (α=0.01). While there is a large individual variation in the amount of the human sebum secretion, the length of time to MFD almost doubled in the panelist who experienced the most effect. This result supported our prediction based on the *in vitro* study described in the previous section.

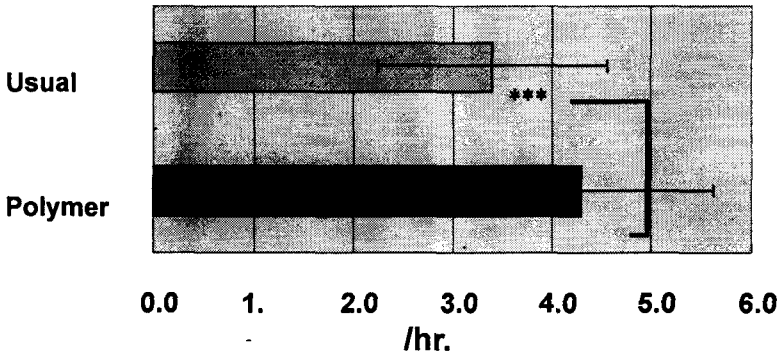


Fig.7 About the timing when subjects started feeling MFD(n=34)

4. Conclusion

Our challenge was to explain why it is that 76% of females in their 40s feel they have a greater tendency to develop MFD now than when they were in their early 20s, and to suggest a solution. We focused on the skin surface morphology that deteriorates with age. Then, we determined the skin surface morphology and the way sebum spreads. Sebum secreted from the sebaceous glands flows along the furrows. In skin whose relief patterns are uniform, furrows are abundant and deep; and it takes a long time for the sebum to overflow the ridges. On the other hand, in skin whose relief patterns are non-uniform, furrows are shallow and scarce; so it takes a relatively short

time for the sebum to overflow and cause MFD. Of course, today's technology does not allow us to smoothen skin relief patterns using make up products. To circumvent this problem, we pursued the development of make up products that will not cause MFD even in persons with non-uniform skin relief patterns. We then planned to form a material that repels sweat and solidifies sebum onto the skin, and developed cross-linking n-butyl acrylate polymers. It became possible to combine these polymers with cosmetics by covering clay minerals with these polymers. It was confirmed that the polymer-covered powder prevented MFD (i.e., physical detachment of the film) in an *in vitro* study and usage testing among human volunteers. We were able to reason by analogy that such an effect is due to two key characteristics of the polymers, absorbing and swelling.

References

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(2) H.Iyanagi,A.Kuroda,Polymer Preprints,Japan,52 No.4,799(2003)