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Analysis of roughness of wave hair formed by thermal perm

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열 펌으로 형성된 웨이브 모발의 거칠기 분석

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Abstract Appearance management through hair beauty forms the basis of the beauty industry, while permanent waves using heat are often used in hair salons, but hair damage due to thermal permanent wave treatment is an inevitable reality. Therefore, this study was conducted for the purpose of presenting an efficient method for thermal permanent wave that can further increase hair wave formation ability and minimize customer's hair damage. After collecting virgin hair from the occipital region, thermal rod pretreatment and thermal permanent wave treatment were performed, and hair roughness analysis and 3D-image were studied using an Atomic Force Microscope. As a result of the study, both the average roughness (Ra) and the ten point average roughness (Rz) were calculated as 223 nm and 853 nm for 4 sections, respectively, showing the highest values. Although the number of samples of the experimental data is limited, the wave forming power can be further increased through this study, and it is expected that it will be practically possible to propose an objective method for thermal permanent wave that can minimize hair damage as well as protect the cuticle of the customer's hair.Judge.

Key Words : Thermal permanent, Wavy hair, Roughness, Hair damage, Hair cuticle

요 약 헤어미용을 통한 외모 관리는 미용산업의 근간(根幹)을 이루면서 열을 이용한 퍼머넌트 웨이브는 헤어살롱에서 많이 시술되고 있지만, 열 퍼머넌트 웨이브 시술로 인한 모발 손상은 불가피한 현실이다. 따라서 모발 웨이브 형성력을 더욱 높일 수 있고 고객의 모발 손상을 최소화할 수 있는 열 퍼머넌트 웨이브에 대한 효율적인 방안을 제시할 목적으로 본 연구를 진행하였다. 후두부의 버진 헤어를 채취하여 thermal rod pretreatment and thermal permanent wave treatment를 한 후, Atomic Force Microscope를 통한 모발 거칠기 분석과 3D-image를 연구하였다. 연구 결과 평균 거칠기(Ra)와 십점 평균 거칠기(Rz) 모두 4구간이 각각 223㎚와 853㎚로 산출되면서 가장 높은 수치를 나타냈다. 실험 데이터의 표본이 적은 한계성을 지니고 있으나 본 연구를 통해 웨이브 형성력을 더욱 상승시킬 수 있으며, 고객 모발의 큐티클 보호와 함께 모발 손상을 최소화할 수 있는 열 퍼머넌트 웨이브에 대한 객관적인 방안 제시가 현실적으로 가능해질 것으로 판단한다.

주제어 : 열 퍼머넌트, 웨이브 모발, 거칠기, 모발 손상, 모 표피

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1. Introduction

Modern instinctive desire to become beautiful is one of the basic human needs across the ages and in all countries of the world[1]. The attitude of trying to show oneself pretty to others is a being that can not be overlooked in modern society because it is used as a direct or indirect tool to express the values f the times and cultural trends[2]. Thus, for modern people, it can produce external beauty with positive images visually and emotionally, and at the same time, it can be used as a means of communication with society and expression of individuality[3]. The active act of aesthetic management is being used as a part of expressing aesthetic desires or conveying a nice impression to others, not only for women but also for men[4]. Therefore, to a degree that it is not an exaggeration to say that appearanceism is prevalent in modern society, it is a trend that one does not spare any economic and time investments to decorate his/her appearance[5]. In line with the trend of the 'appearance management craze', the domestic beauty industry continues to develop explosively, and apart from Korea, it is booming worldwide with the chasing popularity of 'K-beauty'[6].

Among the beauty industries, hair beauty is a business that expresses the appearance beautifully by grooming human hair and body according to the tastes and requirements of customers[7]. Modern people who are sensitive to fashion pursue psychological stability and happiness by changing and directing the hair style that leads the times in various ways, while at the same time making their own career and life more enriched[8]. As such, hair beauty in the modern society is gradually evolving and developing into the concept of a complete body of human beauty. The hair style, which is used as a symbol of one's identity or sexy appeal, serves as a source of confidence that expresses the appearance of modern people more beautifully and expresses individuality[9].

If hair beauty in the past was harmonized with the coeval leading industries and created a hair style with only trendy shapes or colors, hair beauty in modern society is changing to a trend that pays attention not only to external beauty expressions, but also to hair and scalp health[10]. The hair has the function of protecting the human body by blocking ultraviolet rays and buffering external shocks. In addition, it has the function of releasing heavy metals such as zinc (Zn), mercury (Hg), and arsenic (As) that cause negative effects in the body[11]. In the modern society where the concept of healthy beauty (美) is being re-illuminated, the need to manage hair and scalp along with the cultural flow of well-being trend emerges[12].

Modern people give themselves a lot of permanent wave treatment using heat to complement and complete their image and hair style more beautifully. However, due to heat permanent wave treatment in which physical and chemical treatment is inevitable, the oil-moisture balance of the hair is broken, cortical cells and intermittent substances are leaked to the outside and the hair is decomposed and eventually broken. Even if heat permanent wave is treated on damaged hair for external beauty, it is difficult to expect the formation of desired wave.

Therefore, it is necessary to present an efficient strategy for heat permanent wave that can further increase the wave forming power on dry damaged hair with the cuticle can be peeled off, and minimize customer's hair damage. Hence, in this study, we would like to present an efficient strategy for thermal permanent wave treatment that causes damage while having a harmful effect on the hair cuticle.

2. Experimental Method

2.1 Hair sample

This study used the sample hair from the hair of a 17-year-old unmarried woman living in Mokpo City, Jeollanam-do, who had no smoking or specific disease, and has not been treated chemically for the last five years or more.

As for the sample production with the intention of using the hair of the occipital region, the sample for this experiment was collected by measuring and binding the 25cm length(1 section of 4.1cm each from the scalp) required for the experiment and cutting it using blunt scissors. The collected sample hair was divided into 4g each for easy experimentation, and about 1cm was fixed with silicone, the fixed part was wrapped with paper tape, washed with a neutral shampoo, and then dried naturally.

2.2 Procedure devices and drugs

The permanent wave treatment devices used in this study were Tdd-1500 (setting machine), Rod 22mm, clip, Non-woven fabrics, end paper, bowl, coloring comb, rat tail comb, and M company's hairless head dummy. The permanent wave solvent is a solvent exclusively for heat permanent wave from A company that is used in the field. With regard to the first agent, a creamy product that is usually treated on hair as a reducing agent that cleaves cystine bonds was used, and regarding the second agent, a liquid neutralizing agent whose main component is hydrogen peroxide was used as an oxidizing agent that recombines reduction and cleaved cystine bonds.

2.3 Thermal rod pretreatment and thermal permanent wave treatment

For this experiment, a 22mm round heat rod used in the market was purchased and the heat forming power was checked. The rods showing different temperatures in heat forming power were cut in half, and the inside of the rod was observed, and the rod was selected as an experimental rod. The first agent of 5g used in this study was prepared, and the first agent was applied 7cm from the hair root direction to the hair shaft direction, and naturally left for 10 minutes.

After the time elapsed, the first agent was connected to the end of the hair, and a natural leave time of 10 minutes was set. After the softening test, it was washed with a neutral shampoo to wash off the first agent remaining on the hair. The moisture was dried using a towel and dried leaving about 25 ± 5% of an appropriate moisture content, and two half-winding was performed using a 22mm rod. After 10 minutes of heat treatment by setting at 180°C. in the setter, it was left naturally for five minutes. Then, after cooling the heat, the non woven fabric was removed, and the heat was cooled again for five minutes and rod-out. Apply the second agent, a neutralizer, and let it sit naturally for 10 minutes, and the sample was rinsed clean with lukewarm water, towel-dried, trimmed in the wave direction, and naturally dried at room temperature.

2.4 Atomic Force Microscope (AFM)

Atomic Force Microscope is a type of atomic microscope called 'Scanning Probe Microscope (SPM)' which was released as a successor model of 'Scanning Tunneling Microscope (STM)'[13]. Unlike STM, which can only measure electrical conductor samples, AFM can measure even non-conductor samples, and measurement is possible regardless of the limitation of measurement space or electrical characteristics[14].

To analyze the roughness of hair formed by heat permanent wave using atomic force microscope, after cutting each sample hair into appropriate 1cm, it was measured by placing it on a stub treated with carbon tape on a metal circular disk so as not to move.

Atomic force microscopy describes the three-dimensional structure of the sample surface by using the 'van der Waals force' that expresses the repulsive force and attractive force between atoms[15]. That is, AFM measurement uses a probe to measure the height of the hair surface, and by measuring the surface based on the part where the probe comes down and touches the surface, it can measure the roughness of the hair sample. After attaching the probe to the surface of the sample, the state of the hair surface roughness was observed using a repulsive force vertically caused on the surface. The 3D hair structure using Atomic Force Microscope (Multimode-8, Bruker, Santa Barbara, CA, USA) measured the roughness of the hair surface under the same conditions of 40㎛ width and 10㎛ length.

2.5 3D-image

The line-profile represents the roughness data value for the hair, and the 3D-image was measured in the direction of the cuticle of the hair sample. As the 3D-image can photograph the indicators of Topograpy in three dimensions from various angles and directions, it is possible to accurately analyze hair surface loss, lift, and roughness[16]. And as shown in the 3D-image analysis results, in the results of the line profile as well, a clear image of the surface roughness of the hair cuticle and the shape of an angle parallel to the axis of the unique hair distribution can be confirmed.

3. Experiment Results

3.1 Hair roughness of sample 1 sectio

When measuring the roughness of the hair sample by measuring the width of 40㎛ and the length of 10㎛in the measuring range, Fig. 1 shows the shape of section 1 as a graph.

The height (Min) of the lowest part was -358㎚, the height (Max) of the highest part was 688㎚, and the mean height was 120㎚. Based on this mean line, the average roughness (Ra) indicating how far each of the values s apart was calculated as 171㎚. In addition, on the basis of the mean line, the ten point average roughness (Rz), which is the sum of the average of the five absolute values f the highest numerical value and the average of the five absolute values f the lowest numerical value, was calculated as 767㎚. The 3D-image has relatively little color change in the height of the roughness of the hair, and showed a slight irregular change in roughness.

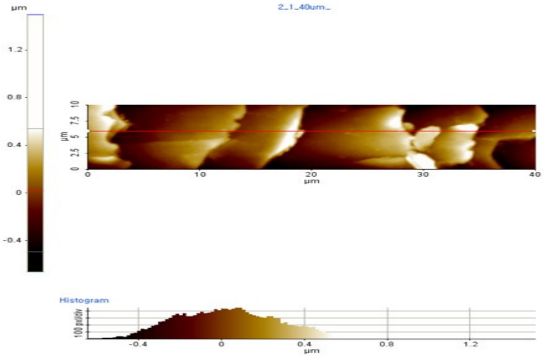

Fig. 1. Hair roughness of sample 1 section.

3.2 Hair roughness of sample 2 section

When the hair roughness was measured with the sample 2 section in the range of 40㎛ width and 10㎛ length, Fig. 2 shows the cross-sectional shape as a graph. The height (Min) of the lowest part was -265㎚, the height (Max) of the highest part was 826㎚, and the average height (mean) was 201㎚. Based on the mean line, the average roughness (Ra) was calculated as 188㎚, and based on the mean line, the ten-point average roughness (Rz) was calculated as 836㎚.

Even with the naked eye, it was possible to confirm the lifting phenomenon and rough cross section due to the cracking and dropping of the cuticle. It is in the same context as a previous study of Lee Jeong-eun[17] that the cuticle melts after the heat permanent wave treatment so that the boundary can not be recognized or irregular swelling or crumpling is observed.

On the other hand, although hair roughness can be caused only by the physical impact or brushing that occurs in daily life, as hair protein denaturation occurs due to heat permanent wave treatment and the cuticle abrasions or peels off due to heat generated during treatment, so it is judged that the roughness of the hair surface increases.

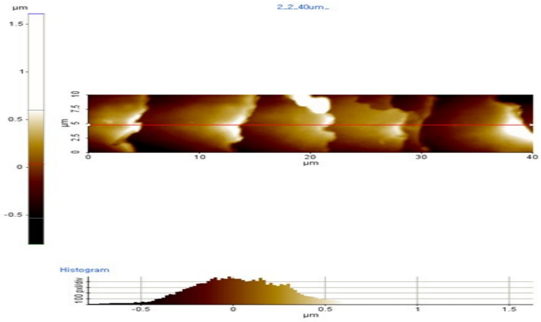

Fig. 2. Hair roughness of sample 2 section.

3.3 Hair roughness of sample 3 section

When measuring the roughness by taking the range of 40㎛ width and 10㎛ length of the hair sample, Fig. 3 shows the shape of the section in a graph.

The height (Min) of the lowest part was -444㎚, the height (Max) of the highest part was 434㎚, and the average height (mean) was 70㎚. Based on this mean line, the average roughness(Ra) was calculated as 179㎚, and based on the mean line, the ten-point average roughness was calculated as 718㎚.

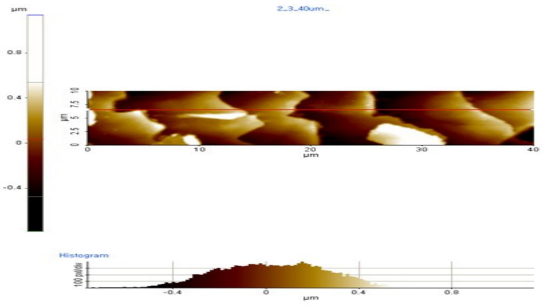

Fig. 3. Hair roughness of sample 3 section.

3.4 Hair roughness of sample 4 section

The result of measuring the roughness of the cross-sectional shape of the hair sample section 4 is shown in Fig. 4.

The height (Min) of the lowest part was -580㎚, the height (Max) of the highest part was 877㎚, and the average height (mean) was 101㎚. The average roughness (Ra) was calculated as 223㎚, and based on the mean line, the ten point average roughness was calculated as 853㎚.

It could be seen that section 4 does not have a clear boundary between cuticles compared to other sections, and that a large drop-off phenomenon appeared on the cuticle surface as the scale of the cuticle surface was widened or separated. In other words, the visible surface roughness is very severe, the color change of the 3D-image is very large, and irregular and large changes in height could be seen. Also, based on the horizontal axis of section 4, it is judged that the hair in section 4 is more damaged than the other sections through the frequent changes in the height of the graph on the roughness data.

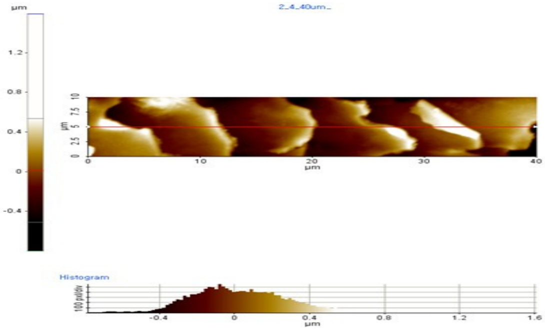

Fig. 4. Hair roughness of sample 4 section.

3.5 Hair roughness of sample 5 section

The graph for measuring the roughness of hair sample section 5 in the range of 40㎛ width and 10㎛ length is shown in Fig. 5.

The height (Min) of the lowest part was -365㎚, the height (Max) of the highest part was 643㎚, and the average of the height (mean) was 52㎚. In addition, the average roughness (Ra) was calculated as 171㎚ and represented the same value as for section 1, and the ten point average roughness based on the mean line was calculated as 729㎚.

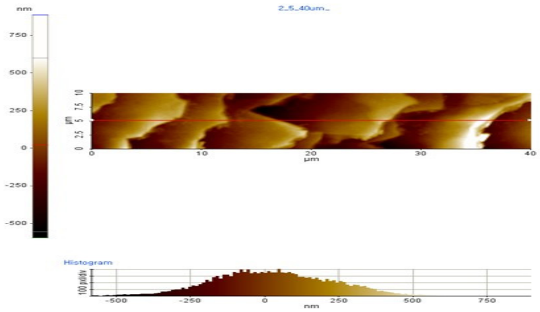

Fig. 5. Hair roughness of sample 5 section.

3.6 Hair roughness of sample 6 section

When measuring the roughness of hair sample section 6 with a range of 40㎛ in width and 10㎛ in length, if the cross-sectional shape is shown as a graph, then it is as shown in Fig. 6.

The height (Min) of the lowest part was -472㎚, the height (Max) of the highest part was 675㎚, and the average height (mean) was 14㎚. The average roughness (Ra) based on the mean line was calculated as 162㎚, showing a lower value than sections 3 and 4. In addition, the ten point average roughness based on the mean line was 764㎚.

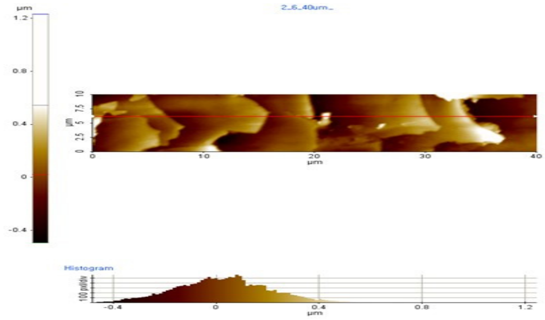

Fig. 6. Hair roughness of sample 6 section.

4. Conclusion

Since the sample of the experimental data is limited, it is necessary to diversify the hair of the experimental group in the follow-up study. The results of roughness analysis for hair formed with heat permanent wave through Atomic Force Microscope are as follows.

First, as the average roughness (Ra) was calculated as 171㎚, 188㎚, 179㎚, 223㎚, 171㎚, and 162㎚ respectively for section 1, section 2, section 3, section 4, section 5, and section 6, section 4 showed the highest numerical value.

Second, the ten point average roughness (Rz) is calculated as 767㎚, 836㎚, 718㎚, 853㎚, 729㎚, and 764㎚ respectively for section 1, section 2, section 3, section 4, section 5, and section 6, and section 4 was the highest, followed by section 2. Third, the 3D-image showed the height and lowness of the hair scale shape in proportion to the roughness value of each section.

Through the above research results, it was found that the excessive heat of the thermal permanent wave directly harms the cuticle and acts as a direct cause of hair damage. Therefore, in subsequent studies, it is necessary to derive an appropriate temperature of the thermal permanent wave that can reduce hair damage to the maximum. In addition, this study is expected to present objective data for the development of an efficient thermal permanent wave treatment tool.

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