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ELECTRO PHOTONIC ANALYSIS OF HAIR AND NON HAIR FIBERS AND INVESTIGATION OF DIFFERENT HAIR TREATMENTS

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The investigation of different fibers and hair treatments is an important task for cosmetology. The results of Electro Photon Analysis of hair and non hair fibers, and hair with different treatments are presented.

Materials and Methods

Hair and non hair filaments. In the experiments on comparison of GDV characteristics of hair and non-hair fibers three types of non hair filaments and different samples of virgin hair were measured. Also the composite swatches were investigated. Fibers were configured with the swatch diameter d = 3 mm and lengths L = 30 mm and calibrated by weight. For the diameter of 3 mm and length 30 mm the following weights of swatches were used:

FG (Fiber Glass) – 0.14 g
PT (Polypropylene Tow) – 0.1 g
SA (Spun Acrylic) –0.04 g
UPVWH (Unpigmented Virgin White Hair) – 0.1 g
VMBH (Virgin Medium Brown Hair) – 0.1 g
VMBH+SA – 0.05 g of VMBH and 0.02 g of SA.

Results are presented in the figures 1 and 2, for every sample of filaments 6 swatches were measured. Every swatch was measured once with 50 bmp frames with 5 seconds interval. The voltage level was v = 120. Temperature and relative humidity were fixed (T = 24^0C, RH = 37 %).

After the data processing the following results were obtained. All non hair fibers had the significantly higher values of Area and Intensity of glow in comparison with samples of hair (with 95 % confidence). The GDV parameters of composite swatch were closer to the parameters of hair glow in comparison with non-hair samples.

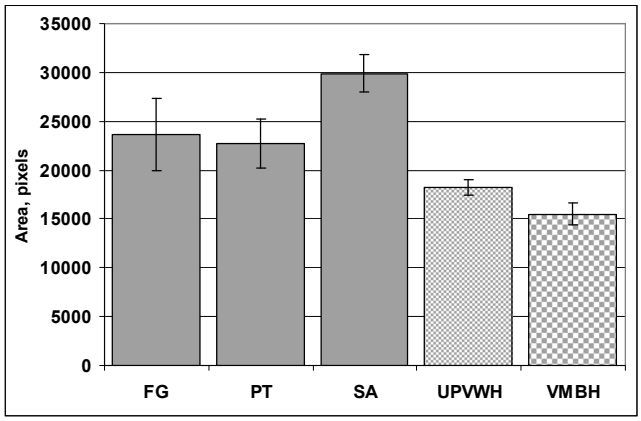

Figure 1. Area of hair and non-hair fibers.

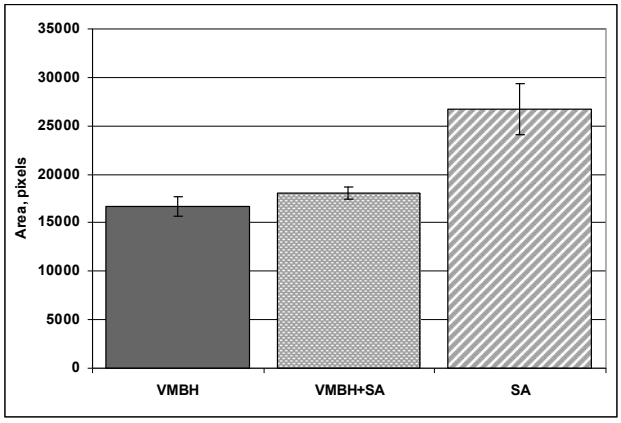

Figure 2. Average Area of VMBH, VMBH+SA and SA

Experiments on hair treatments. In the experiments on investigation of influence of bleaching agent on hair 20 swatches from initial hair samples were made (30 mm, 0.1 g). 10 swatches were initial (without any influence) and 10 swatches were bleached with Schwarzkopf dust-free bleach and 12 % oxigenta lotion for bleaching. In these experiments 100 bmp pictures were captured for every series. In figure 3 the average intensity of initial and bleached hair, measured during two different experiments are presented.

The values of glow intensity of bleached and initial hair swatches have significant differences (with 95 % confidence). The averaged values of glow intensity of initial swatches from the same head were very closely in different experiments, conducted at 3 week's interval.

In the experiment with different treatments of the samples of Virgin Medium Brown Hair (VMBH) the following treatments were used:

T1. Treated with NaOH relaxer
T2. Dyed then straight waved then conditioner
T3. Dyed only
T4. Straight-waved
T5. Untreated.

Details of treatments:

Relaxer treatment (T1). Tha hair swatch was treated at 25 °C for 30 min with 10 g of Revlon Realistic Creme Relaxer. After treatment the hair was rinsed thoroughly for 3 min under running tap water and then shampooed for 5 min a

neutralizing (acidic) shampoo. The hair was then rinsed again for 3 min, towel blotted and air dried;

Hair dyeing treatment (T2 and T3). Both swatches were dyed each with 10 g of L'Oreal Excellence Creme hair color (# 6 A) for 30 min at 25 °C. After coloring the swatches were rinsed for 3 min under running tap water and then shampooed with an ammonium laureth sulfate -containing shampoo. Then the swatches were rinsed free of foam, blotted and air dried.

Straight waving treatment (T2 and T4). Both swatches (T2 after dyeing) were treated at 25 °C with 10 g each of Toni Silkience Waving lotion for 30 min. Afterwards the swatches were rinsed for 3 minutes under tap water, towel blotted and treated each for 5 min in 5 g of hydrogen peroxide neutralizer. It was rinsed again and shampooed with an ammonium laureth sulfate-containing shampoo. The swatches were then towel blotted and air dried.

Every swatch was measured with series of 50 bmp frames (with 5 seconds interval). Temperature and relative humidity were fixed (T = 23^0C, RH = 37 %) during the experiment. During the experiment 6 swatches of every hair sample were measured. Obtained data is presented in figure 4.

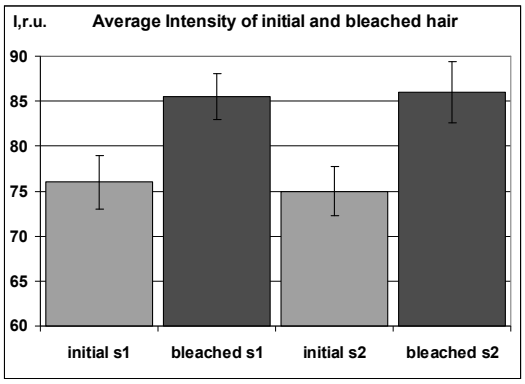

Figure 3. The intensity of initial and bleached hair glow.

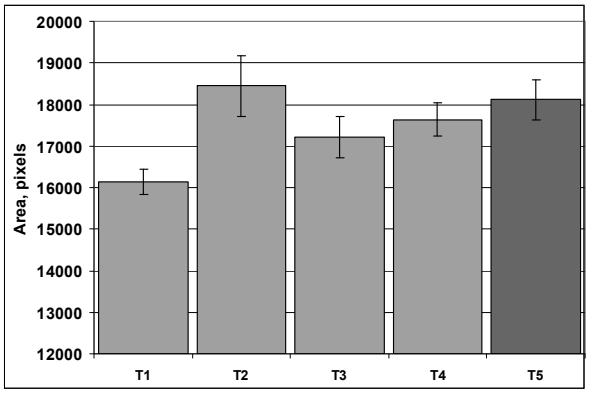

Figure 4. Average Area of GDV hair glow.

Summary

The main results of the investigation of hair, non hair fibers and EPAH with different hair treatments are as follows:

1. Statistically significant difference (p = 0.05) between hair and non-hair fibers were obtained. All non hair fibers had the higher values of Area and Intensity of glow in comparison with samples of hair;
2. Statistically significant difference (p = 0.05) between initial non-treated hair samples and bleached hair were obtained. The other types of hair treatment did not show statistically significant difference.

ELECTRO PHOTONIC ANALYSIS OF HUMAN HAIR AND INFLUENCE OF HUMIDITY

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Ascertaning the physical properties of human hair under the influence of environmental factors is important for dermatology and cosmetic science. Recently, gas discharge visualization (GDV) has been utilized for the investigation of human hair [1-3]. The method of Electro Photonic Analysis of Hair (EPAH), based on GDV technique is described and investigation of humidity influence presented.

Materials and methods of research

Virgin, not treated commercial human hair were measured. From all hair samples swatches of the following configuration were prepared: 30 mm long, 0.1 g weight. The experimental setup is presented in figure 1. A swatch of hair 8 was placed in the hair fixing device 9 so that cross section of hairs touched the glass electrode 4 of GDV Camera 1. Hair sample was grounded by metal rod 10. The discharge area was covered with light-proof cover 11. Electric impulses from generator 2 were applied to conductive layer 3, covering optical window 4 from below and electromagnetic field was generated around the hair sample. The charged particles were emitted and the sliding gas discharge 12 was generated. Spatial distribution of the discharge glow was recorded by the optical system 5, transformed into a digital format and sent to the computer as BMP files.

The parameters of GDV Capture were: voltage level v = 120 V, exposure – 300 ms, number of GDV images – 50, capture interval – 5 sec. During the experiments the temperature and relative humidity were recorded (T = 22-24^0 C, RH = 34-38 %).

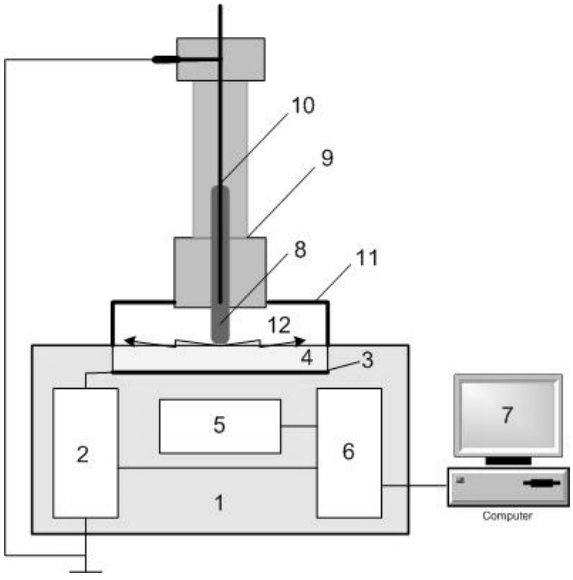

Figure 1. Scheme of the experimental setup: 1 – GDV Camera, 2 – generator, 3 – conductive transparent layer, 4 – transparent dielectric glass, 5 – the optical system, 6 – control block, 7 – computer, 8 – swatch of hair, 9 – hair fixing device, 10 – grounded electrode, 11 – light-proof cover, 12 – sliding gas discharge.

Results

Humidity had a marked influence on GDV parameters of hair glow. For the investigation of humidity, a special optiglass box with hygrometer was used. Initial relative humidity was 30 %, then a glass with warm water was placed in the box, and relative humidity in the box gradually increased to 100 %.

In figure 2 the typical character of area dependence on relative humidity is presented. The glow area decreased with increasing humidity for all samples.

At 100 % humidity hair were kept for some time. As seen from figure 2, the signal decreases for about 15 – 20 minutes and reaches saturation.

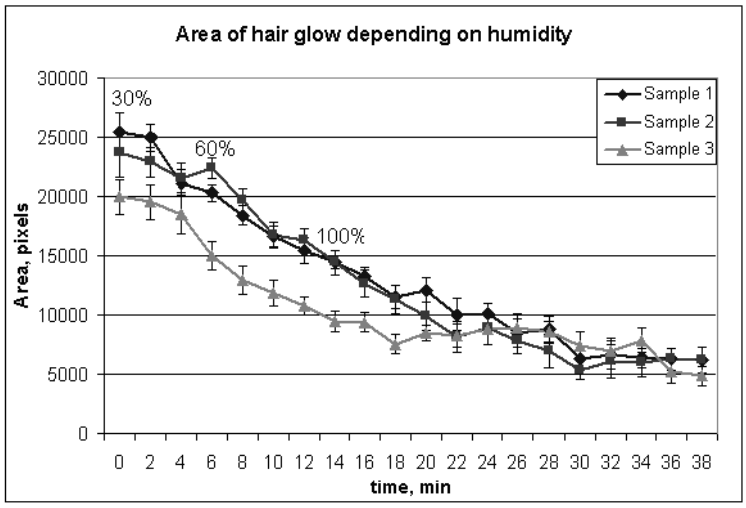

Figure 2. Time dynamics of hair glow Area with increasing of relative humidity from 30 % to 100 % and later keeping with relative humidity 100 %.

Relative humidity had a significant influence to the parameters of hair glow: the area was always decreasing with increase of humidity. The decreased area may be caused by the following process: with increasing humidity the conductivity of hair filaments increases and electron flow comes from the tip of the metal electrode directly to the surface of the glass electrode; less and less hair fibers take part in electron flow and the area of GDV image decreases.

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ESTIMATION OF REPRODUCIBILITY AND EXPERIMENTAL ERRORS OF GDV HAIR DATA

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Data reproducibility and estimation of experimental errors are very important for any methods of investigations. Stability and reproducibility of GDV bioelectrography method are described in number of works [1,2]. Analysis of systematic errors and reproducibility in the experiments with the test-object (metal cylinder) [2] demonstrated a high reproducibility of GDV method and the level of systematic errors below 5%.

The technique of GDV investigation of hair is described in details in works [3,4]. In this article the estimation of reproducibility and errors of GDV hair experiments is presented.

To calculate the errors of experimental results and choose the method of statistical data processing it is necessary to know the kind of data distribution. The analysis of results of more than 30 experiments (with at least 100 experimental points in every experiment) demonstrated, that the parameters of GDV hair glow have normal distribution. In all cases the average value almost coincided with the median. The median values were located

approximately in the middle between the 25 and 75 percentile; 16 and 84 percentile were closely related to the boundaries of standard deviations from the average value. So, the GDV hair data may be considered as normal distribution. This distribution allows processing of data by parametric statistical methods and description in terms of average, standard deviation and confidence interval.

In the experiments on reproducibility the swatches 55 mm long and 0.4 g in weight were measured. The results of one of the experiments with swatches of "dry" hair (time after cutting more than 20 days) are presented in figures 1 and 2. The experiments were conducted at room conditions (T = 22^0C, H = 42 - 44%). In every series of the experiment 10 avi-files were measured. The exposure of voltage was 5 seconds; the frequency of record of GDV images was 20 frames/sec. The errors of the measurements didn't exceed 5-8%.

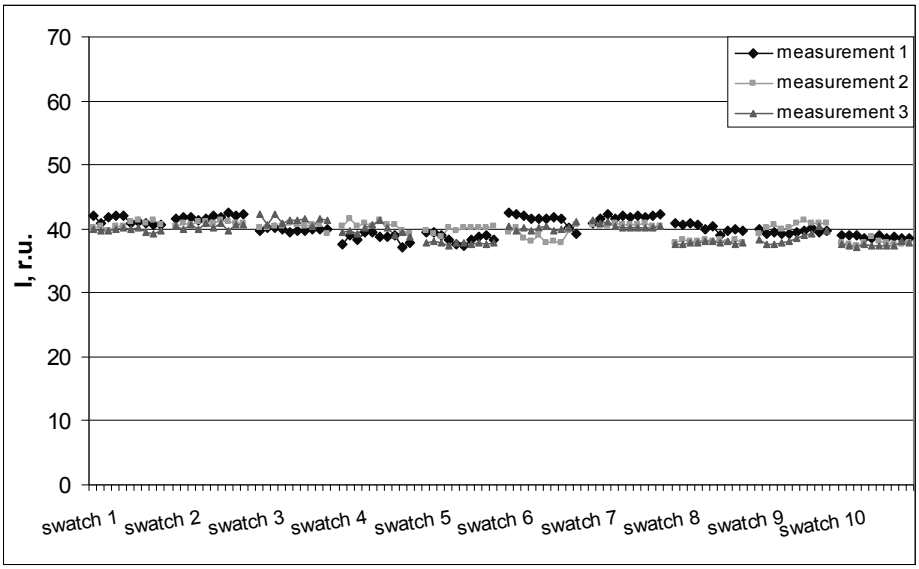

Fig.1. Results of three consistent measurements of time dynamics of GDV hair glow intensity.

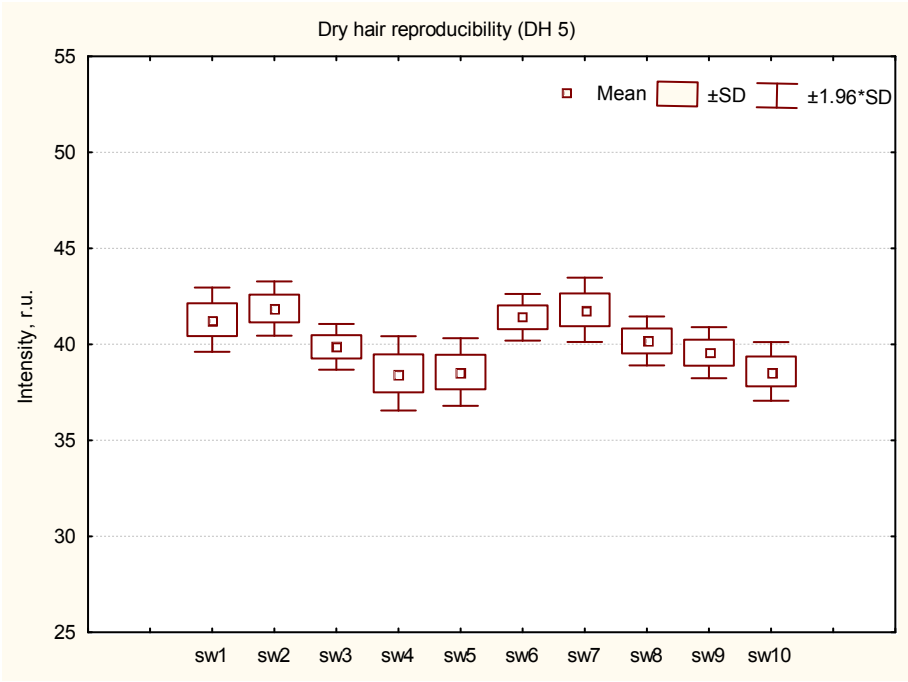

Fig.2. Values of average, standard deviations and confidence intervals of GDV glow intensity for 10 hair swatches (1000 experimental points for every swatch).

It is significant, that hair has a complicated internal structure and high biological variability [5,6]. For example, values of resistance of hair fibers, taken from different regions of a head, vary in range of 40 % [7]. Besides, such factors as environmental effects, seasons, living conditions, taking some medicines and daily hair care routines have a great influence on hair characteristics [6]. These facts should be taken into consideration during the conducting of the experiments and data analysis. Therefore hair swathes were taken from the occipital part of the head at one time. It is also very important to form the identical hair swatches (55 mm, 0.4 g) and place them on the electrode accurately.

It was demonstrated, that the parameters of GDV hair glow vary during the measurements. This can be interpreted as the change of hair properties under the influence of impulse electromagnetic field. These changes depend on individual properties of hair, but it is necessary to reduce the number of the measurements to one or two series.

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