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Revolutioning hair claim substantiation: an advanced technology for multiparametric “in vivo” evaluation

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INTRODUCTION

Nowadays, hair play a crucial role in defining social identity and consumers ask always more to customized solution. The hair It is not only part of the human body, it is also a part of the human personality-part of one's identity. How you wear your hair tells a lot about you as a person. Hair is so simple but it is so fundamental.

For these reasons huge resources are invested every day for hair care. This trend affects both care and hygiene products and equipment developed for the treatment, analysis and care of the hair. The increasing market has also enhanced the value of properties of cosmetic products with regard to the effects attributed to the cosmetic product. In this connection, a standard covering cosmetic products has been introduced at the regulation level, which requires the verification of the safety and efficacy requirements not closely correlated with the actual nature of the cosmetic product.

For these purposes, it is fundamental to use validated instrumental methods able to verify such effects. In particular, to verify the safety, effectiveness, and performance of a cosmetic formulation, it is essential to develop suitable experimental designs performing “in vivo” evaluations, that is, in the real conditions of use, which may take place over very different periods of time (from a few minutes to months), depending on the kind of product and the functionalities to be ascertained.

Despite this need, there are few devices able to provide rigorous information, in particular in vivo, about both the external characteristics of the hair (such as color and shine) and in terms of conditions and structural integrity. In fact most of the technologies used for hair analysis, such as colorimeters, tensometers and high magnification microscopy technologies are, in some cases, difficult to use in vivo and for other cases absolutely unusable.

Moreover almost all the equipments for the in vivo study of the hair are limited to the evaluation of density and caliber, in rare cases to the evaluation of the gloss.

Actually, the devices suitable to support claims related to hair products present many limits, first of all the need of differents techniques, such as colorimeter, glossimeter and so on. Otherwise, mechanical approach to demonstrate the product effectiveness in restructuring hair is actually limited to “ex vivo” analyses (single hair or strands) using probes for

tensiometer or more sofisticated and costly devices. The purpose of this work is to describe an innovative system for the “in vivo” evaluation of hair.

The system described in this work, based on the FST patented technology, delivers a holistic and highly accurate assessment of the hair which relates to the quali-quantitative study of surface characteristics, mechanical properties and, indirectly, structural properties. From a technical standpoint, the Hair Morphology Tester based on FST technology consists of a plurality of sources of electromagnetic radiations adapted to be oriented spatially and to irradiate the hair according to a selected angle of incidence, an image acquisition device adapted to receive a reflected and/or dispersed radiation or a fluorescence radiation emitted, and an image processing unit designed to process images and classify them according to a database. Based on scientific principles, this technology offers reliable and repeatable qualitative and quantitative data with a validated scientific precision.

From a practical perspective, the system delivers a holistic and highly accurate assessment of the hair which relates to the quali-quantitative study of surface characteristics, mechanical properties and, indirectly, structural properties.

METHODS

The device consists in an image acquisition base adapted to receive a reflected and/or dispersed radiation emitted, and an unit designed to process images and to classify them according to a database. It provides outputs as numerical scores obtained from a suitably developed software. The cross-analysis of color, shine, degree of dispersion and frizz giving as output numerical scores traceable to the characteristics of the substrate, examples of which include color shade classification (SC), anti-yellow index (AYI), hair shine index (HSI), integrity index (II) and hair frizz index (HFI). This means that the technology can simultaneously handle aspects of texture, color, and structure, making it perfectly suited to meet the needs of cosmetic testing.

Conventional technologies such as colorimeter, glossimeter, optical microscopy and potential zeta analysis tests were used to validate each parameter.

Natural strands were used to build calibration curves of different parameters. Chemical treatment with tyoglicolate at different concentrations for different time of contact permitted to obtain a different degrees of chemical damage of the hair instead of the hair straightener treatment was used as an example of thermal degradation of hair.

RESULTS

The results obtained from the instrument regarding the color of the strands were correlated with the RGB color system using a Skin-Colorimeter Flex CL 440 (Cutometer dual MPA580, Courage&Khazaka, Cologne, Germany).

Figure 1 shows the good correlation between the color class obtained from the instrument and the RGB color system.

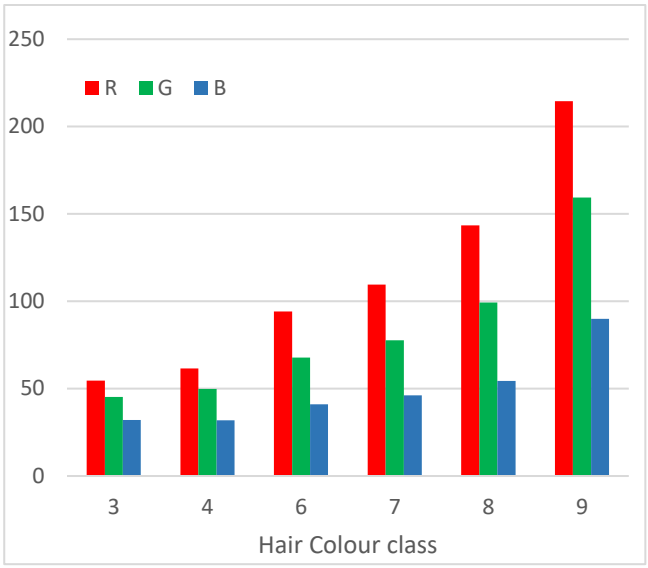


Figure 1. Hair color classes obtained from Hair morphology Tester.

Figure 2 shows images of frizzy hair (a) and natural hair. The Hair Frizz value is normalized to 1 for uniform alignement hair and analysis performed on trasformed image (as shown in figure 2c) provides the numerical score of Hair Frizz Index, varying between 0.5 to 2, as a very frizzy hair.


a)

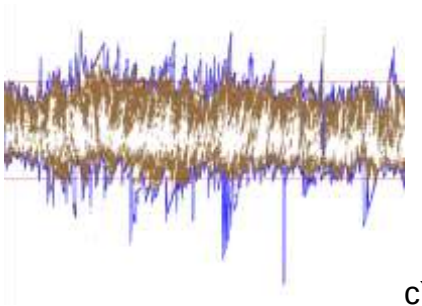
b)

c)

Figure 2. a) frizzy hair image; b) uniform aligned hair; c) image representative of the software analysis of frizzy hair image

In order to evaluate la capability of the instruments to evaluate hair shine, a correlation of value obtained from software elaboration with gloss values obtained from Skin-Glossymeter GL 200 (Cutometer MPA580, Courage & Khazaka, Cologne, Germany) was performed.

The images below reported show red colored strands before and after chemical degradation. It is clear that red strands loose shining after chemical treatment.

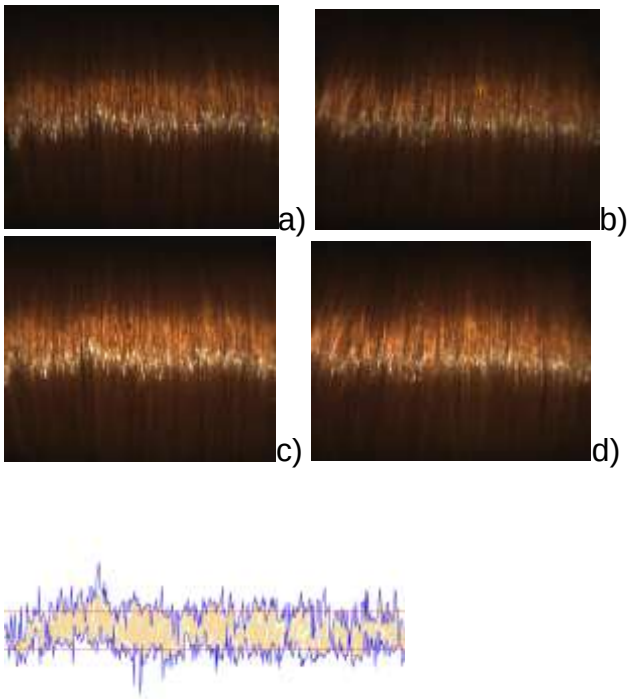


Figure 3. Red strands before (figure a and c) and after chemical degradation (figure b and d). e) software elaboration of image for shining index evaluation

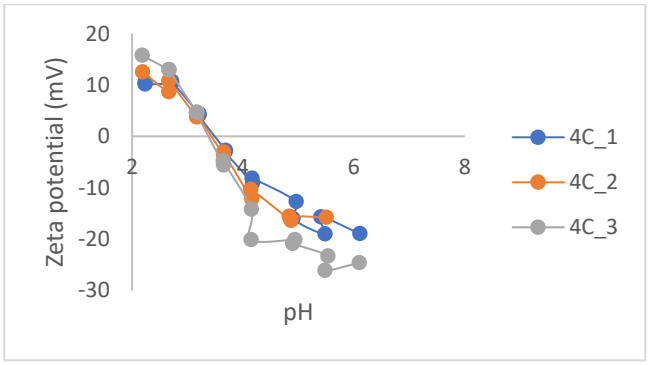
The Hair Shine Index obtained from the instrument is varying from 0,4 to 1,5 (very shiny hair). 1 represents the value for natural hair.

Regarding integrity evaluation strands treated with chemical substance and subjected to 200 thermal treatments were investigated. Figures 4 show optical microscope images of samples of hair. Figure 5 shows the softwere elaboration of hair image taken with laser light.

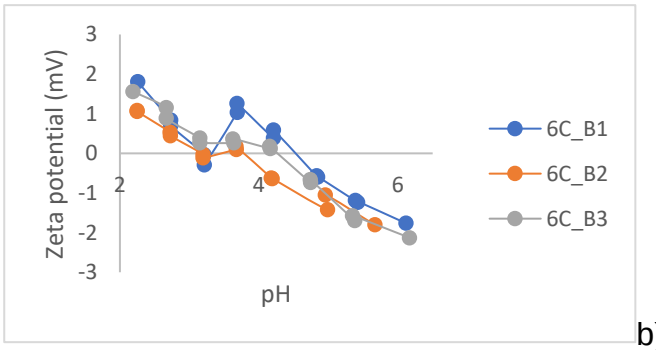
Figure 4. Optical images of: a) normal hair; chemical damaged hair; c)thermal damaged hair

Figure 5. Software elaboration of laser image for Integrity analysis

The damage degree of hair was confirmed by zeta potential analysis of hair surface, as shown in figures 6.



a)



b)

Figure 6: a) zeta potential behavior vs pH of natural strands; b) zeta potential behavior vs pH of chemically damaged strands

Results show that natural strands present a negative zeta potential (of about -20mV) at pH below their isoelectric point and a positive charge (of about 15mV) at pH above their isoelectric point instead of the chemical treatment modified dramatically that chemical characteristics.

CONCLUSION

The technology can simultaneously handle aspects of texture, color, and structure, making it perfectly suited to meet the needs of cosmetic testing of hair care product.

One of the most significant advantages of the new Hair Morphology Tester/Filament Surface Tester here described is its applicative versatility: it can be used to assess hair both "*ex vivo*" or "*in vivo*" mode across a wide range of operational contexts with immediate data reading.

In fact, the analysis is easy, quick and non-invasive, allowing easy examination of hair without damaging it, thus handling all hair types of panelists or strands, different textures and colors and wet or dry conditions, ensuring comprehensive testing of a full range of products.

The system's capability to determine the degree of well-being, indirectly assess the structural integrity of the hair and provide information on combability and resistance to breakage enables its involvement in the development of appropriate experimental testing protocols which can be characterized by different time periods, short/long or mid-term, and methods depending on the type of product and its functionality.

The technology opens up numerous scenarios within the testing field ranging from color preservation/protection/enhancement to hair health/shine and hair strength or damage repair. Anyway, its resourceful and multifaceted use can include opportunities for characterization studies or research project on hair.

Keyword: hair evaluation, hair products, image analysis, claim substantiation