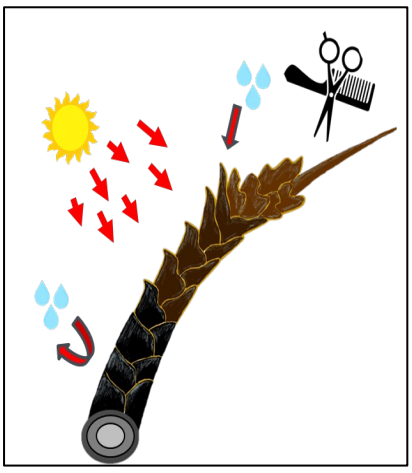
A Holistic Approach for Spatial Mapping of Hair Surface Properties of Ethnic Indian Hair

Ranju Prasad Mandal,* Marie Hensel, Leonie Hansen, Daniela Kessler-Becker
Henkel Beauty Care Disruptive Technologies, Henkel AG & Co. KGaA, Düsseldorf, Germany
*ranju.mandal@henkel.com

Introduction

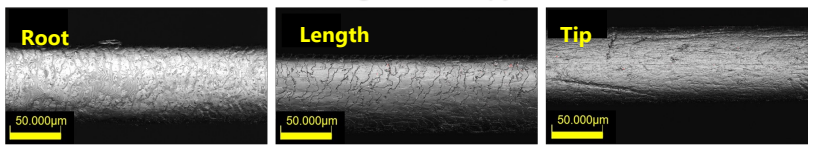
Hair is an integral part of beauty concepts regardless of ethnicity. After its generation from hair follicles, hair travels a long journey through growth, regression and resting phases. Throughout time, hair experiences many physical and chemical changes as it is exposed to a multitude of different factors of daily life. Studies report the effect of different stimuli, such as UV light, combing, and other mechanical treatments like drying, washing etc. These external factors cause physical and chemical changes in hair. None of these reports are focused on systematically studying hair aging, specifically the Indian hair type. In this work, we carry out a detailed analysis with Indian hair using some well-known and some less explored analytical techniques. During this process, the properties along the hair from root to tip were studied to give an overview on the morphological and the chemical changes throughout the aging process and, most importantly, to find out the correlation between these characteristics. This study aims not only to understand the hair surface more vividly but to pave the way to future hair applications.



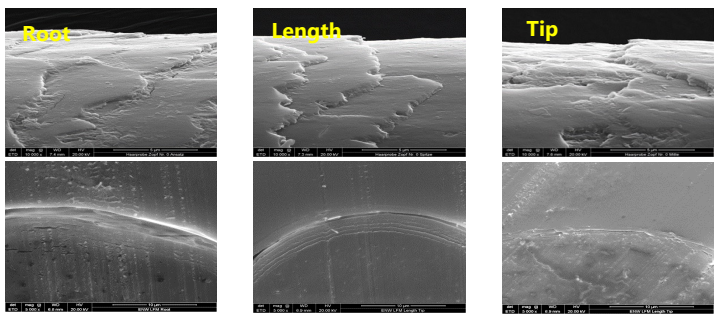
Results

Surface Morphology

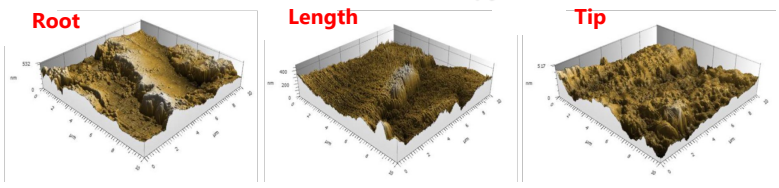
Laser Scanning Microscopy (LSM)



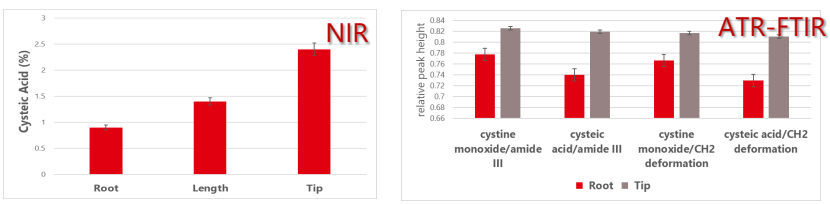
Scanning Electron Microscopy (SEM)



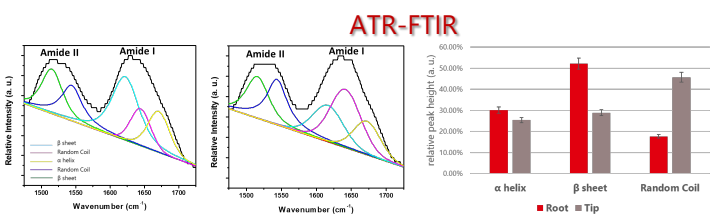
Atomic Force Microscopy (AFM)



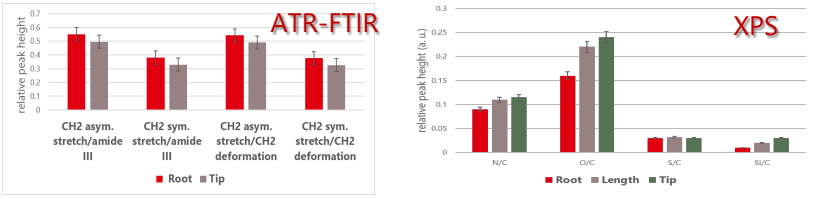
Cysteic Acid



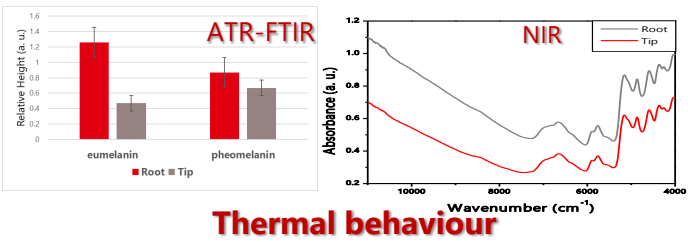
Protein Conformation



Surface Lipids

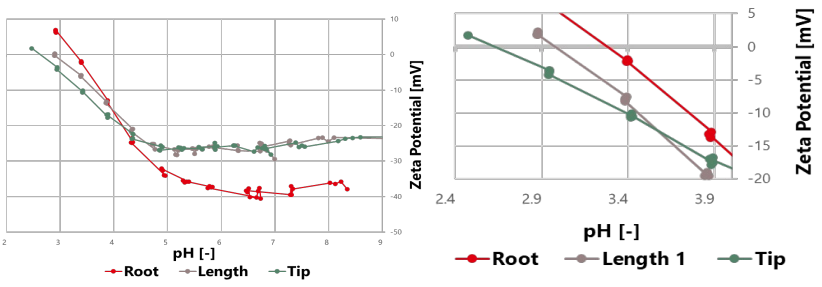


Melanin Distribution



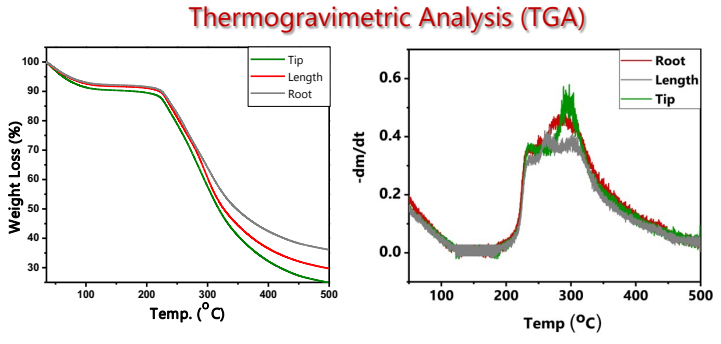
Surface Charge & Hydrophilicity

Zeta Potential



Thermal behaviour

Thermogravimetric Analysis (TGA)



Conclusion

- This study deals with the detailed characterization of the chemically untreated Indian hair to understand the effects of aging better.
- Morphological studies like LSM, SEM and AFM showed a decrease in surface lipid concentration, increased cuticular damage and roughening of hair as it grows and is exposed to weathering, all of which finally leads to the complete lifting of cuticles cells at the tip.
- ATR-FTIR spectra better help to understand the change on relative amounts of lipids and sulphur oxidation products and the change in protein structure from regular structures at the root to an irregular one in the tip.
- Zeta potential studies show different surface charge, hydrophilicity and Isoelectric Points (IEPs) of hair from root to tip.
- TG study shows the different chemical nature of the hair parts.
- Overall, for the first time, the study highlights the fine dependence between fiber compartmentalization and its physical, chemical nature of the hair along the length.

Materials and methods

Indian hair samples were obtained from Kerling International Haarfabrik GmbH, Germany. The braids were shaved at the scalp, have a length of 20 cm and weighed 46 g. A whole braid of hair from a single person was used. All hair samples were cleaned properly with 10% SLS solution adjusted at pH 10. For measurement of root, length, and tip they were cut into separate parts. Starting from the top, the first and last 5 cm were marked as root and tip and the 10 cm at the middle marked as length. For microscopic measurements (LSM, SEM and AFM) single fibers were used and for other measurements single strands were used for analysis and all measurements were done in triplicates.

References

1. Robbins, C. R., 1988, Chemical and Physical Behavior of Human Hair. Springer New York, NY.
2. Richena, M.; Rezende, C. A., Morphological degradation of human hair cuticle due to simulated sunlight irradiation and washing. J. Photochem. Photobiol. B 2016, 161, 430-440.
3. Tokunaga, S.; Tanamachi, H.; Ishikawa; K., Degradation of Hair Surface: Importance of 18-MEA and Epicuticle. Cosmetics 2019, 6, 31.
4. Luxbacher, T., 2020, Handbook of Natural Fibres (Second Edition), Elsevier Ltd., Amsterdam, Netherlands