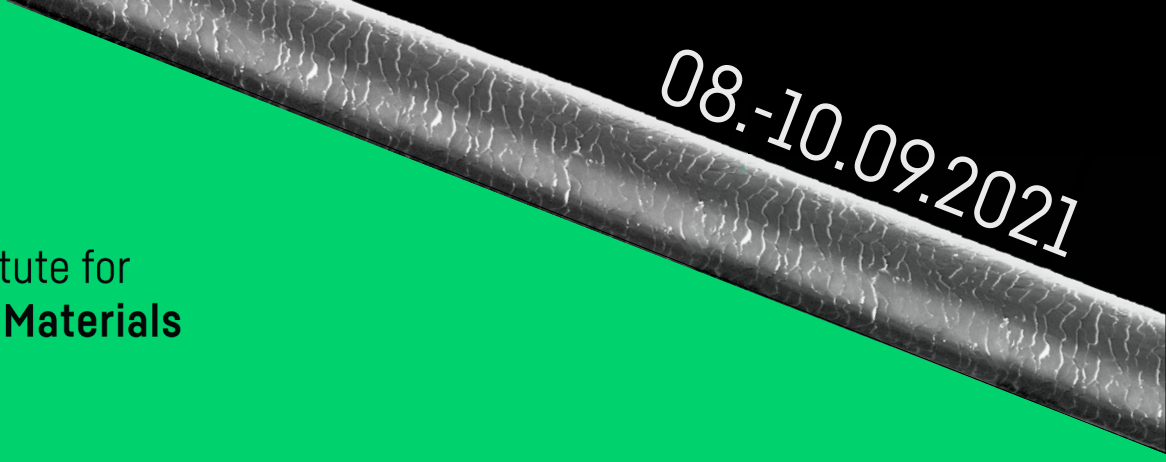

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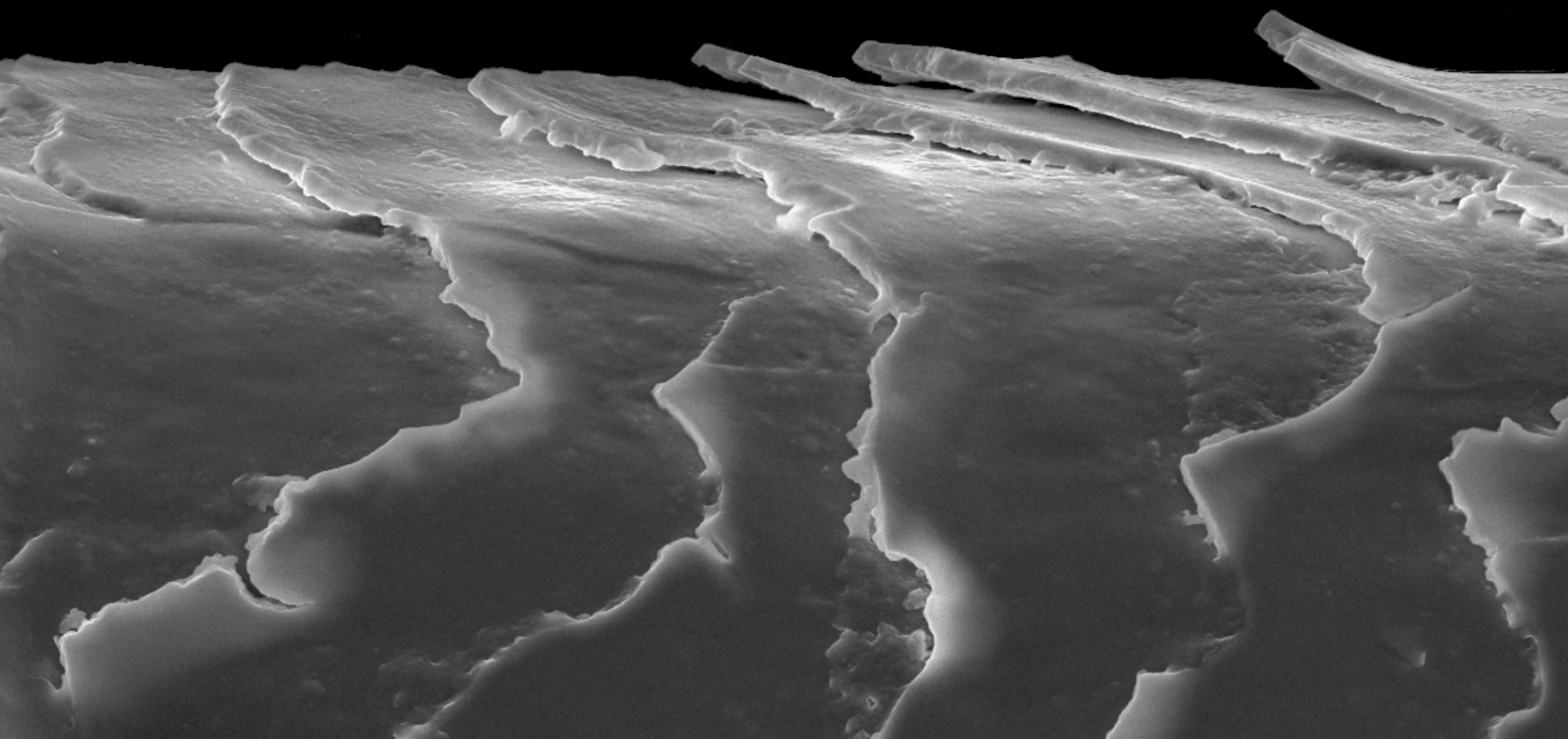
Book of Abstracts

HairS'21

22nd International Hair-Science Symposium



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Wednesday, September 08, 2021

13:30 GET TOGETHER AND REGISTRATION

14:00 OPENING AND INTRODUCTION
Andrij Pich, DWI – Leibniz Institute, Germany and Carl-Uwe Schmidt, Wella, Germany

14:30 **Plenary Lecture**: Current Understanding on the Physiology of Human Scalp Hair Graying (Canities)
Desmond J. Tobin, Charles Institute of Dermatology, University College Dublin, Ireland

15:30 INTERACTIVE COFFEE BREAK

A. Dive In Session „Meet the Plenary Speaker"
Meet Desmond J. Tobin and other experts in a lively face-to-face online discussion about the greying of hair.

B. "Speed Dating" Session with DWI
You have the opportunity to get acquainted with our DWI experts from different research fields.

C. Connect Room
Interact with other HairS'21 participants in a more casual setting.

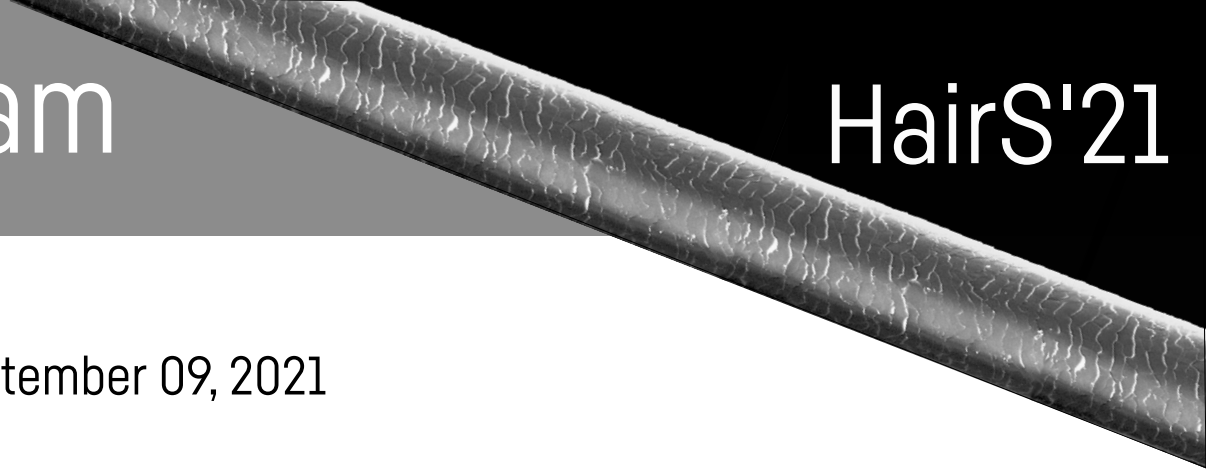
16:00 Hair Aging: Variation by Race and Ethnicity
Neelam A. Vashi, MD, Boston University School of Medicine and Boston Medical Center, USA
Elsabe Cloete, Hair and Skin Research Lab, University of Cape Town, South Africa

16:30 The Contribution of Curl to the Mechanical Response of Human Hair Fibres
Malebogo Ngoepe, Department of Mechanical Engineering, University of Cape Town, South Africa

17:00 Grey Hair: Molecular and Structural Insights
Silvia Centeno Benigno & Oleksandra Kuzmich, DWI – Leibniz Institute, Germany

17:30 INTERACTIVE PLATFORM WITH DWI
In this session, you can meet the DWI Experts and gain insights into their works in a smaller setting.

18:00 END



Thursday, September 09, 2021

13:30 GET-TOGETHER

14:00 New Bio-Based Hydrolyzed Corn Starch Hair Styling Polymer for "Natural" Styling Benefits

Kinjal Joshi, DOW Silicones, Belgium

14:30 **Plenary Lecture**: Cell Membrane Lipids - Function and Impact on Hair Health

Jennifer Marsh, P&G, USA

15:30 INTERACTIVE COFFEE BREAK

A. Dive In Session „Meet the Plenary Speaker“
Meet Jennifer Marsh and other experts in a lively face-to-face online discussion about the Cell Membrane Lipids.

B. Brainstorming Session: „Sustainability in Hair Care“
While this topic is very high on the agenda of every hair care player, the questions on how many of these ambitions are hitting the shelves and, more importantly, the consumer in a meaningful way remain to be explored.
The purpose of this brainstorming session is to chat & connect, which has been a challenge on its own in the past 18 months, and ideally have a vivid discussion to gain a fresh perspective on this topic.

C. Connect Room
Interact with other HairS'21 participants in a more casual setting.

16:00 A New Class of Aqueous Cationic Dispersion Polyurethanes for Oxidation and Semi-Permanent Colors

Narjis Ali Askar, Lubrizol Advanced Materials, USA

16:30 A Novel Terminal Hydroxyamino Silicone that Delivers Multifunctional Benefits to Damaged Hair

Charlene Courtet, DOW Silicones, Belgium

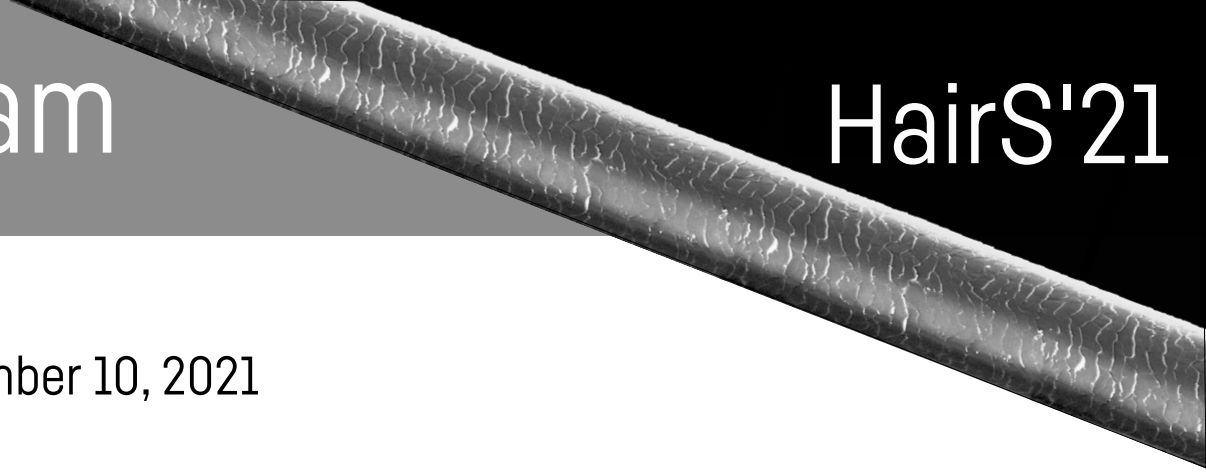
17:00 A Nanoscale Coating for Hair

Cesar Rodriguez-Emmenegger, DWI – Leibniz Institute, Germany

17:30 INTERACTIVE PLATFORM WITH DWI

In this session, you can meet the DWI Experts and gain insights into their works in a smaller setting.

18:00 END



Friday, September 10, 2021

13:30 GET TOGETHER

14:00 Genetics of Female Pattern Hair Loss

Regina C. Betz, Institute of Human Genetics, University of Bonn, Germany

14:30 **Plenary Lecture**: Genetics of Male Pattern Hair Loss

Stefanie Heilmann-Heimbach, Institute of Human Genetics, University of Bonn, Germany

15:30 INTERACTIVE COFFEE BREAK

A. Dive In Session „Meet the Plenary Speaker“
Meet Stefanie Heilmann-Heimbach and other experts in a lively face-to-face online discussion about Hair Loss.

B. Brainstorming Session “Diversity & Inclusion: Implications on Hair Care”
Arguably a topic with many different interpretations, perceptions, and expectations. This brainstorming session presents a great opportunity to hear different opinions and possible approaches from the highly diverse audience in attendance on how the hair care industry can best contribute to making D&I happen. Just as the sustainability session, the primary purpose of this session remains the same, which is to chat and connect with each other after such a long time.

C. Connect Room
Interact with other HairS’21 participants in a more casual setting.

16:00 Specialty Fiber Identification in SEM Images Using Machine Learning

Oliver Rippel, Institute of Imaging & Computer Vision, RWTH Aachen University, Germany

16:30 Investigating the Mechanical Properties of Different Polymers by DHCR and Torsion-Pendulum

Clarissa Brechtken, Henkel, Germany

17:00 The Surface Properties and Water Adsorption Behaviour of Hair Fibers

Meishan Guo, Surface Measurement Systems, UK

17:30 BEST PAPER AWARDS / CLOSING REMARKS

18:00 END

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Dr. Juliana Kurniadi, DWI – Leibniz Institute for Interactive Materials

Abstract Book:

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Current Understanding on the Physiology of Human Scalp Hair Graying (Canities)

Desmond J. Tobin, Charles Institute of Dermatology, University College Dublin, Ireland

Plenary Lecture

Hair graying (canities) is one of the earliest, most visible aging-associated phenomena, whose modulation by genetic, psychoemotional, oxidative, senescence-associated, metabolic and nutritional factors has long attracted skin biologists, dermatologists, and industry.

During this talk I will emphasize that human hair graying invariably begins with the gradual decline in melanogenesis, including reduced tyrosinase activity, defective melanosome transfer and apoptosis of HFPU melanocytes, and is thus a primary event of the anagen hair bulb, not in the melanocyte-stem cell niche called the bulge. Eventually, the bulge MSC pool becomes depleted as well, at which stage graying becomes largely irreversible. There is still no universally accepted model of human hair greying, and the extent of genetic contributions to graying remains unclear. However, oxidative damage likely is a crucial driver of graying via its disruption of HFPU melanocyte survival, MSC maintenance, and of the enzymatic apparatus of melanogenesis itself. The contribution of neuroendocrine factors, micropthalmia-associated transcription factor and others requires more detailed study. Another important open question is how hair follicle melanocytes age intrinsically, how psychoemotional stress impacts this process, and how current insights into the gerontobiology of the human hair follicle can best be translated into retardation or reversal of graying.

Keywords: Melanocyte; Hair Follicle; Oxidative stress; Reactive oxygen species; Melanoblast; Hair; Melanin; Pigmentation

References:

Sikkink SK, Mine S, Freis O, Danoux L, Tobin DJ. Stress-sensing in the human greying hair follicle: Ataxia Telangiectasia Mutated (ATM) depletion in hair bulb melanocytes in canities-prone scalp. Sci Rep. 2020 30;10(1):18711.

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Hair Aging: Variation by Race and Ethnicity

Neelam A. Vashi, MD, Boston University School of Medicine and Boston Medical Center, USA

Aging is an unavoidable biological process with many influencing factors that results in visible manifestations on all cutaneous appendages, including the hair. The hair follicle is a particularly unique structure that undergoes many changes over time. While skin aging and hair loss are extensively discussed in the dermatology literature, hair aging has not received similar attention. Similar to skin, hair aging comprises both intrinsic aging, which includes the natural physiological changes that occur with time, and extrinsic aging, or changes associated with environmental exposures and physical stress caused by daily grooming.

The most well-recognized sign of intrinsic aging is graying of the hair. However, hair aging changes go far beyond color alterations, with many other hair properties. such as diameter, density, shape, growth patterns, and mechanical and tactile aspects affected. The unique characteristics of hair aging in different ethnicities provides information that will aid in a culturally sensitive approach and recommendations.

Keywords: Hair aging, graying, race, ethnicity, hair damage

References:

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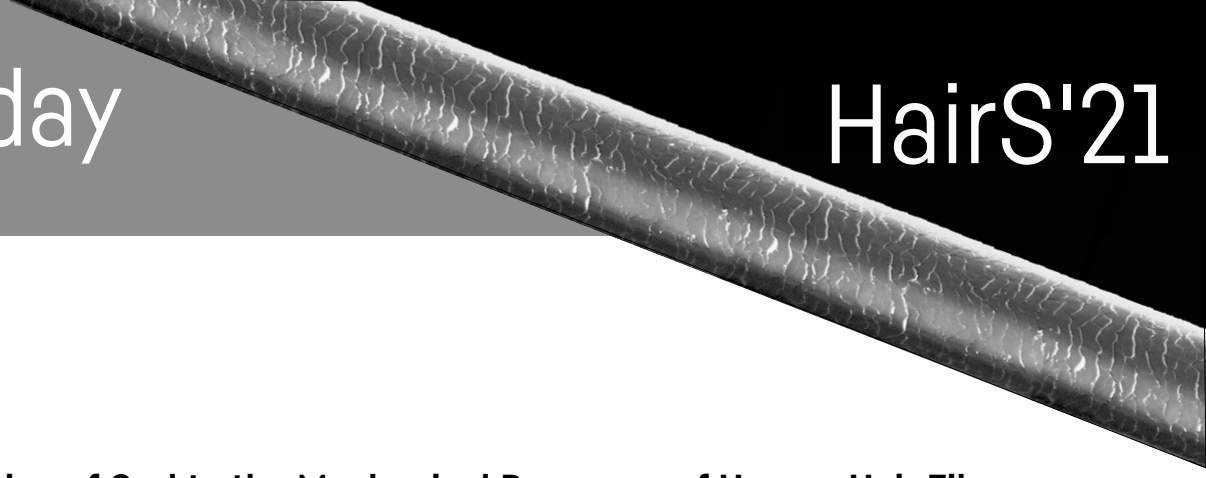

The Contribution of Curl to the Mechanical Response of Human Hair Fibres

Malebogo Ngoepe[1], Elsabe Cloete[2]

[1] Department of Mechanical Engineering, University of Cape Town, Cape Town (South Africa)
[2] Hair and Skin Research Lab, University of Cape Town, Cape Town (South Africa)

The mechanical response of human hair fibres is an area interest for a broad range of fields. While there are many studies focusing on the role of crimp in keratin fibres, few have examined the impact of curl in human hair fibres. Even though there is an abundance of literature on human fibres from individuals of varying origins, traditional race-based classification schemes have confounded results.

Our work and findings arose from laboratory and bathroom observations. During preparation for tensile testing in the lab, we noticed that curly fibres could be straightened by applying a gentle mechanical force. This supported the observation by many individuals with curly hair, who noticed a straightening effect when applying mechanical forces either by plaiting or braiding. In both instances, the application of water could reverse the effect, resulting in a retrieval of curl. Stress-strain curves from static tensile tests revealed the presence of a toe-region that was present in curly hair fibres and absent in straight fibres.

The length of this region was related to the degree of curl of the fibre. These observations led to a hypothesis that the toe-region arose from a hydrogen bonding mechanism that is present in curly hair fibres and can be disrupted by mechanical force. Further investigations using cyclic testing showed that this toe region was present in the first cycle of testing but disappeared as the number of cycles increased.

Keywords: Curly hair fibres; Mechanical response; Hydrogen bonding; Tensile testing; Cyclic testing

References:

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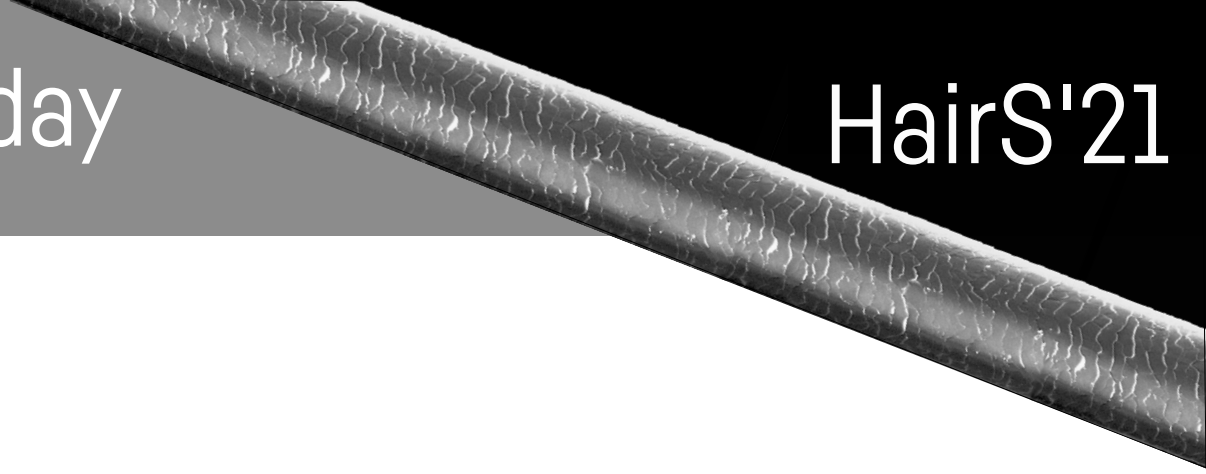


Grey Hair: Molecular and Structural Insights

Silvia Centeno Benigno, Oleksandra Kuzmich, DWI - Leibniz Institute for Interactive Materials, Aachen

The loss of pigment in hair fibres is a quite familiar phenotypic change associated with the aging. The grey hair is also known for being hard to handle in terms of colouring and hair styling. In DWI we investigate grey and aged hair also in order to establish a valid list of healthy hair criteria.

In this preliminary study, we have analysed commercially purchased samples of brown, grey and white hair. The focus of the study was on the molecular composition, structure and damage effects due to chemical treatment. In order to study the difference on the molecular level we have performed: amino acid analysis; protein analysis; lipid extraction followed by GC-MS analysis. To study the structure and its sensitivity to chemical treatment, we have resorted to Fluorescence Lifetime Imaging Microscopy (FLIM) of the autofluorescence signal of hair cross sections.

Interesting results were obtained from the analysis of lipid extracts. The amount of lipids extracted from pigmented hair was sufficiently higher. Based on GC-MS analysis a significant difference in amounts of squalene, fatty acids, fatty alcohols and sterols was observed.

In the FLIM study, we have found a correlation between the lifetime histogram maximum and the inner structure of the hair shaft, being normally shifted to shorter values for the unpigmented hairs. In addition, we found a higher sensitivity for oxidation for the pigmented hairs with respect to the unpigmented samples.

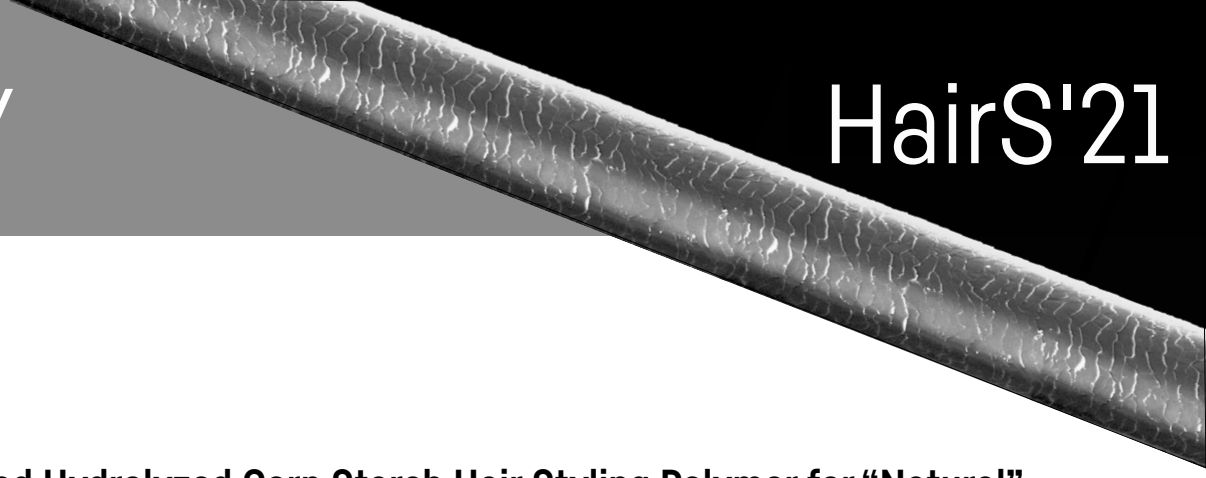
Keywords: Grey hair, GC-MS, FLIM, Lipids, Oxidation

References:

Chromatographic determination of amino acids by the use of automatic recording equipment, S. Moore, Methods in Enzymology, Vol. 6: 819-831, 1963

Characterization of the Proteins of Human Hair and Nail by Electrophoresis, Robert C. Marshall, The journal of Investigative dermatology, 80:519-524, 1983

Electrophoresis, Robert C. Marshall, The journal of Investigative dermatology, 80:519-524, 1983



New Bio-Based Hydrolyzed Corn Starch Hair Styling Polymer for "Natural" Styling Benefits

Charlène Courtet[2], Bethany Prime[1], Kinjal Joshi[3], Beth Johnson[1], Hannah Lehman[3], Kristen Agbato[1]

[1] DOW, Midland, MI, USA [2] DOW Silicones Belgium SRL, Seneffe, Belgium [3] DOW, Collegeville, PA, USA

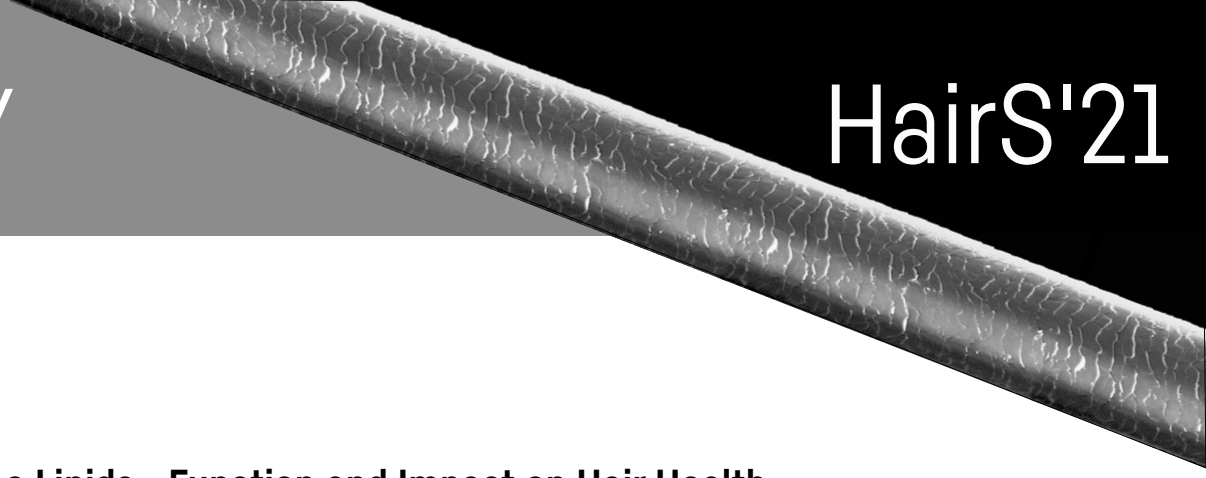
The use and interest in 'natural' products have been on the rise in the beauty care industry. Consumers desire natural products, with a similar or better performance than their synthetic alternatives. Recently, Dow has developed a bio-based, non-GMO, hair styling fixative which can range from superior stiffness to soft-touch styling. Derived from corn, the polymer is a 100% natural origin hydrolyzed corn starch. In formulation, this polymer acts as a transparent film-former and styling aid with the added benefit of being non-hygroscopic.

Designed for use in both all-natural and high-performance traditional hair styling products, application testing indicates styling performance comparable to or better than polyvinylpyrrolidone (PVP) and other corn starch fixatives. In leave-on styling applications, this new polymer delivers superior performance in humidity resistance, curl retention and frizz control compared to other ingredients, even at low concentration levels. When combined with silicone, it offers additional benefits such as increased volume, improved sensory, and enhanced healthy-looking hair after treatment. This polymer can be easily formulated into various product formats, including gels, waxes, creams and sprays which allows for creative textures and a customized consumer experience. This new bio-based ingredient offers formulators an exceptional alternative for both natural and traditional hair styling without compromising performance.

Keywords: bio-based, corn-based, hair styling polymer, natural ingredient, humidity resistance, curl retention, film former, styling product

References:

Mintel Group Ltd. study as cited in drugstorenews.com, February 2, 2018: "Natural, organic hair care grows with consumer demand," https://www.drugstorenews.com/beauty/natural-organic-hair-care-grows-consumer-demand/



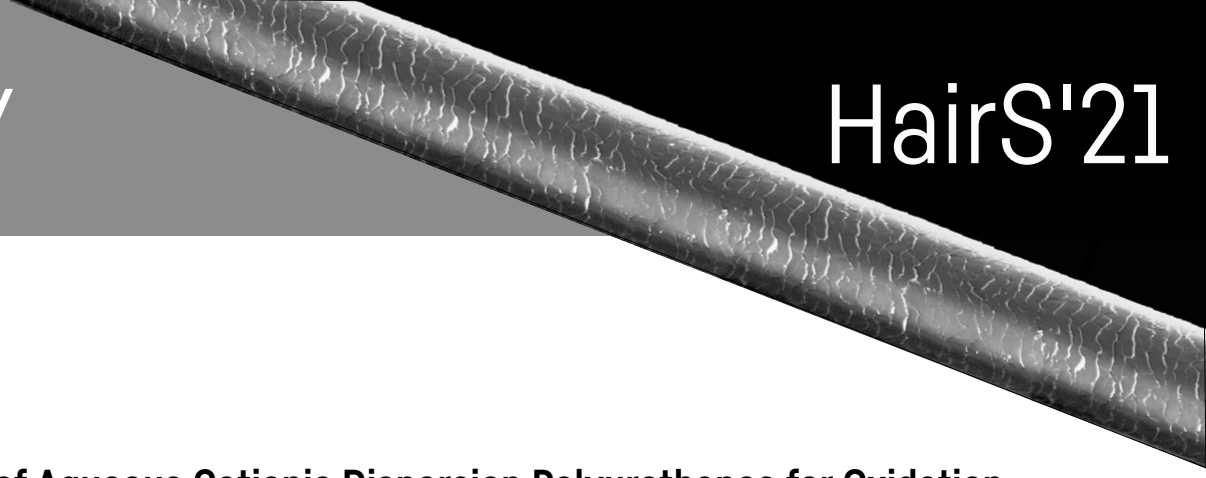
Cell Membrane Lipids - Function and Impact on Hair Health

Jennifer Marsh, The Procter & Gamble Company, Mason, Ohio

Plenary Lecture

The Cell Membrane Complex of hair plays an important role in the structural integrity of hair as well as being an important pathway for penetration of materials into hair. In this talk we will review what's known about its structure and some of our recent work on the role of its constituent lipids on the reactive chemistry of hair. Specifically, how lipid structure changes as a function of UV and color insults and the consequent impact on hair single fiber properties. A range of methods used to visualize lipids will be shared including confocal fluorescence microscopy, Nano-SIMS, and TEM-EDS.

Keywords: Hair Lipids Cell Membrane Complex



A New Class of Aqueous Cationic Dispersion Polyurethanes for Oxidation and Semi-Permanent Colors

Narjis Ali Askar, Alex Lubnin, Qundeel Zaidi, Jean Xavier Harry, Carole Lepilleur [US][1]

[1] Lubrizol Advanced Materials, Cleveland, Ohio, USA

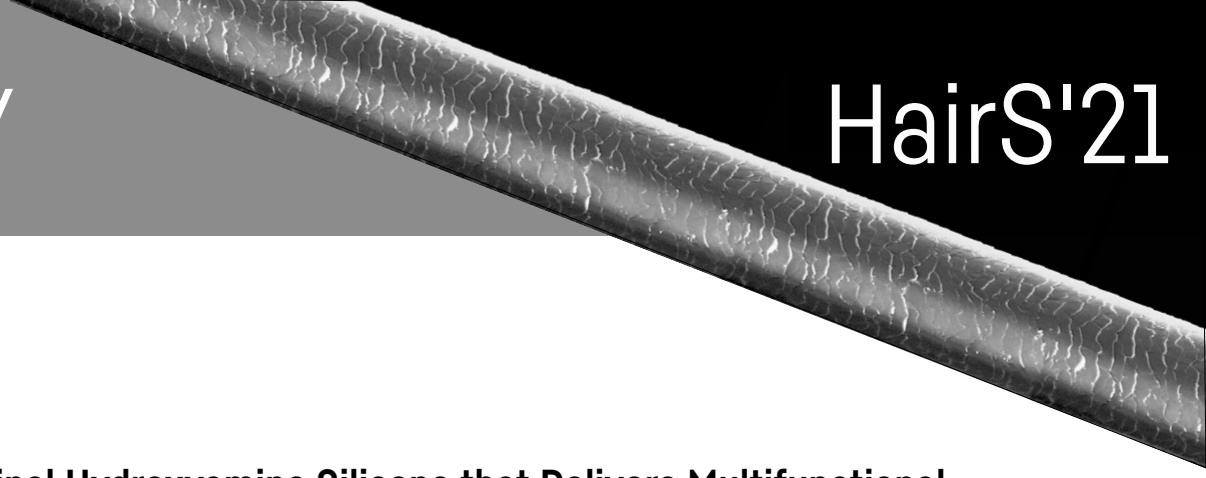
Improving color protection and elasticity of hair fibers during coloring process are the ongoing challenges for hair-dye formulators. Anionic and non-ionic polyurethanes are good film formers and are often used to this end, but these polymers are hydrophilic which makes them sensitive to water, and they do not provide long-lasting durable effects. To meet the challenge, novel cationic polyurethanes were designed with two distinct features:

1. Amino groups are tethered away from the backbone of the polymer which provides for a higher degree of amine group mobility for better dye hydration and solubilization.

2. The polymer has a unique transpose structure. In its native aqueous dispersion state, the amine is in a form a salt with a volatile acid, and in the dry state on hair, it reverts to its unneutralized free amine form. This unique ability of the polymer to change between the salt and the free amine forms renders it capable of becoming hydrophobic after drying helping with resistance to washings and color retention.

In this presentation, we will review the effects of these novel polymers on color intensity and saturation measured by delta L and a. Fluorescence tagging will demonstrate polymer penetration in hair matrix. Effect on hair protection would be demonstrated by wet and dry DSC measurements and propose a mechanism underlying the enhanced interaction of the mobile pendant amine groups with the dye molecules.

Keywords: Tethered amines - Pendant amino group on polyurethane backbone, Terminal amines - Amino group on polyurethane backbone, Transpose structure - Interchangeable structure between salt and unneutralized form



A Novel Terminal Hydroxyamino Silicone that Delivers Multifunctional Benefits to Damaged Hair

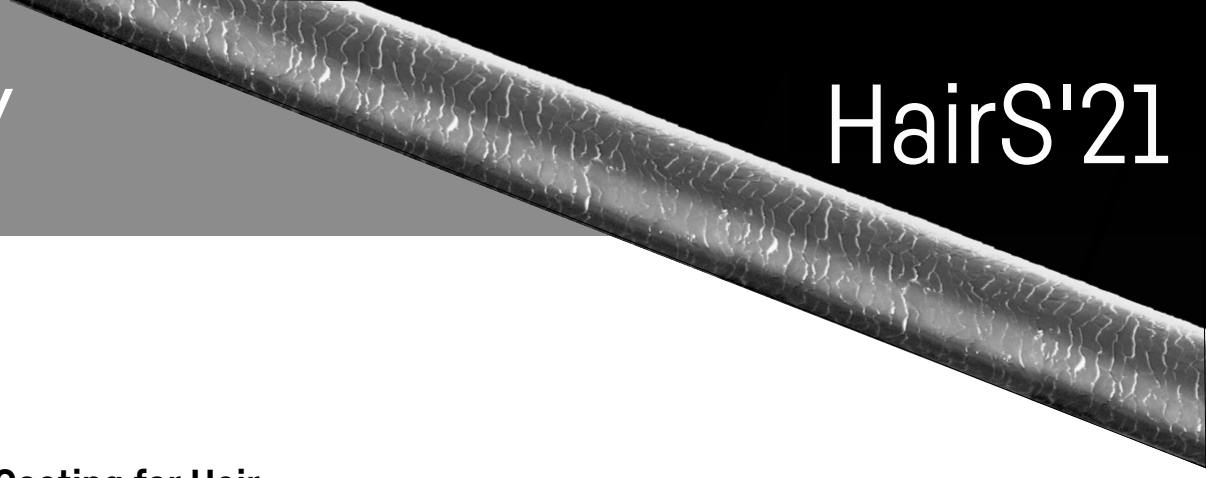
Charlène Courtet[2], Eve Suthiwangcharoen[1], Beth Johnson[1], Dawn Carsten[1], Hannah Wedge[1], Roque Gochez[1], Bethany Prime[1], Kristen Agbato [1]

[1] Dow, Midland, MI, USA [2] Dow Silicones Belgium SRL, Seneffe, Belgium

Dow recently developed bis-Diisopropanolamino-PG-Propyl Disiloxane/Bis-Vinyl Dimethicone Copolymer, an innovative terminal hydroxy amino-modified silicone (THA) that provides an exceptional sensorial experience in multiple hair care applications. THA consists of siloxane chain which imparts softness, amines at the terminal chain which improve the silicone deposition onto the hair, and hydroxy groups which provide a unique sensory enhancement and superior performance compared to other aminosiloxanes even at low use levels.

THA provides a shield to protect hair from heat, damage during the coloration process, breakage and everyday damage while delivering a healthy look and feel that is improved with each step of your hair care routine. This low cyclic amino functional siloxane polymer can be added to any shampoo or conditioner line to offer consumer an improved experience. It allows to maintain formulation viscosity without yellowing issues which can be problematic with standard aminosilicones. All of these benefits ultimately make this new polymer an excellent solution for conditioning in the hair market. It is an appealing product to those seeking an easier and faster haircare routine.

Keywords: terminal hydroxyamino silicone; hair conditioning; healthy hair; multifunctional benefits; silicone; hydroxySHIELD

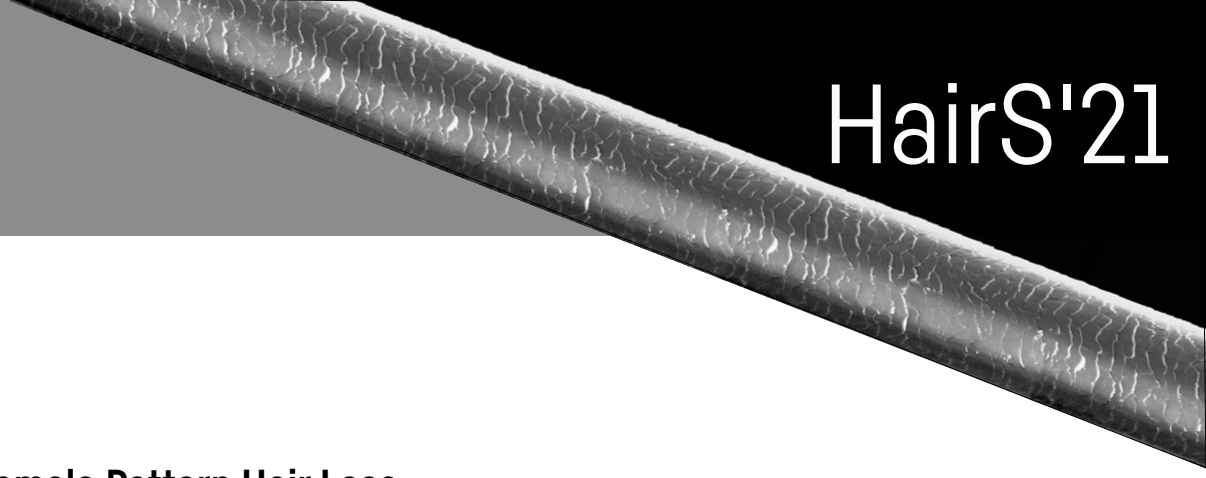


A Nanoscale Coating for Hair

Lena Witzdam, Manuela Garay Sarmiento, Juliana Kurniadi, César Rodriguez-Emmenegger
DWI- Leibniz Institute for Interactive Materials, Aachen

In hair, molecules assemble into hierarchical levels at different length scales which endow this material with excellent properties. Many of these properties are controlled by the surface of the hair, including wettability, suppleness, friction, gloss and even up to a certain extend the diffusion of dyes. Unfortunately, it is the surface of the hair that suffers the largest damages during everyday exposure to external elements and treatments. But how can we protect and repair the surface beyond the current treatments? Our task is to generate a molecularly-thick film that mask the reactive groups, shield the charges, minimize attraction to soiling elements and is liquid-like, meaning minimal friction for combing while causing no change to its bulk properties. In this talk, we will introduce our advances towards a new type of nanoscale coating that is inspired on the self-cleaning and lubricious surface of the respiratory tract airways. The coating consists of an ultra-thin hydrogel covalently bound to the hair that can swell only orthogonally and that display tightly packed polymer chains, brushes. The latter provide a physical barrier to the adsorption of macromolecules, reduce friction and enhance the dyeability.

Keywords: brushes, nanocoatings, ultra-thin hydrogels



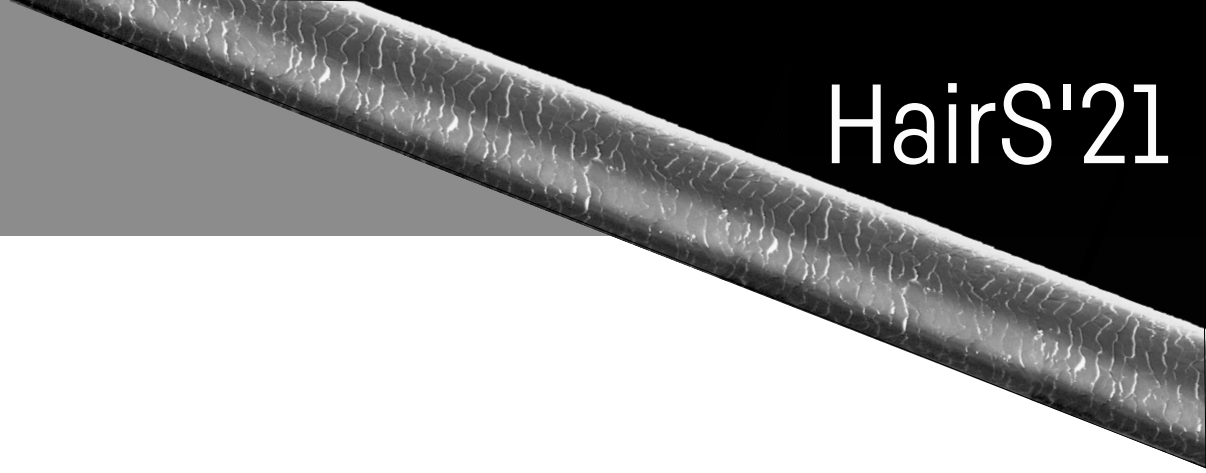
Genetics of Female Pattern Hair Loss

Regina C. Betz, Institute of Human Genetics, University Hospital Bonn, Germany

Female pattern hair loss (FPHL) is the most common hair loss disorder in women, with an increasing prevalence with age. This type of hair loss typically presents as a diffuse reduction in hair density that mainly affects the mid and frontal regions of the scalp with preservation of the frontal hairline. Deep recession of the fronto- temporal hairline and true vertex balding, as seen in men, occasionally occur in women, but are uncommon. Nevertheless, the regressive changes that occur in hair follicles in FPHL are similar if not identical to those that occur in male balding (M-AGA). It is well established that M-AGA is a genetically determined androgen-dependent trait, and it has long been assumed that FPHL shares the same aetiology. Recently published studies by others and us have been restricted to candidate gene approaches and could not clearly identify any susceptibility locus/gene for FPHL but suggest that the aetiology differs substantially from that of M-AGA. We present these data and - in addition - some preliminary results of a genome-wide association study for FPHL.

Currently available therapies for FPHL are unsatisfactory, and there is a demand for new treatment strategies. Therefore, molecular genetic studies could help to better understand the pathophysiology behind FPHL.

Keywords: Female pattern hair loss, genetics, genome-wide association study, multifactorial



Genetics of Male Pattern Hair Loss

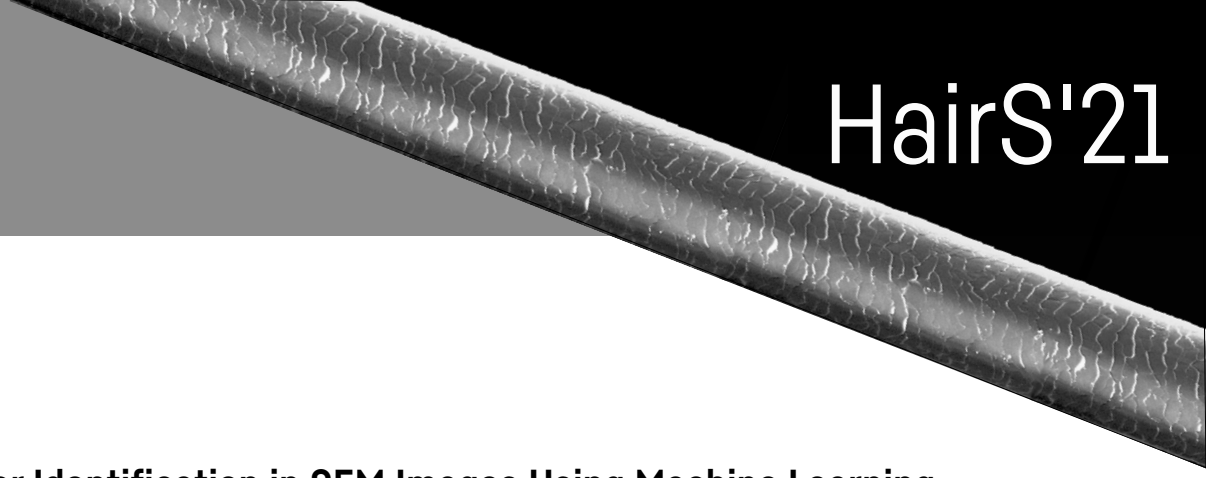
Stefanie Heilmann-Heimbach, Institute of Human Genetics, University of Bonn, School of Medicine & University Hospital Bonn, Germany

Plenary Lecture

Male-pattern hair loss (MPHL) is an age-dependent, highly heritable trait with a lifetime prevalence of ~80% in European men. The phenotype is characterized by a distinctive pattern of progressive hair loss from the scalp. The pathobiology of MPHL remains incompletely understood and current MPHL treatments can have severe adverse effects and are of limited efficacy in many patients. Therefore, studies that clarify the biological underpinnings of key-pathophysiological features of MPB and enable the identification of novel molecular targets for more effective therapeutic intervention are needed.

Molecular genetic studies that enable the systematic identification of early causal events have proven to be very successful in the elucidation of the (patho)biologocial basis of MPHL. Over the past decade, genome-wide association studies have identified more than 300 genomic loci that contribute to MPHL development that yielded unprecedented insights into contributing genes, pathways and disease mechanisms as well as the association of MPHL with other human traits and disorders. In my talk, I will give an overview on past achievements and current trends in MPHL genetic research and their potential for MPHL prediction and treatment.

Keywords: male-pattern baldness, genomics, genetic association, pleiotropy



Specialty Fiber Identification in SEM Images Using Machine Learning

Oliver Rippel[1], Khosrow Rahimi[2], Juliana Kurniadi[2], Andreas Herrmann[2], Dorit Merhof[1]

[1] Institute of Imaging & Computer Vision, RWTH Aachen University, Aachen, Germany
[2] DWI – Leibniz-Institut für Interaktive Materialien, Aachen, Germany

Animal fiber identification is a crucial aspect of fabric production, as specialty fibers such as cashmere are often targeted by adulteration attempts. Since animal fiber identification is difficult, it is currently performed by human experts using Scanning Electron Microscopy (SEM).

Many Machine Learning (ML) algorithms have been proposed to tackle the automated identification of animal and specialty fibers. While ever-increasing classification performance is reported, algorithms are evaluated under laboratory conditions only. The real-world applicability of the proposed methods has not yet been evaluated.

We perform such an evaluation for the first time in our work, and identify 3 underlying factors of fiber morphology that affect ML classification performance:

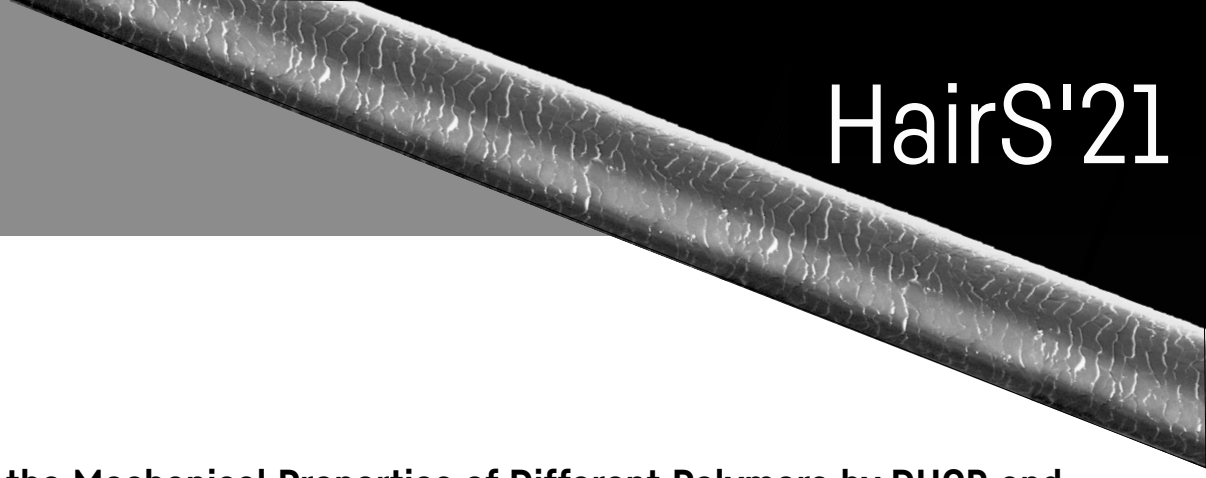
(I) Inter-special variances,

(II) Inter-racial variances of,

(III) Variance in quality of fibers, affected e.g. by chemical processing.

We demonstrate that the performance of proposed algorithms decreases when factor combinations absent from the training dataset occur during application. Thus, focus should be put on constructing large-scale datasets that encompass all variations expected under application conditions. Furthermore, identifying instances where the ML prediction can not be trusted by means of Out-of-Distribution (OOD) Detection should be an additional focus in future research.

Keywords: Specialty fiber identification, Machine Learning



Investigating the Mechanical Properties of Different Polymers by DHCR and Torsion-Pendulum

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The aim of this study is to extend the knowledge gained through the dynamic humidity curl retention (DHCR) to determine the influence of the polymers in the composite (polymer/hair) in order to differentiate the polymers and characterise their properties. The DHCR, as a further development of the High Humidity Curl Retention, is a method to determine the time-dependent ability of treated hair strands to retain a certain hairstyle under rapid humidity change [1].

The performance of the polymers in the DHCR indicated a drastic change of the mechanical properties of the polymer through the humidity variation. Therefore, the softening behaviour by moisture is investigated with regard to its effects on the mechanical properties using the torsion-pendulum method where the storage and loss moduli are determined [2].

For a more profound understanding of the pure polymer characteristics the interaction with an inert carrier is investigated. Based on the determined moduli, it is possible to define the humidity-dependent glass transition [3]. By considering both methods, we want to generate new insights into the moisture-dependent properties of the polymers in order to achieve a better explanation of their behaviour.

Keywords: curl retention, glass transition, humidity dependence, mechanical properties

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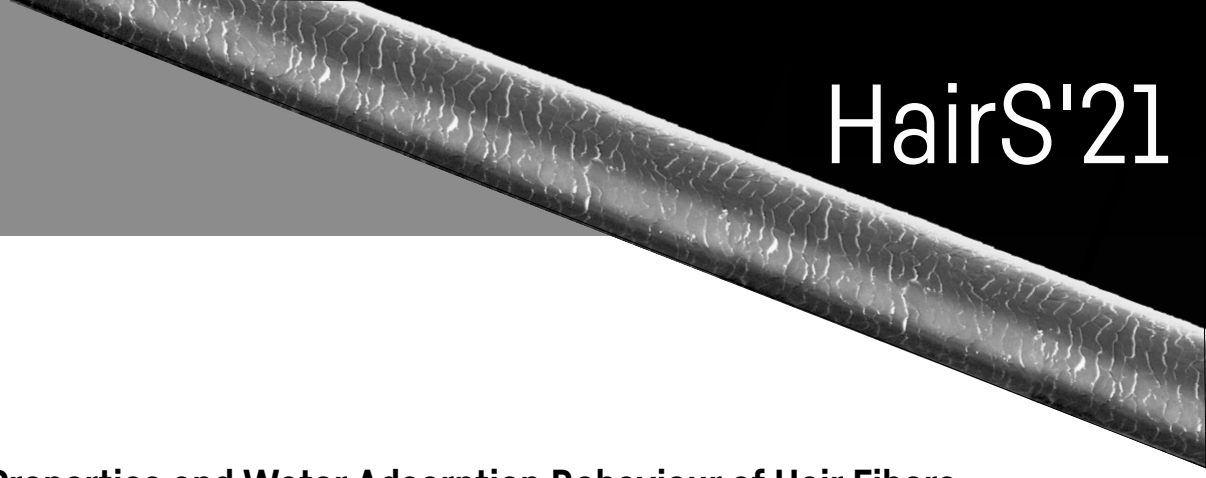

The Surface Properties and Water Adsorption Behaviour of Hair Fibers

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The Dynamic Vapour Sorption (DVS) system provides a well-established method for the determination of water sorption and desorption properties. It has been used successfully in the past to determine the moisture content and moisture sorption kinetics for a wide range of materials, including hair and skin.

DVS could also be applied to study the adsorption kinetics and water diffusion at different temperatures. This study reports on differences on untreated and chemically treated human hair fibres through organic vapour and moisture sorption isotherms. The diffusion coefficient values for powdered hair and hair fibres showed faster diffusion for organic vapour which would represent fragrance molecules. Gravimetric water sorption experiments confirmed that chemically induced damage affected levels of water and organic vapour sorption by hair. The presence of hysteresis in all samples may be related to the swelling upon sorption.

Keywords: Relative Humidity, DVS, Moisture, Vapor, Sorption

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