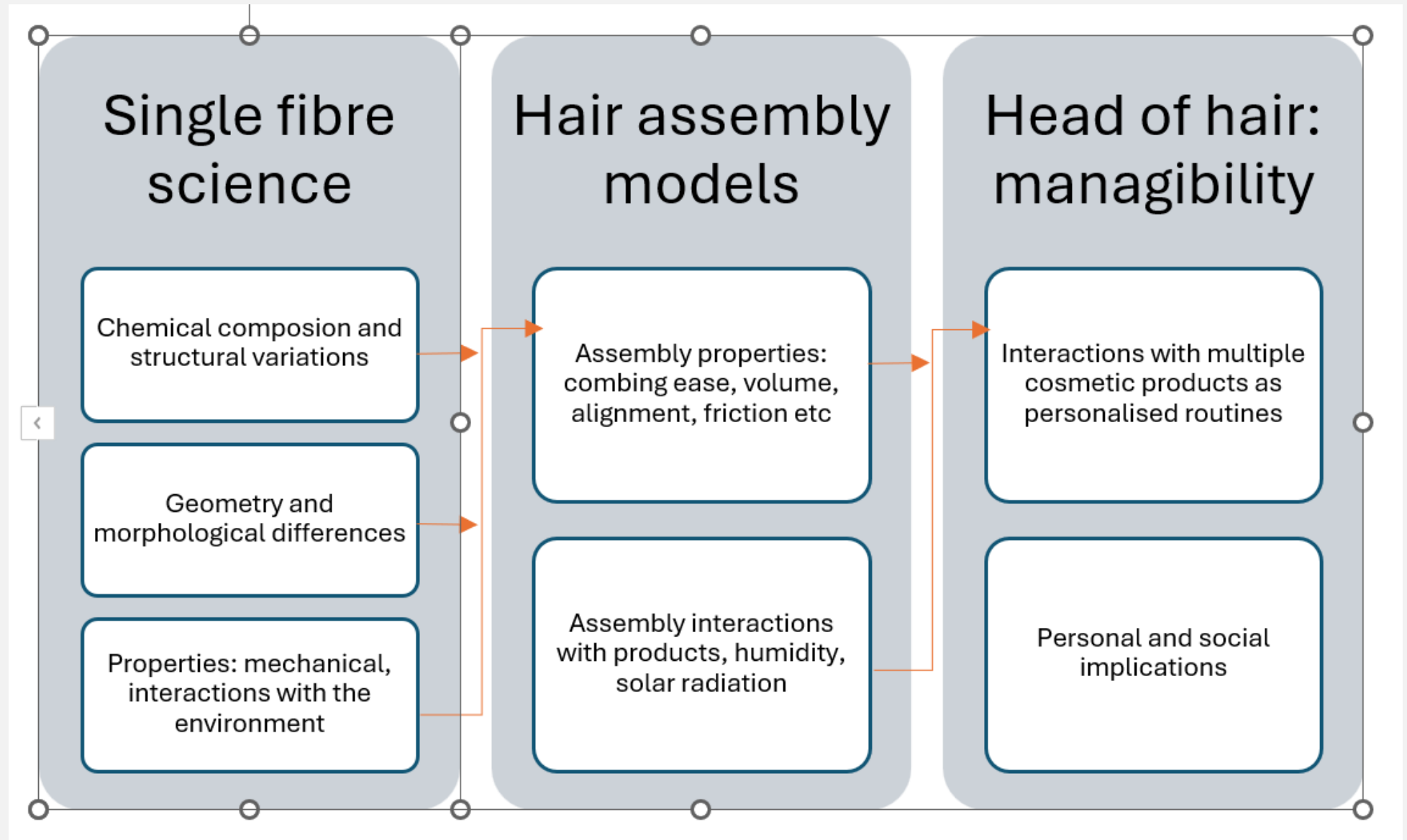


Human hair in focus: A multidisciplinary exploration of its chemical composition, morphology, properties and cultural contexts

Gabriela Daniels: Director of Science Programmes, UAL



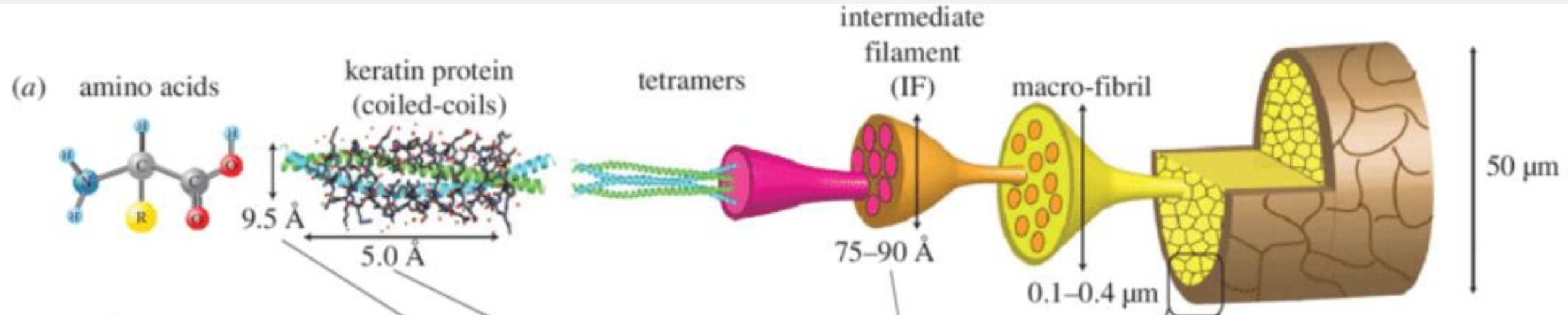




Single fibre science: chemistry and morphology

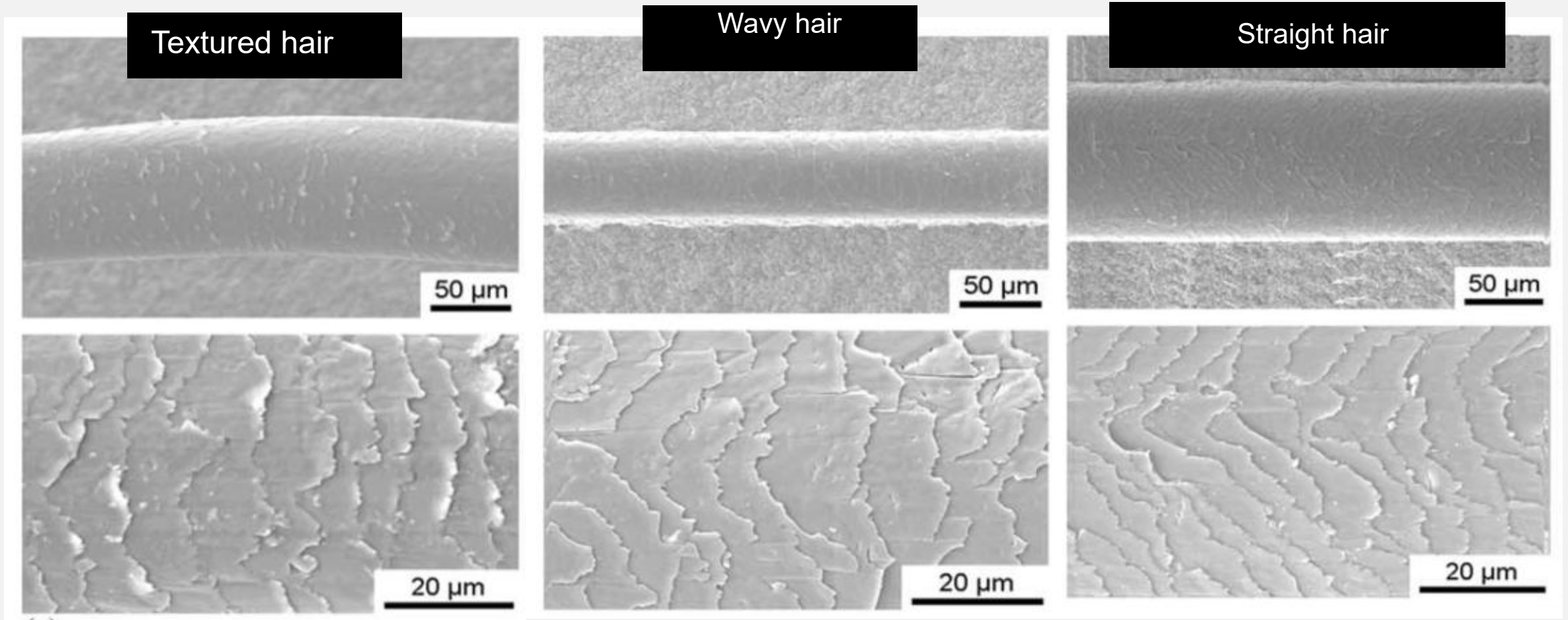


Hair fibre structure



Soomro, A., Alsop, R.J., Negishi, A., Kreplak, L., Fudge, D., Kuczmarski, E.R., Goldman, R.D. and Rheinstädter, M.C., 2017. Giant axonal neuropathy alters the structure of keratin intermediate filaments in human hair. *Journal of The Royal Society Interface*, 14(129), p.20170123.

Hair diameter and cuticle variations



Cuticle thickness and melanosome distribution

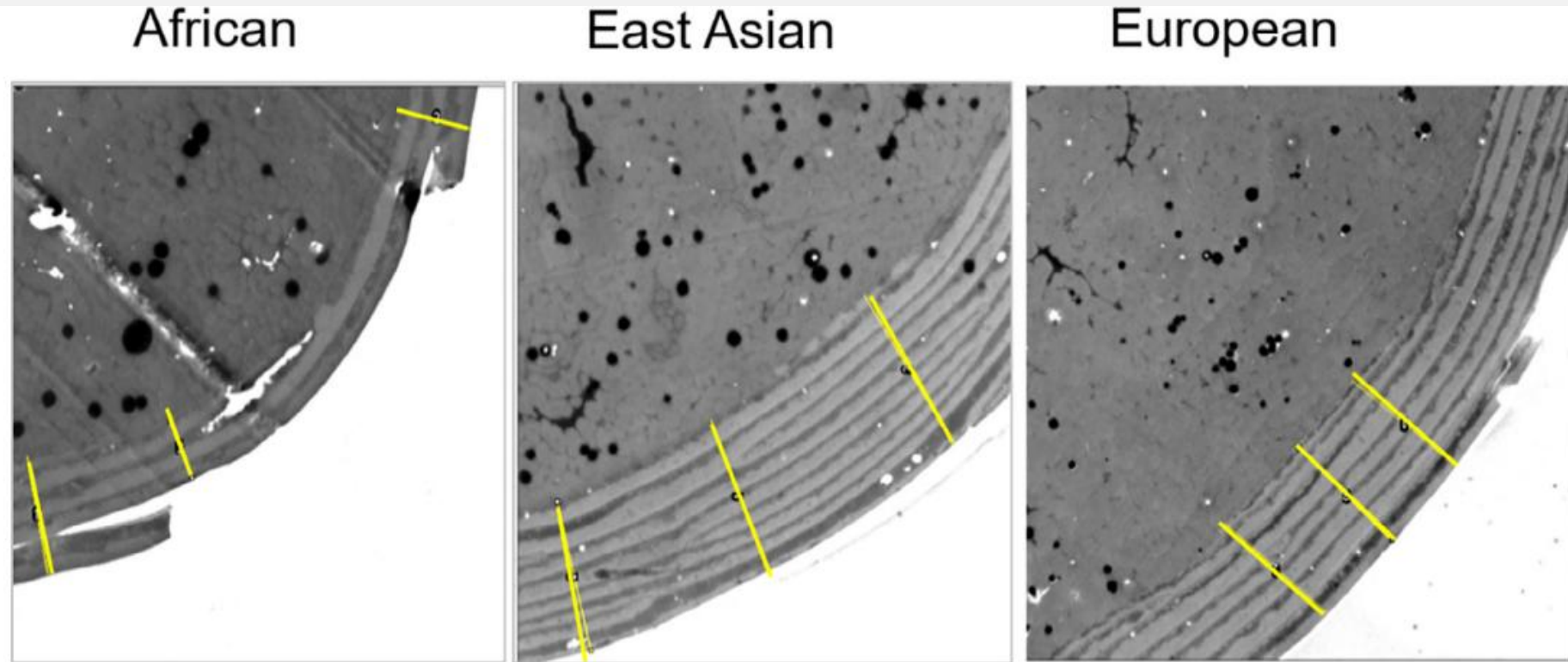


Fig. 2. Cuticle thickness measurements captured at three locations (yellow lines) on each image. Four areas from each cross-section measured for median cuticle thickness for $n = 60$ individuals.

Koch, S.L., Shriver, M.D. and Jablonski, N.G., 2019. Variation in human hair ultrastructure among three biogeographic populations. *Journal of structural biology*, 205(1), pp.60-66.

Chemical composition variations of hair

Amino acid composition of hair: so far considered insignificantly varied between hair with different curl level or colour

Lipid content: appeared more varied according to age, gender and ancestry

Surface lipids: bound and free are lost with time and due to chemical treatments

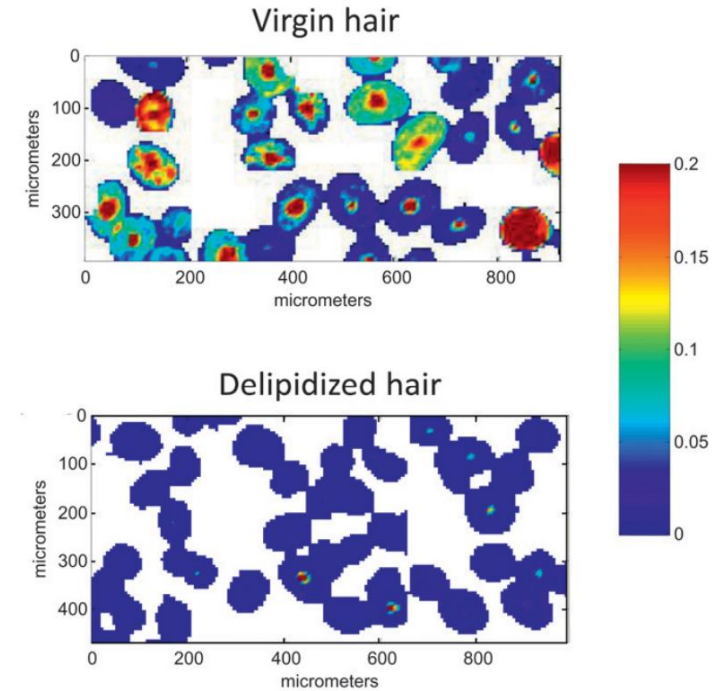


Figure 3. FTIR spectroscopic imaging of hair cross sections obtained by monitoring the lipid peak (2850 cm^{-1}).

McMullen et al., 2013. Determination of physicochemical properties of delipidized hair. *J. Cosmet. Sci*, 64, pp.355-370.



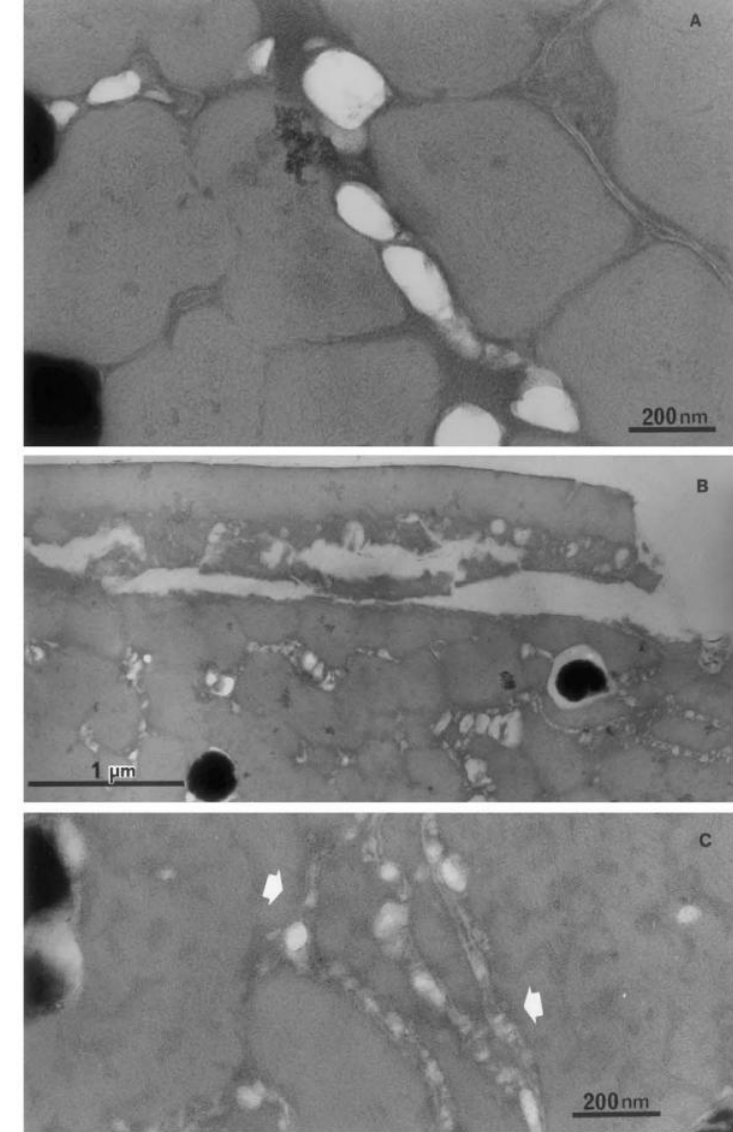
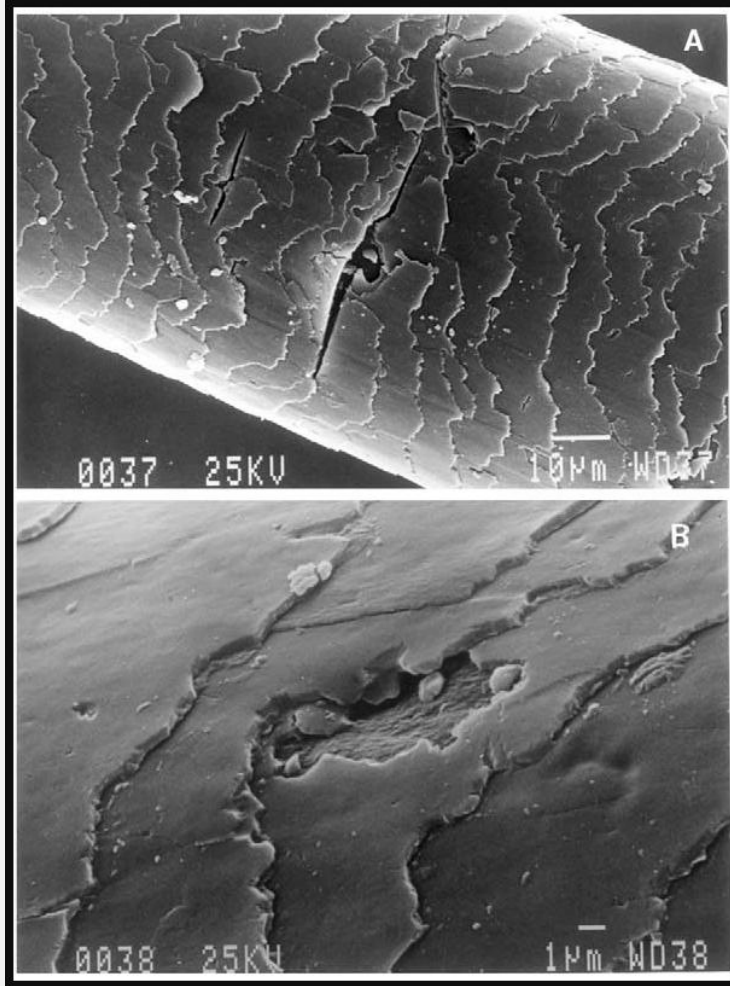
Hair assembly testing: properties and interactions with cosmetics



Impact of daily hair care routines

Hair, water and surfactants

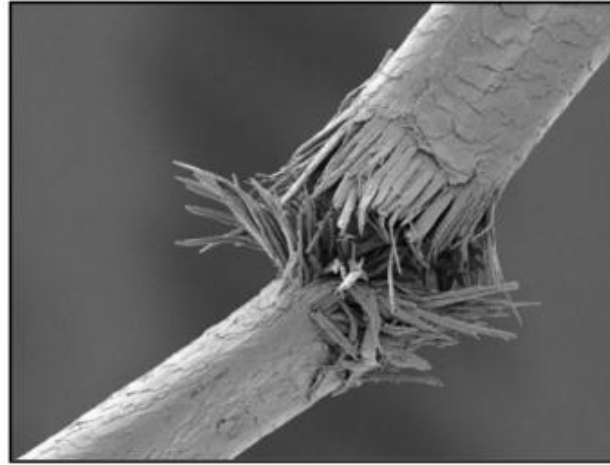
Scanavez, C., Silveira, M. and Joekes, I., 2003. Human hair: color changes caused by daily care damages on ultra-structure. *Colloids and Surfaces B: Biointerfaces*, 28(1), pp.39-52.



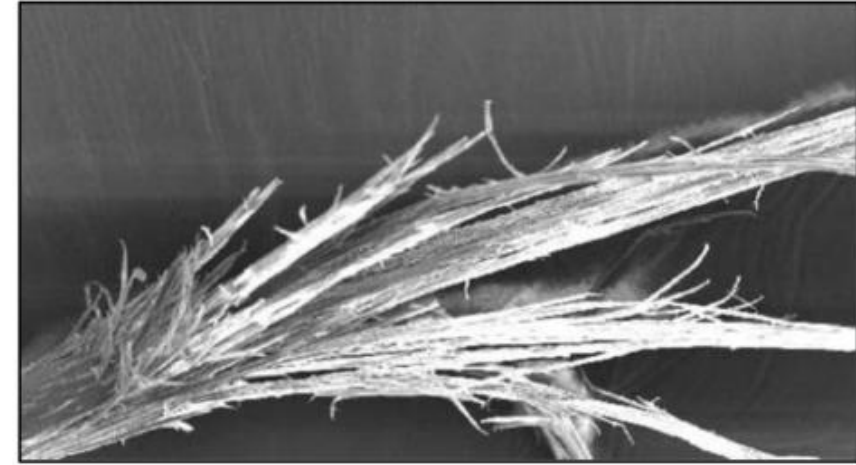
Impact of daily haircare routines

Split ends and hair breakage resulting from:

- **poor haircare routine**
- **excessive chemical treatment leading to cuticle destruction**



Trichorrhexis Nodosa



Trichoptilosis (Split ends)

Kumara, G.U.A., Wadimuna, W.M.D.R.W. and Lakshmi, A.V., Cosmetic Benefits of Shirodhara Treatment: A Comprehensive Review of Its Impact on Scalp, Hair and Skin Health.

Hair knotting

- Curlier fibres – knot formation
- Knots cause torsional and bending stress resulting in structural damage
- Catastrophic failure of fibres: fragility

Khumalo, N.P., Doe, P.T., Dawber, R.R. and Ferguson, D.J.P., 2000. What is normal black African hair? A light and scanning electron-microscopic study. *Journal of the American Academy of Dermatology*, 43(5), pp.814-820.

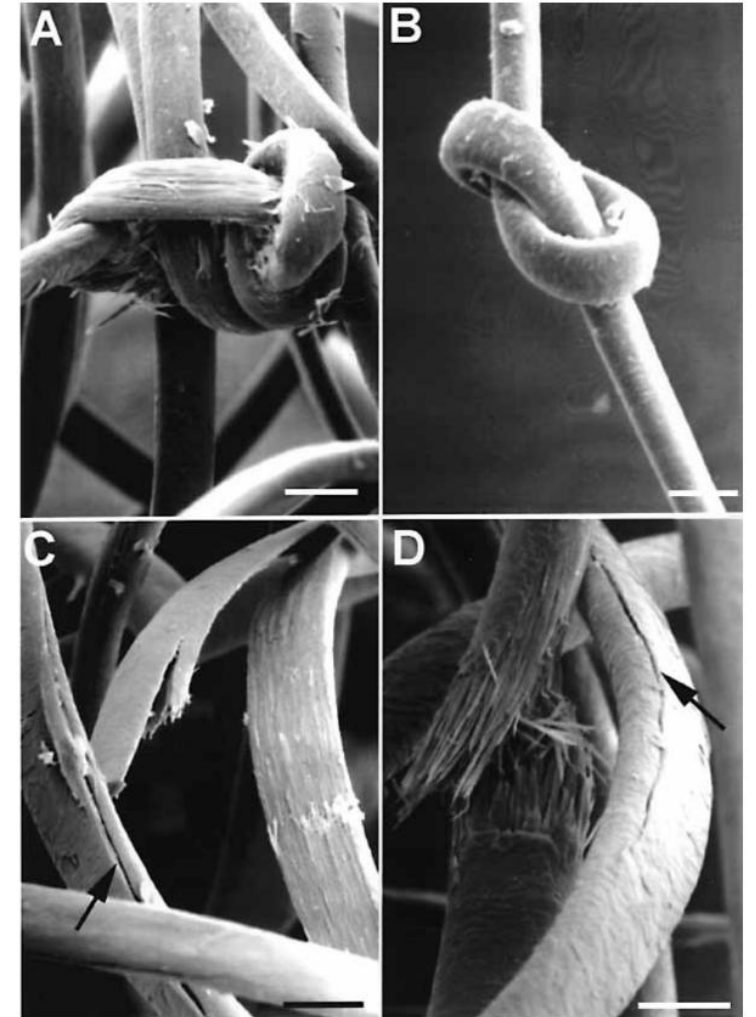


Fig 1. **A**, Detail of knot in the African hair. Note complex nature of the knot with damage to the cuticle exposing the cortical fibers. **B**, Detail of the only knot observed in the Caucasian hair, which appears to be looser with no damage to the cuticular layer. **C** and **D**, Details from African hair mat shows the longitudinal fissures of the shafts (*arrows*) plus examples of splitting (**C**) and breaking (**D**) of the hair shaft. (**A-D**, Scale bar = 0.1 mm.)

Hair manageability of textured hair

- Wetting hair prior to styling product application
- Hair sectioning correlated with wetting
- Number of products used correlated with high aesthetic goals

One hundred and twenty-three (n=123) participants who had self-identified as having a natural curl type 4 hair, according to a popular (non-scientific) hair typing system, were surveyed (Qualtrics, USA). The recruitment of participants from the UK and USA took place via Prolific Academic (Prolific Academic Ltd, UK).



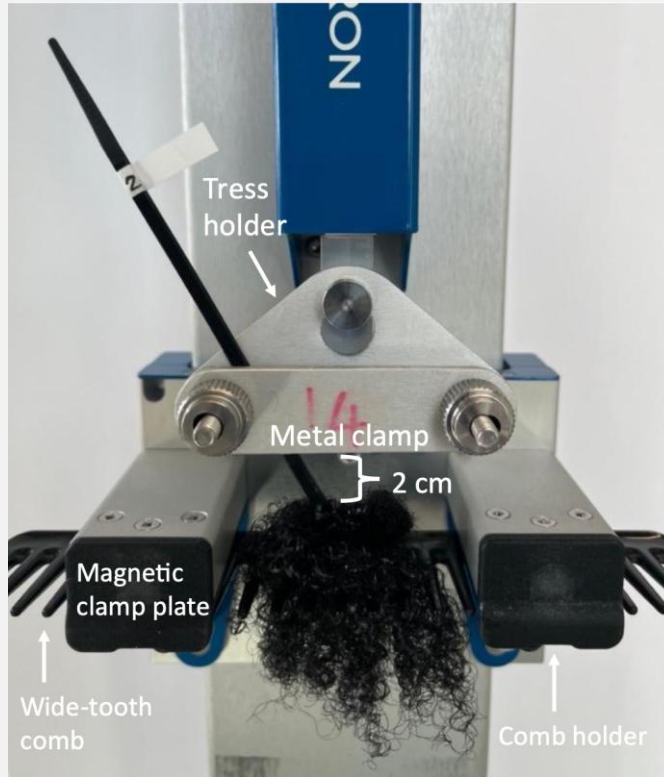
Products and testing of textured hair

Phase	INCI	Trade Name, Supplier	Contr. (w/w%)	Act. (w/w%)
A	Cetearyl Alcohol	Surfac CS (Surfachem, UK)	5	5
	Ceteareth-20	Eumulgin® B2 (BASF, UK)	2	2
	Triolein	AlgaPür™ (Lubrizol, USA)	0	5
B	Aqua	Deionised water	89.5	84.5
	Glycerin	Glycerin (Phoenix, UK)	3	3
C	Preservative	Azelis, UK	0.5	0.5



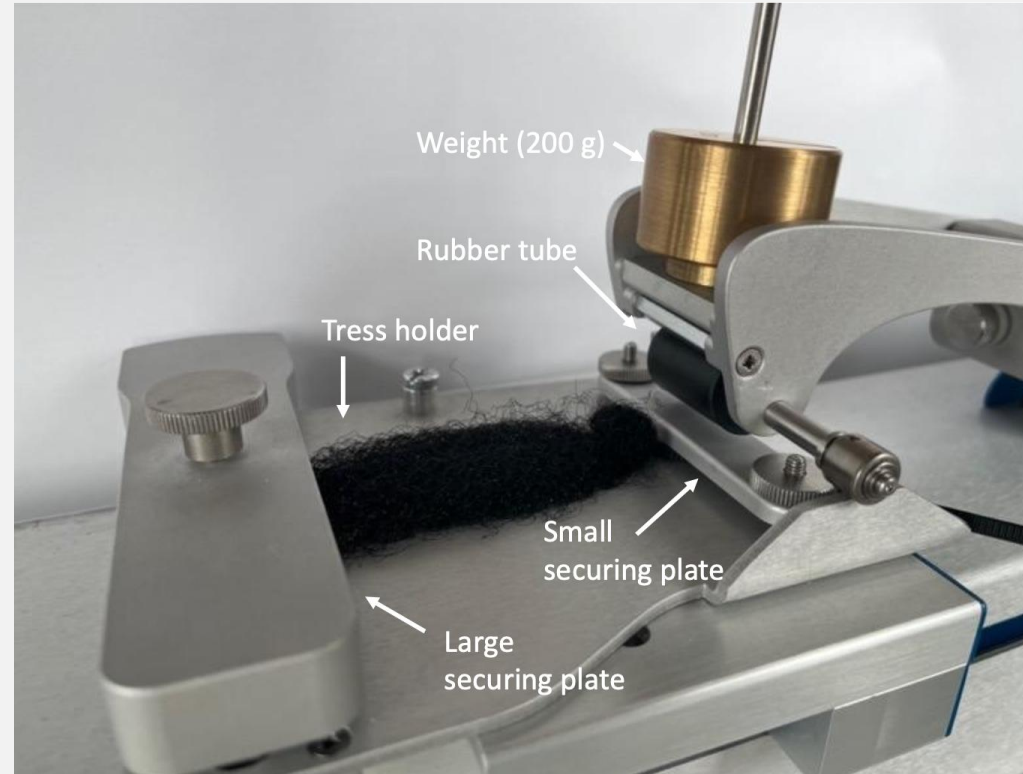
Figure 1. Hair tresses for testing

Hair tress testing



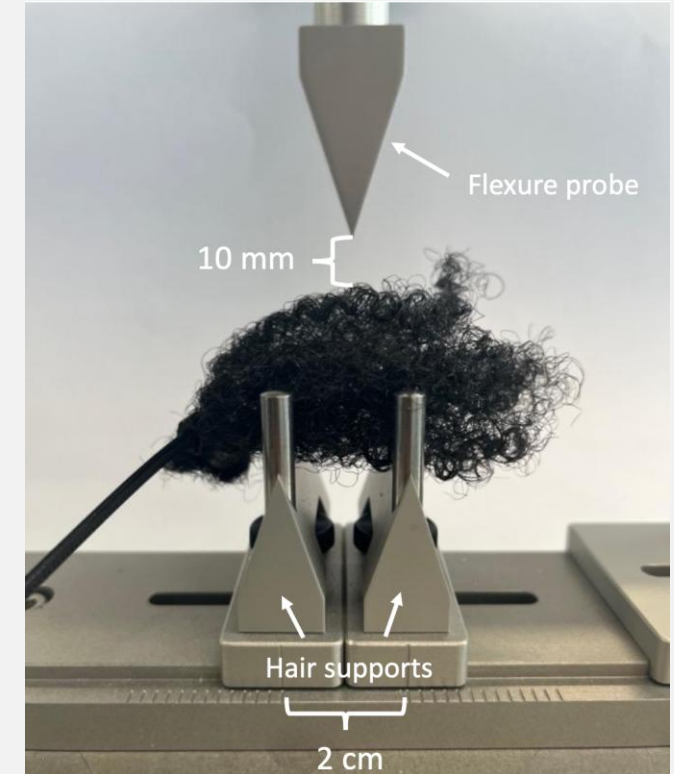
Wet combing tests

Fibre.one (Diastron, UK)



Dry friction tests

Fibre.one (Diastron, UK)

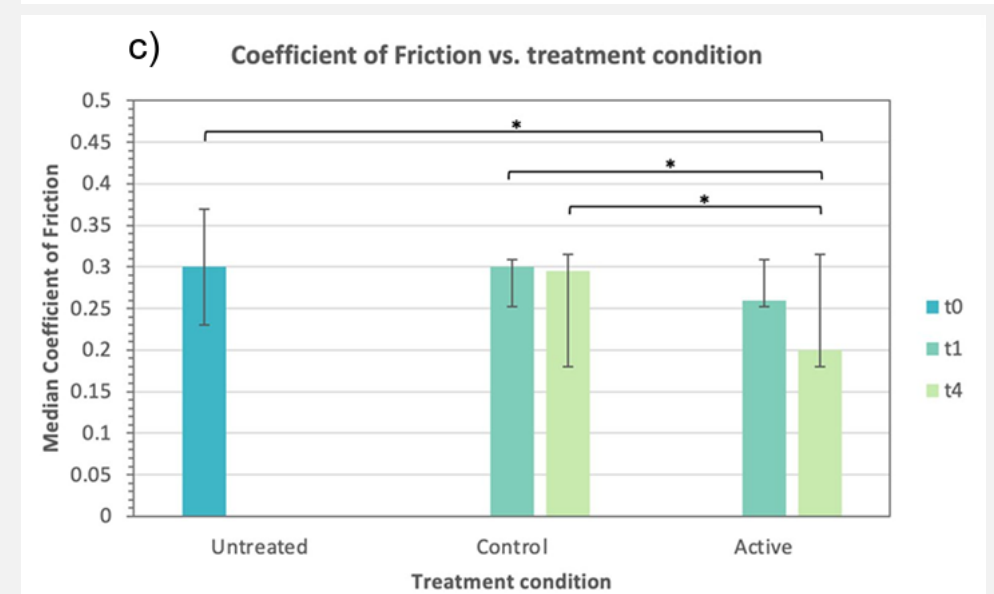
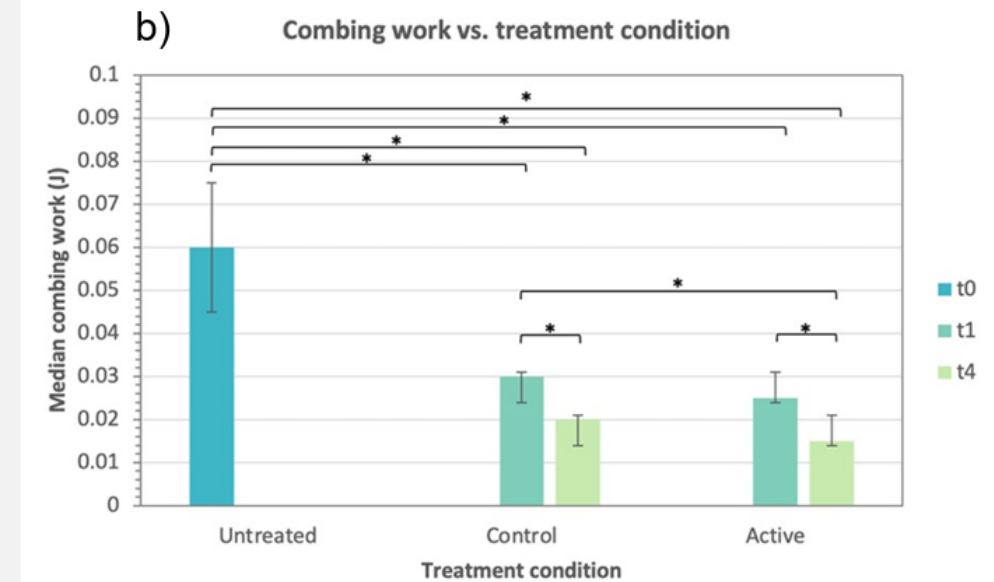
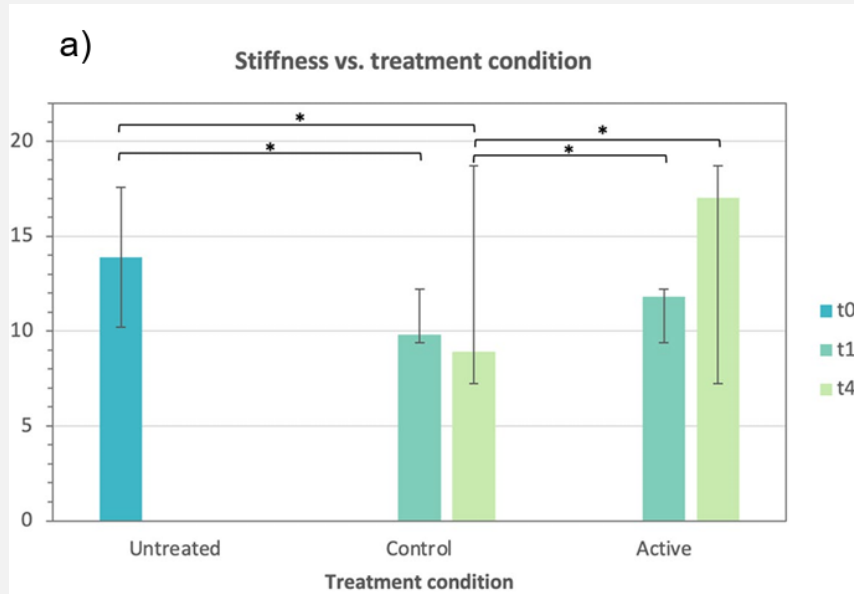


Tri-point bending test

TA.XT Plus Texture Analyser
(Stable Microsystems, UK)

Cumulative product application effect

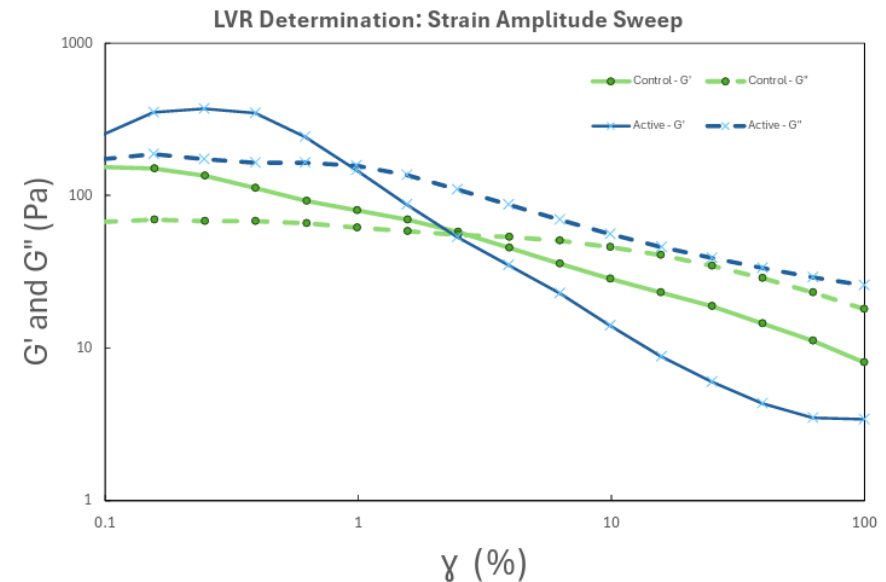
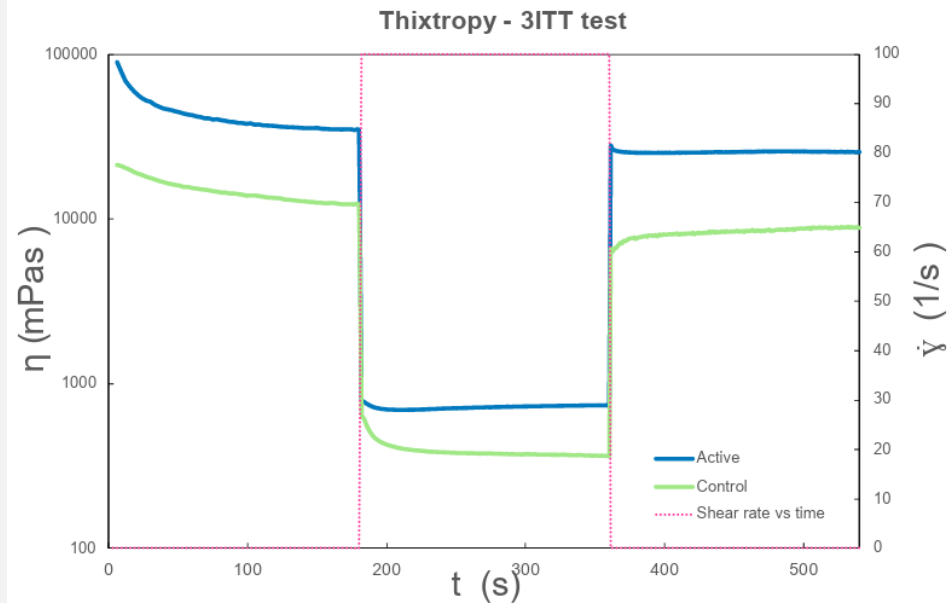
- ❑ Reduced combing,
- ❑ Reduced tress surface friction
- ❑ Increased stiffness



Daniels, Gabriela and Mahir, Temi-Lola and Jiao, Yimeng and Baltazar, Diogo and Heitmayer, Maxi (2025) *Explorations of consumer relevant testing of textured hair*. In: International Federations of Societies of Cosmetic Chemists, 15-18 September 2025, Cannes, France. Available: <https://ualresearchonline.arts.ac.uk/id/eprint/24761/>

Product rheology

Table 2. Key results from rheological tests and texture analysis.	Steady State Shear rate sweep	Oscillatory strain sweep		3ITT result	Spreadability test	
	Zero-shear viscosity (η_0) (Pa·s)	Critical strain (%)	G' & G'' Crossover strain (%)	Recovery %	Firmness (g)	Stickiness (g)
Control	9.0 ± 3.3	$0.4 \pm 0.2\%$	$2.0 \pm 0.9\%$	$37.3 \pm 2.8 \%$	121.4 ± 10.8	135.4 ± 11.4
Active	20.2 ± 8.7	$0.4 \pm 0.1\%$	$1.0 \pm 0.5\%$	$28.8 \pm 4.8 \%$	184.0 ± 13.8	220.0 ± 15.5



<https://ualresearchonline.arts.ac.uk/id/eprint/24761/>



**Cultural context:
personal and social significance**



Mixed methods research: case study 1

- ❑ Real life contextual understanding
- ❑ Based on rigorous qualitative data and quantitative data integration
- ❑ Used in healthcare research, technology UX research

Exploratory Sequential Design



<https://catalyst.harvard.edu/community-engagement/mmr/>

Exploration of curly hair manageability

Subjective Evidence-Based Ethnography (SEBE)

Daniels, G. and Heitmayer, M., 2024. Taxonomy for the assessment of the subjective experience of curly hair manageability. *International Journal of Cosmetic Science*, 46(6), pp.1074-1087.



SEBE vs interviews

SEBE:

- ❑ Reduces researcher's bias by focusing on the video material
- ❑ Reduces the recall errors
- ❑ Based on the consumer language

Daniels, G. and Heitmayer, M., 2024. Taxonomy for the assessment of the subjective experience of curly hair manageability. *International Journal of Cosmetic Science*, 46(6), pp.1074-1087.



Hair goals

8

International Journal of
Cosmetic Science



TAXONOMY OF HAIR GOALS, PERCEPTIONS AND ESTEEM

Aesthetic goals

- sleek hair
- less frizz
- curl definition

Haptic goals

- smooth hair
- soft hair
- less tangled hair

Practical goals

- quick results
- easiness
- longevity of style

Emotive goals

- healthy hair
- natural hair
- gaining recognition

FIGURE 2 Subjective evidence-based ethnography data analysis outcome, identifying four main hair styling goals with respective subgoals ($n=14$).

Daniels G, Heitmayer M. Towards a taxonomy for assessing and classifying the needs of curly hair: A mixed method, ethnographic and quantitative data study. *Int J Cosmet Sci.* 2024; 46: 746–760. <https://doi.org/10.1111/ics.12952>

Hair esteem

- Higher hair esteem correlated with more time and knowledge invested in hair and higher emotive goals (strong)
- Hair esteem declined with age and increased with hair length (weak)
- Curlier hair correlated with more knowledge and time invested in haircare

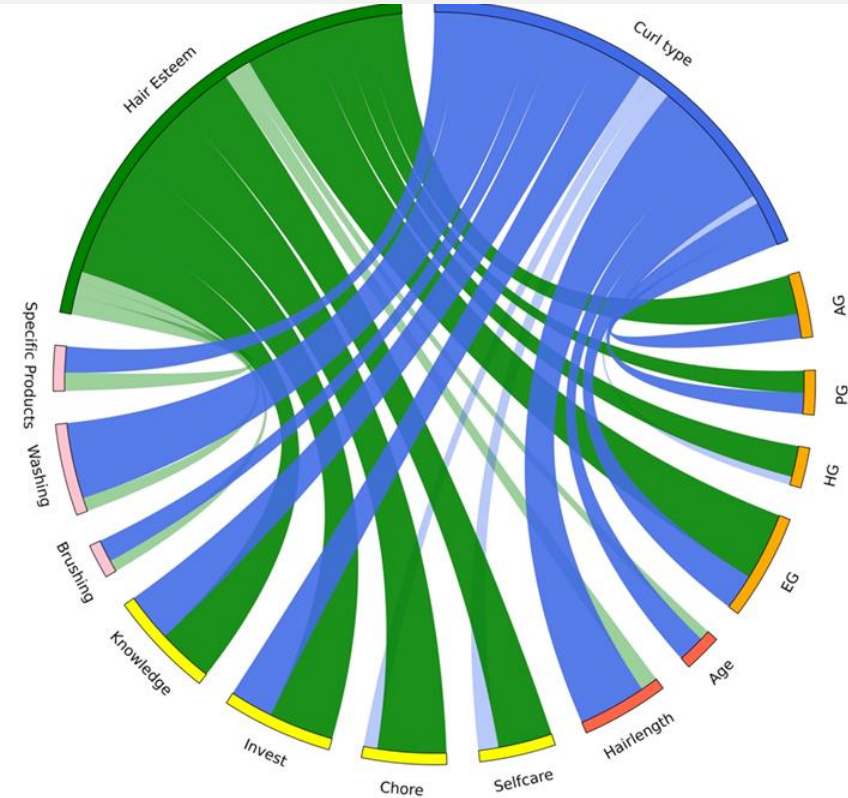


FIGURE 5 Chord diagram visualizing the correlations between hair esteem (green), curl type (blue), and key variables in the sample. Hair goals are presented in orange, demographics in red, hair care perceptions in yellow, and practices in pink. The thickness of the chord indicates correlation strength. Light chords depict non-significant relationships.

Hair esteem questionnaire adopted from: Bankhead, T. and Johnson, T., 2014. Self-esteem, hair esteem and Black women with natural hair. *International Journal of Education and Social Science*, 1(4), pp.92-102

Mixed methods research: case study 2

- ❑ Build comprehensive understanding
- ❑ Explain statistical results in more depth

Explanatory Sequential Design



<https://catalyst.harvard.edu/community-engagement/mmr/>

Hair changes with age: Women (age>59) from African and Afro-Caribbean descent leaving in the UK

Survey structured to compare hairstyling practices over a period of 30 years (pre and post menopause)

- With age, the frequency of chemical hair treatments and styles such as extensions and waving declined
- Hair coloring did not change significantly over time
- Hair manageability became more important, whilst visits to hairdressers went down

Daniels, G., Khadaroo, A., Hur, Y.J., Searing, C., Terrelonge, D. and Zeilig, H., 2025. "I am now being who I am and I'm proud of it": Hair related personal and social identity and subjective wellbeing of older Black women in the UK. *Journal of Women & Aging*, 37(2), pp.111-130.

<https://ualresearchonline.arts.ac.uk/id/eprint/23170/>

Themes from the qualitative analysis

Hair aging

- Hair greying and personal responses
- Other hair aging symptoms
- Time, effort and practicality when managing the above
- The role of hairdressers

Hair and identity

- Hair and Black women's personal identity
- Influence of others and fashion
- Representation of Black women's hair as well as aging hair
- Politics and hair: Black women's hair as a form of resistance

Hair and subjective well-being

- Healthy hair and the choice of cosmetics
- Feelings and emotions related to haircare
- Hair damage in a more general context
- Chemical processing and well-being related to European hair standard's hegemony

<https://ualresearchonline.arts.ac.uk/id/eprint/23170/>

Concluding remarks

- ❑ Studies of fibre properties and interactions are critical for establishing how the fibres change in response to cosmetics
- ❑ Hair manageability from human perspective varies and should be incorporated in technical tests as far as feasible
- ❑ Hair matters to humans and supporting health and wellbeing via hair and scalp care

Thank you!