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Raman Spectroscopy Case Study:

Characterising Bleached Hair Damage

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‘Blondes have more fun….?’

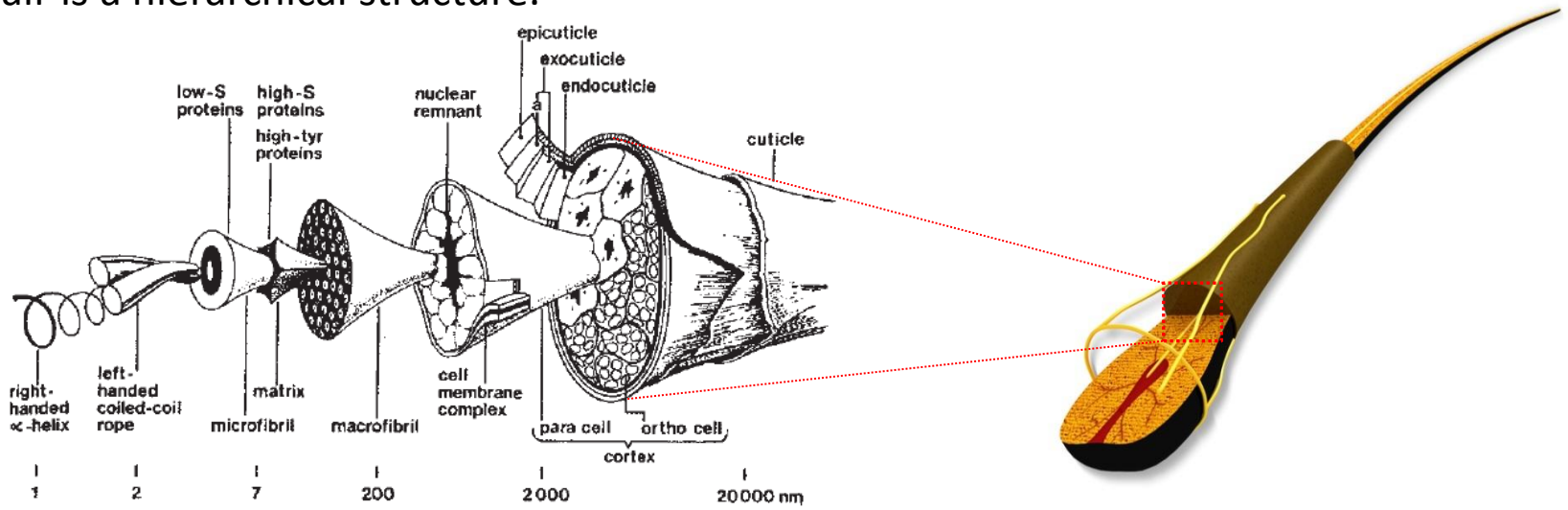
Research Case Study

- Hair is susceptible to changes and damage induced by:
  - Mechanical factors:
    - Heating, blow drying and brushing
  - Environmental factors:
    - Exposure to sunlight and salt water
  - Internal factors:
    - Age and nutrition
  - **Chemical factors:**
    - **Bleaching and colouring treatments**

Characterising Hair Damage

Research Case Study

- Hair is a hierarchical structure.



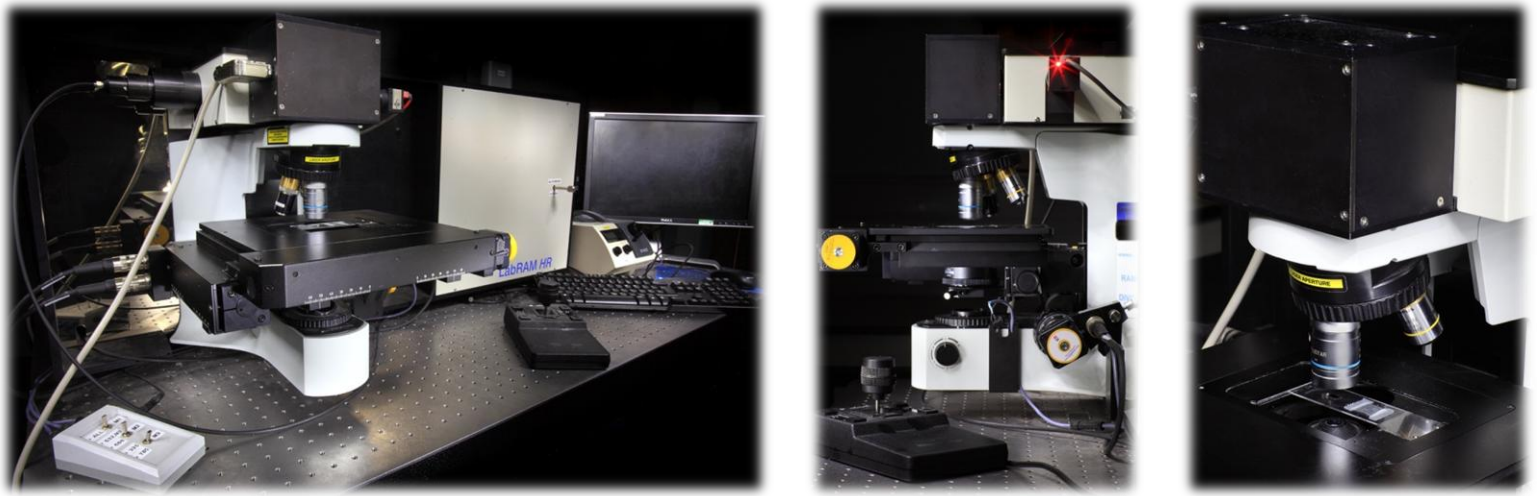
Kuzuhara, A. Analysis of Structural Change in Keratin Fibers Resulting from Chemical Treatments Using Raman Spectroscopy. 2005. ***Biopolymers, 77 (6), 335-344***

- Current techniques to evaluate the penetration of chemicals into the internal volume simply give an average of the whole structure.
- Better characterisation would allow discreet localisation and assessment of chemical damage.

Confocal Raman Spectroscopy

Research Case Study

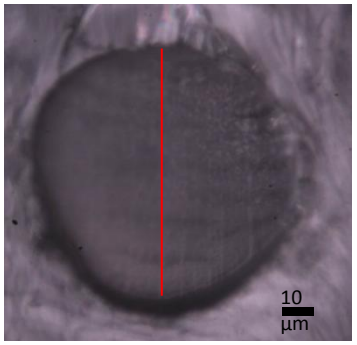
- Confocal Raman mapping is an '*in-situ*', non-destructive chemical analysis and imaging technique.
- It uses the spontaneous inelastic scattering of light to generate spectra unique to a material's molecular composition and state.
- It requires no sample extraction, purification or labelling, and provides molecular level information about the components in hair with high spectral resolution.



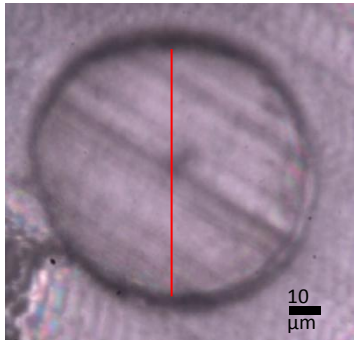
Raman Mapping

Research Case Study

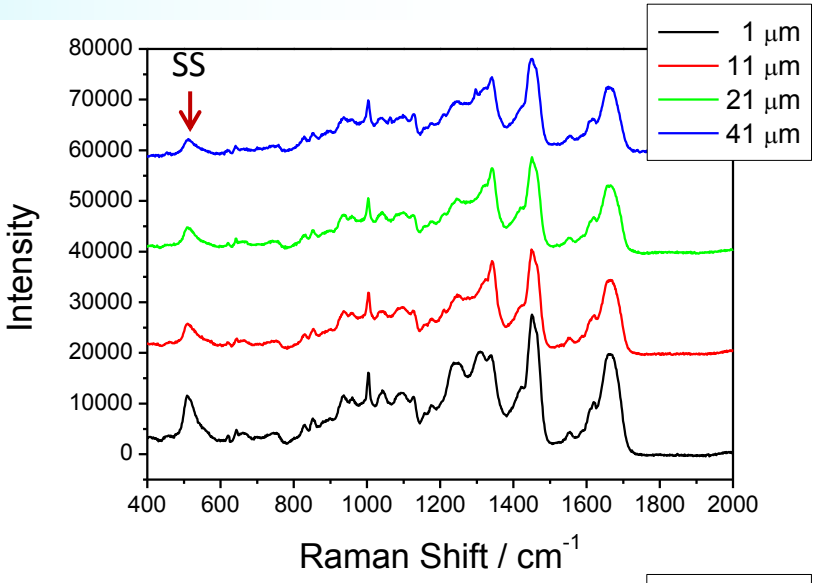
- A cross section of bleached hair was compared to non-bleached hair.
- Samples were mapped along the width of the cross section (red line).
- The graphs opposite show Raman spectra at various distances from the outside of the sample.
- SS (di-sulphide) groups form cross-linkers in keratin fibres and contribute to the physical and mechanical properties of hair.
- The Raman shift for this band occurs at 430 -550 cm^{-1}

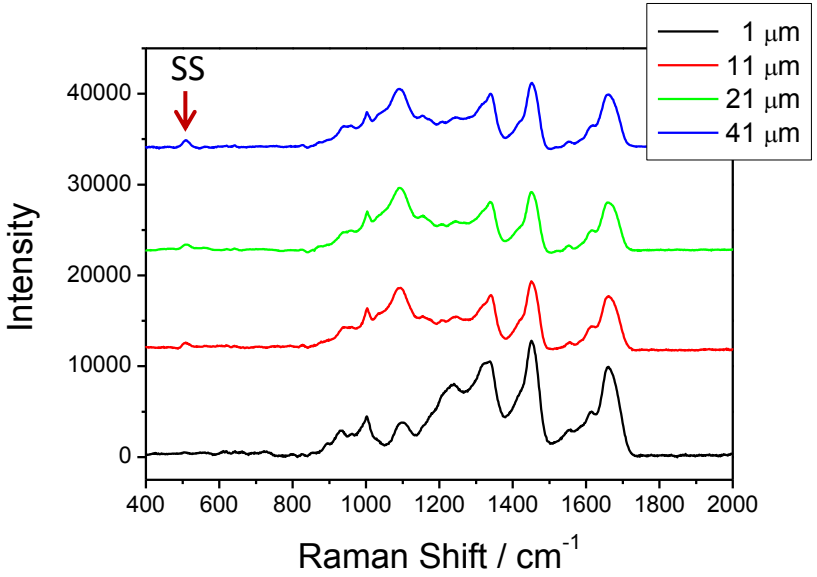


Non-Bleached Hair



Bleached Hair

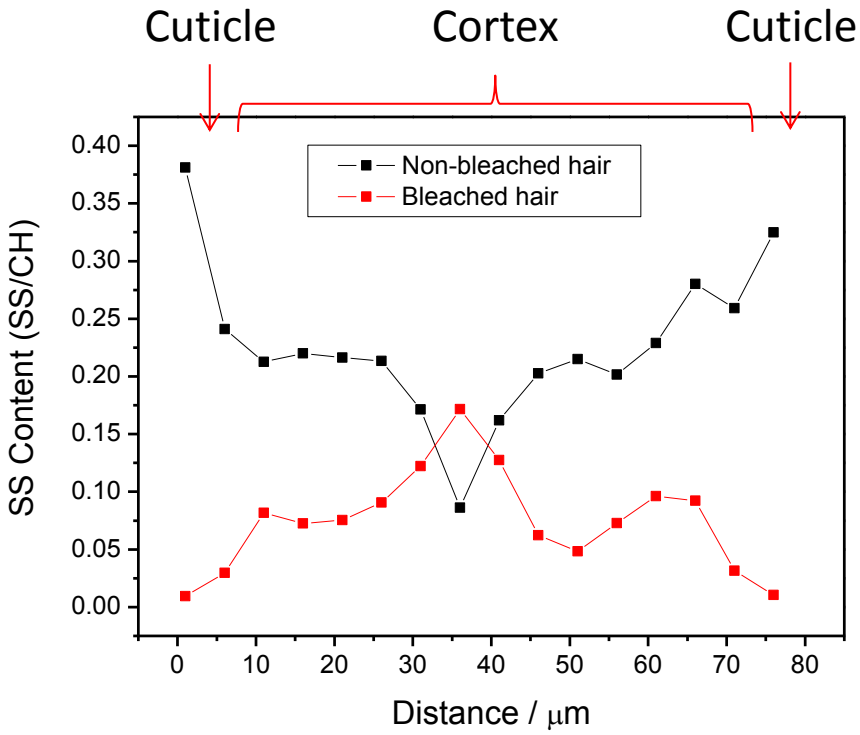




Content Tracking

Research Case Study

- Bleaching decreases the SS content at the cuticle, destabilising hair structure.
- Bleach does not penetrate significantly into the centre of the cortex as SS content in the centre is the same as in the non-bleached sample.



Depth profile of the SS content (SS band normalised to the CH band)

Summary

Research Case Study

- Confocal Raman spectroscopy can provide '*in-situ*' analysis of chemical damage across the hierarchical structure of a hair.
- It can be applied to look for subtle changes or differences in material chemistry.
- It has been used to show a reduction in SS bonds caused by bleaching, linked to a reduction in the mechanical strength of hair.
- The reduction of SS bonds was not observed in the central cortex of the hairs, suggesting bleach penetration was not sufficient to reach this far.

Further Information

Research Case Study

For further information on how Raman spectroscopy, or the Nottingham Nanotechnology and Nanoscience Centre could help with your applications, systems and designs please contact:

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