



Cosmetics



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Cosmetics is moving closer to the pharmaceutical industry in terms of the fight against counterfeits and the quality controls required before launching on the market, so authentication and tracking techniques, as well as monitoring the effectiveness and the safety of components are the main challenges facing this sector.

The vectorization of active ingredients to increase the effectiveness and the use of natural substances to replace conventional chemical preservatives is the key to making innovations in cosmetic products more acceptable.

The advantages of synchrotron radiation at SOLEIL:

- Access to microanalysis and scanning electron microscopy (nanometer to micrometer beams of light)
- Significant gain in chemical imaging spatial resolution, on the tissue, cellular and intracellular scale.
- Determination of the structural footprint of crystalline materials, for the detection of counterfeits by powder diffraction.
- Dynamic in situ monitoring of structural modifications in molecular constituents.
- The coupling of thermal, mechanical and structural analyses to study the nano- and micrometric architecture of gels, emulsions and colloids.



Main synchrotron applications for the sector:

- Verification of the effectiveness and safety of active ingredients
- Integration of natural substances into formulations
- Rheological properties and aging of oil-water surfactant mixtures
- Distribution of cosmetics and their effect on the biochemical constituents of tissues
- Analysis of the molecular architecture and chemical mapping of skin, hair and nails



The distribution of lipids on sections of virgin Caucasian and African-American hair was compared by using infrared microscopy and synchrotron radiation with very high spatial resolution. Notably, the shape and intensity of CH_2 , CH_3 , amide I and amide II bands, before and after delipidation with solvent, were studied.

Regarding the Caucasian hair, lipids are localized predominantly in the medulla, and in smaller amounts in the cuticle, unlike African-American hair that shows an infrared spectrum that is identical over its entire section and is also insensitive to delipidation. The physicochemical properties of hair are thus closely linked to ethnicity.

The study has also shown that synchrotron infrared microscopy, used to map the lipid content in a cross section of hair, is the first analytical tool able to reveal the presence of fatty acids and salts in the medulla (see Figure on the left).

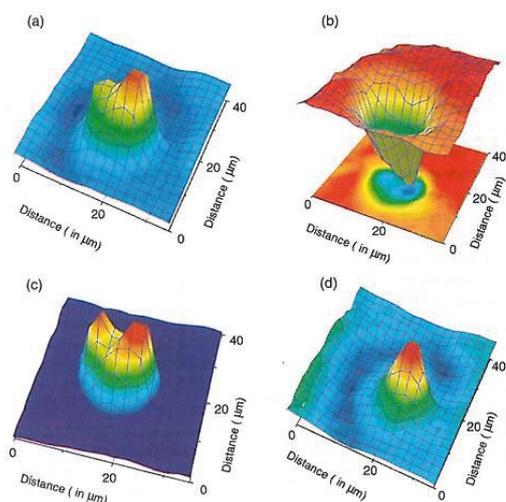


Figure: Map showing the chemical distribution (step = $2\mu\text{m}$, opening = $3 \times 3 \mu\text{m}^2$, 4 cm^{-1} , 64 scans) near the medulla of a Caucasian hair: (a) lipids (CH_2 groups), (b) protein (amide I), (c) COO -groups, (d) $\text{C} = \text{O}$ groups.

A mixture of fatty acids (long alkyl chain and terminal $\text{C} = \text{O}$) and fatty acid salts (COO -terminal) is found in high concentrations in the medulla of Caucasian hair, where the protein content is lowest.



Paul Dumas, Head of the SMIS beamline at SOLEIL Synchrotron.

The contribution of synchrotron infrared to the cosmetics sector

Synchrotron light in the infrared range is used to determine the chemical composition of the various compartments of the hair and skin, with spatial resolution of the order of a few micrometers.

Layers between 5 and 10 microns thick, in the stratum corneum of the skin and in the cuticle in hair, were used in specific studies to understand the role of lipid layers in the protection of these human tissues. With cosmetic treatments, the dual role of penetration of the active agent into the underlying layers (epidermis in skin and cortex in hair, respectively), and also preservation of the structure of these protective lipid layers, has been validated and characterized.

Infrared microscopy with synchrotron radiation has enabled the hair coloring process to be studied, by determining the depth of penetration into the hair of the cosmetic agent and checking the non-destruction of secondary structures of proteins that make up the cortex. The presence of lipids in the medullary canal of Caucasian and Asian hair has also been demonstrated by this technique.

Penetration of the skin by cosmetics was also studied, showing that the structure of the tissue proteins had not been disturbed.