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Synchrotron Infrared Microspectroscopy of Hair: Is there any Ethnic Dependency?

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Introduction: Human hair is 50-100 μm in diameter and its cross-section reveals three major identifiable regions. The medulla is the center-most portion of the hair. It is 5-10 μm in diameter and composed of loosely packed, keratinized cells that distribute moisture and nutrients to the hair strand. The medulla can be either continuous or discontinuous along the hair length, and often it is completely absent. The cortex makes up the bulk of a hair fiber and determines the strength of a hair. It is 45-90 μm in diameter and composed of long embedded cortical cells: it also contains the hair pigment melanin. The outermost layer of a hair strand is the cuticle, which is less than 5 μm in thickness. It is a dense layer of flat keratinized cells, which protects the hair fiber. As far as composition and imaging are concerned, synchrotron infrared microspectroscopy is a perfect tool in hair research.
Previous study has shown that marked difference in biochemical composition of hair cuts between Caucasian-and Afro-American origin exits [1]. This work has been carried out to find out any systematic in different ethical origin

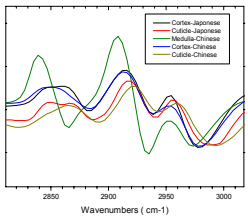
Methods and Materials: In this study, hair samples were collected from virgin hair obtained from Chinese, Caucasian and Japanese young persons. Hair samples were embedded in Tissue–Tek (Reichert_Jung, Heidelberg- Germany) product. Cross-sections were cut at a thickness of 5 μm using a cryomicrotome (MICROM). Infrared spectra were collected either with a 6x6 μm^2 or a 3x3 μm^2 aperture. For the data reported here, IR spectra were recorded with a resolution of 4 cm^{-1}, and either 32 or 64 scans were co-added before Fourier transform processing.

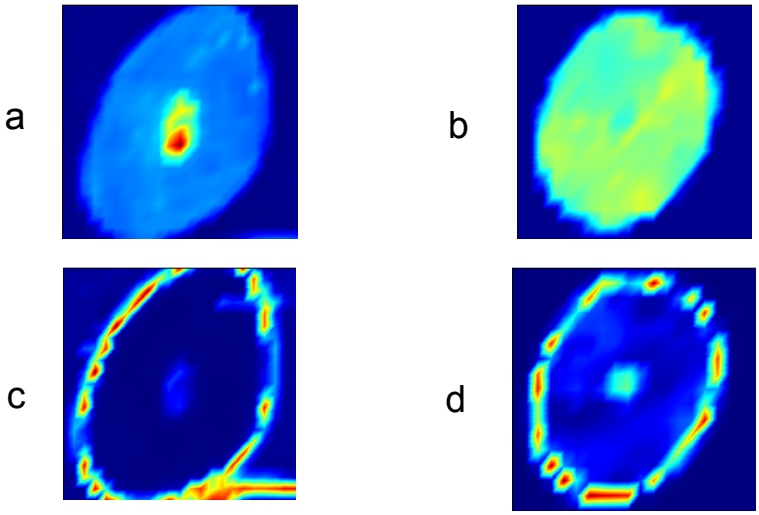
Results: High lipids concentration has been found only the medulla of Chinese origin hairs (see Figure (a) and (b). However, thanks to the high signal to noise spectra, a careful statistical analysis on spectra, in the 2800-3000 cm-1 region, reveals different class for the CH_2, between medulla, cortex and cuticle. Imaging software, based in this hierarchical clustering (Cytospec), allows imaging the location of the lipids more clearly inside the cuticle of each ethnical origin (Figure (c) and (d). Obviously, these lipids are of different composition, therefore properties, as compared with those located inside the medulla. Further studies are underway to study these differences in greater detail.

Conclusions: This study, carried out by infrared microspectroscopy using the synchrotron source, has revealed the marked differences between several hair cuts from different ethnical origin. More studies are still needed to draw a general conclusion about ethnic dependency. However, we have revealed the different nature and/or composition of lipids between the three different regions of hair. Complementary studies are also underway, on the same samples, using X-ray fluorescence microscopy.

References:

[1] Kreplak, L et al. Intern. J. of Cosmetics Science **23** (2001) 1.





Chemical image of CH_2 for a Chinese hair cut (a) and Japanese hair cut (b) Hierarchical cluster analysis, based on the first derivative spectra, shown in this figure, allows to image the specific lipids composition inside the cuticle for both type of hair