

## Non-invasive measurement of water concentration in the skin

This note discusses the capability of the River Diagnostics® Model 3510 Skin Composition Analyzer to rapidly determine in vivo water concentration profiles in the skin, starting at the skin surface and extending into the living epidermis.

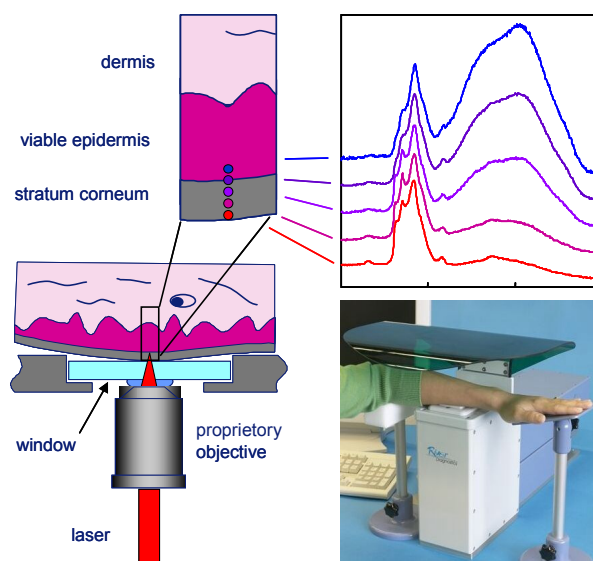
### Introduction

The stratum corneum constitutes the barrier of the body against water loss. The barrier function depends on proper moisturization, lipid balance, and the presence of humectants, especially constituents of Natural Moisturizing Factor. Non-invasive in vivo determination of the skin's molecular composition enables objective assessment of a person's skin condition as well as monitoring of the penetration and effects of topically applied products. The Model 3510 SCA makes this possible. A dedicated confocal Raman microspectrometer fully optimized for in vivo skin measurements, the 3510 uses a specially designed microscope objective to focus low power laser light in the skin, and to collect Raman scattered light with depth resolution of  $< 5 \mu\text{m}$  (typically  $\sim 4 \mu\text{m}$ ). This depth resolution has been found optimal for in vivo Raman experiments of the skin. It combines rapid signal collection with the high spatial resolution needed, for example, for measurements within the stratum corneum, which is 10-15  $\mu\text{m}$  thick on the arm and face.



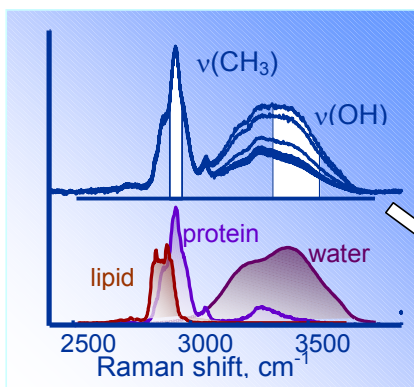
### Determination of water concentration by Raman spectroscopy

A Raman spectrum of the skin is a representation of its molecular composition. The intensity of signal contributions of a molecular species to the Raman spectrum is linearly dependent on the concentration of this species. This enables measurement of water concentration in the skin. The Raman signal of skin in the  $2500\text{-}4000 \text{ cm}^{-1}$  spectral region is primarily due to  $\text{CH}_2$  and  $\text{CH}_3$  stretching vibrations in proteins and lipids ( $\sim 2800\text{-}3000 \text{ cm}^{-1}$ ) and to the OH stretching vibrations of water ( $\sim 3100\text{-}3700 \text{ cm}^{-1}$ ). The water concentration (in mass %) is determined from the intensity ratio of two carefully chosen spectral intervals within these CH stretching and OH stretching regions.<sup>1,2</sup>

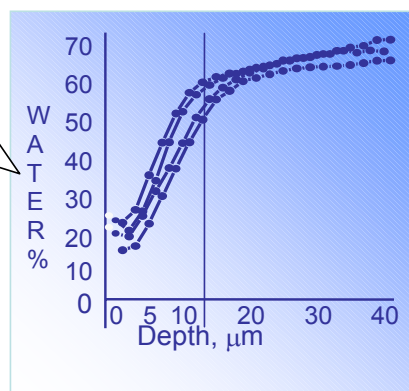


## Method

Determination of water concentration profiles by means of the Model 3510 SCA is rapid and straightforward. The skin of the subject is positioned on the measurement window of the Model 3510 and the image of the skin surface on the window, provided by the built-in video system, is used to select a measurement location. Measurements are initiated from a dedicated measurement template in the River-ICon software.



The template enables the user to choose the depth range over which spectra are measured and the step size between measurements. Signal collection time is typically 1 second per spectrum, which means that the data for a water concentration profile consisting of 20 measurements and a 2-micron step size can be collected within half a minute. For such measurements laser power less than 20 mW at 671 nm is used, which is below the MPE (maximum permissible exposure) for skin.



## Applications

The unique and detailed quantitative information provided by the Model 3510 SCA offers a whole new perspective for fundamental skin hydration studies, skin typing, and development and clinical testing of moisturizing personal care products.

## References

- [1] Caspers PJ, Lucassen GW, Bruining HA, Puppels GJ "Automated depth-scanning confocal Raman microspectrometer for rapid in vivo determination of water concentration profiles" *Journal of Raman Spectroscopy* 31: 813-818 (2000)
- [2] Caspers PJ, Lucassen GW, Carter EA, Bruining HA, Puppels GJ "In vivo confocal Raman microspectroscopy of the skin: non-invasive determination of molecular concentration profiles" *Journal of Investigative Dermatology* 116: 434-442 (2001)

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