

The Use of Confocal Raman Spectroscopy for the Measurement of Skin Hydration *in vivo*

The water content of the outermost skin layer, the stratum corneum, strongly influences the biochemical processes that govern skin condition¹. The ability to measure the extent of hydration of the skin *in vivo* and its distribution as a function of depth is therefore of great importance.

Until recently, the extent of skin hydration could only be measured precisely using destructive methods, or estimated *in vivo*. The *in vivo* methods are subject to numerous interferences and are not spatially well resolved. Confocal Raman microspectroscopy, as implemented in the River Diagnostics model 3510 depth-scanning skin analysis system, (Figure 1) now solves these problems.



Figure 1. The River Diagnostics Model 3510 depth-scanning skin analysis system

Skin scientists can now quickly and accurately measure the moisture profile of the critical outer-

most skin layer, the stratum corneum, with depth resolution of better than 5 μm .²

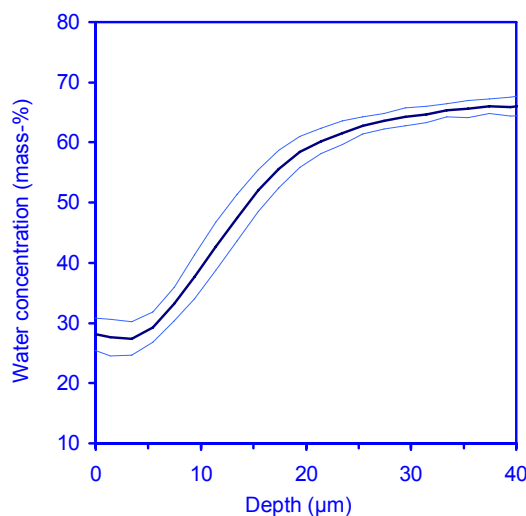


Figure 2. Water profile measured *in vivo* by confocal Raman spectroscopy on the volar aspect of the forearm. One-sigma boundaries (10 replications) are also indicated. Note that this represents real and normal biological variability. The reproducibility of the Raman method is an order of magnitude better.

An example of a water concentration profile measured with the Model 3510 is shown in Figure 2. The profile shows that water concentration increases from approximately 27% near the skin surface to about 60% at a depth of about 20 μm , the approximate thickness of the stratum corneum on the forearm of this subject.

Modification of the moisture content of the skin can be easily studied by this method. In a simple experiment, the skin of a volunteer subject was exposed to liquid water for one hour by soaking with a wet towel. The change in moisture content is shown in figure 3.

¹ C.R. Harding, A. Watkinson, A.V. Rawlings and I.R. Scott, International Journal of Cosmetic Science, 22 21-52 (2000).

² P.J. Caspers, G.W. Lucassen, H.A. Bruining and G.J. Puppels, Journal of Raman Spectroscopy, 31 813-818 (2000).

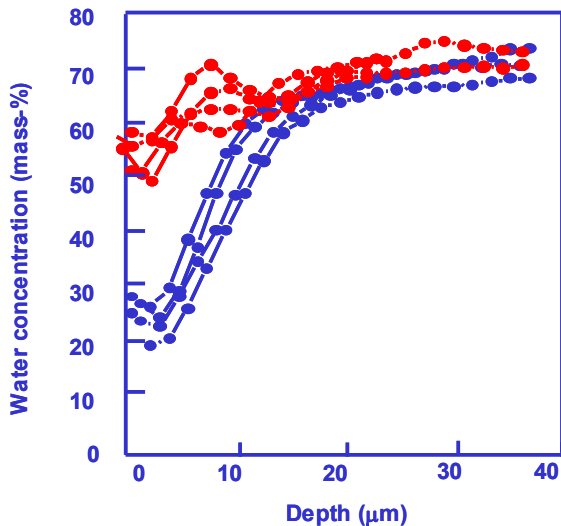


Figure 3. Water content of the skin, on the volar aspect of the forearm, before (blue) and after (red) soaking with a wet towel for 1 hour.

The stratum corneum has become nearly saturated with water, almost to the level of the viable epidermis. In the same straightforward way, the effects of other moisturization treatments, such as creams and lotions, can also be studied with the Model 3510.

The moisture content of skin is also known to increase with occlusion. Occlusion blocks transepidermal water loss (TEWL), resulting in higher equilibrium water concentration in the skin. In fact, many moisturizing agents in common use are effective in part due to occlusive action on the skin.

To explore directly the effects of occlusion, the following experiment was performed. The volar aspect of a volunteer was occluded by application of a dry Hill Top Chamber[®]. Water concentration profiles were recorded at the same location at 3 and 24 hours after application. Figure 4 displays the results of this experiment.

A modest increase in water concentration with time is observed. This result is consistent with the expected mechanism of hydration by occlusion. Since the only source of water accumulating in the chamber is the skin itself, the rate of increase of moisture content is slow compared to the experiment of Figure 3.

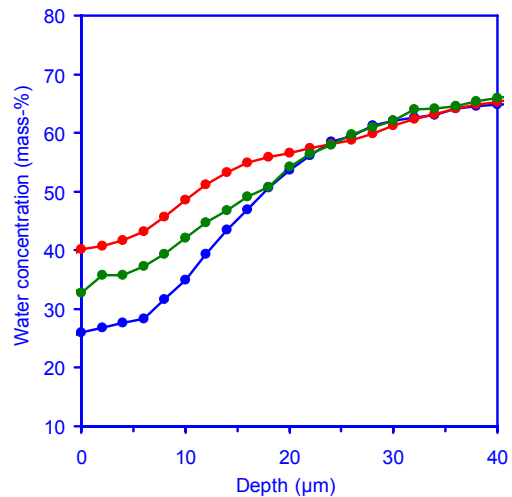


Figure 4. Time study showing the effect on water concentration in the stratum corneum of continuous occlusion for three (green) and twenty-four (red) hours, the blue curve was recorded before occlusion. Each data point was collected in one second. The total time per profile was approximately 20 seconds.

In summary, *in vivo* studies of water concentration in skin are readily carried out using the approach embodied in River Diagnostics' Model 3510 depth-scanning Raman systems. This method shows exciting promise to advanced scientific understanding of moisturization of skin. Furthermore, the method will prove invaluable in product development of topical products designed to promote skin moisturization, as well as for claims verification for such products.

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