Measurement of TEWL

TEWL Measurement

- Transepidermal water loss (TEWL)
- is a good indicator of the integrity of the skin barrier function which inherently refers to the skin's ability to retain moisture.
- An increase in the TEWL indicates an impaired barrier function.
- It is used to assessing the barrier function of skin in healthy individuals or in patients with skin diseases

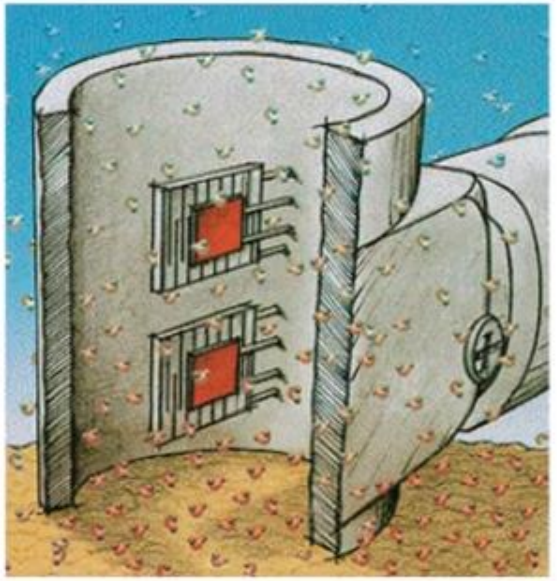
TEWL Measurement

- TEWL is the quantity of condensed water that diffuses across a fixed area of stratum corneum to the skin surface per unit time.
- water evaporating from the skin is measured using a probe that is placed in contact with the skin surface and contains sensors that detect changes in water vapor density.

Introduction

- ✓ **Definition: TEWL is the quantity of condensed water that diffuses across a fixed area of stratum corneum (SC) to the skin surface per unit time.**
- ✓ **The water evaporating from the skin is measured using a probe that is placed in contact with the skin surface and contains sensors that detect changes in water vapor density.**
- ✓ **As water loss across the SC increases, the humidity next to the skin surface rises and creates a humidity gradient that is proportional to the SC water loss.**
- ✓ **TEWL is inferred from measuring the change (or flux) in water vapor density at the skin surface compared with a point farther away from the skin.**
- ✓ **TEWL can be measured using an**
  - ➢ **Open-chamber,**
  - ➢ **Unventilated-chamber, or**
  - ➢ **Condenser-chamber device.**

TEWL and Skin Barrier Function determination by Tewameter



Principle:“Open Chamber” Principle

Applications of TEWL determination

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- ✓ Transepidermal water loss (TEWL) is the most widely used objective measurement for assessing the barrier function of skin in healthy individuals .
- ✓ Skin diseases in which the skin barrier is disturbed, such as atopic dermatitis (AD), contact dermatitis, and psoriasis, are associated with elevated TEWL.
- ✓ TEWL measurements are used as a skin research tool *in vivo* and *in vitro*.

Factors affecting TEWL

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- **Anatomical sites:**
  - TEWL is high at the palms, soles, axillae, and forehead and
  - Low at the calf and forearm.
  - The increased TEWL at sites such as the palms and soles is due to low sebaceous lipid content at these sites.
- **Regional differences** in TEWL may also be due to differences in
  - Sweat gland activity, occlusion,
  - Skin temperature, thickness,
  - Microvasculature
  - Corneocyte size,
  - Maturity, and shedding.

Principle of Tewameter

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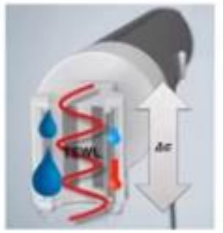
- As soon as the barrier function of the skin is slightly damaged, the water loss will increase (even with smallest damages invisible to the human eye).
- Therefore this measurement is a basis for all cosmetic and dermatological research.
- The Tewameter® probe measures the density gradient of the water evaporation from the skin indirectly by the two pairs of sensors (temperature and relative humidity) inside the hollow cylinder.
- This is an "open chamber" measurement.
- This method is the only to assess the TEWL continuously without influencing its micro environment.



Principle of Tewameter

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The measured values express the evaporation rate in g/h/m2.

Tewameter formula

$$\frac{dm}{dt} = -D \cdot A \cdot \frac{dp}{dx}$$

A = surface [m²]

m = water transported [g]

t = time [h]

D = diffusion constant [= 0.0877 g/m(h(mmHg))]

p = vapour pressure of the atmosphere [mm Hg]

x = distance from skin surface to point of measurement [m]

- Open-chamber system with an unventilated-chamber system and a condenser-chamber system found that the condenser chamber system was the only device that could detect the effect of tape-stripping on TEWL
- Its only device that could discriminate between the effects of moisturizer and petrolatum on skin barrier integrity.
- Condenser-chamber TEWL devices are closed by a condenser that is cooled below the freezing point of water.
- The condenser removes water vapor from the chamber, enabling continuous measurements to be made without the need to interrupt the measurement to allow the water vapor to escape.
- The condenser also controls the microclimate within the chamber by protecting from ambient air movement and controlling the humidity.

Measurement of Transepidermal Water Loss (TEWL)

TEWL varies significantly across different anatomical sites and also depends on sweat gland activity, skin temperature, and corneocyte properties.

Skin barrier dysfunction results in increased TEWL.

Skin diseases in which the skin barrier is disturbed, such as atopic dermatitis (AD), contact dermatitis, psoriasis, and ichthyoses, are associated with elevated TEWL.

TEWL measurements consistently correlate with the percutaneous absorption of topically applied compounds

Measurement of Transepidermal Water Loss (TEWL)

TEWL measurements can be seen as an indirect measure of skin permeability.

TEWL is not measured directly, but inferred from measuring the change (or flux) in water vapor density at the skin surface compared with a point farther away from the skin.

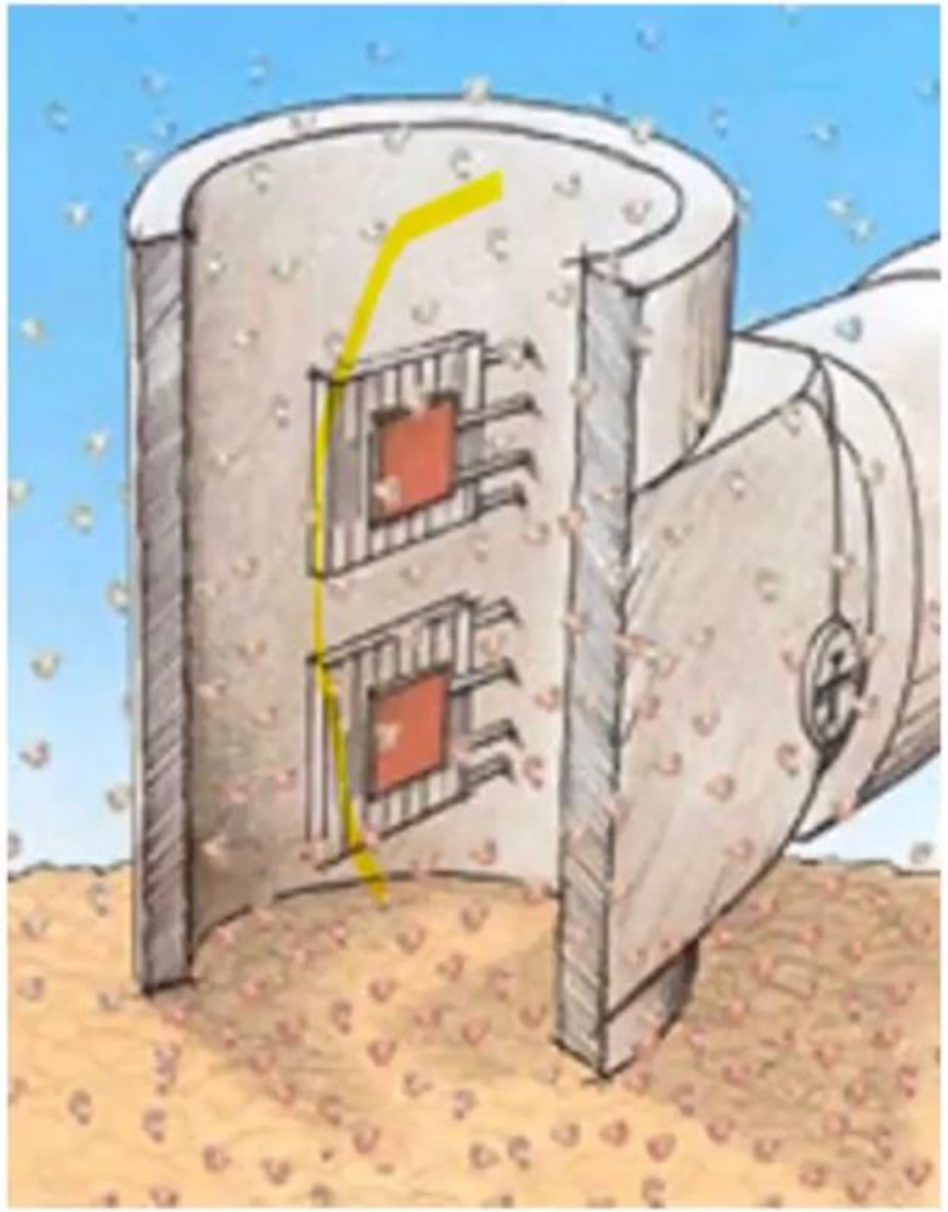
Humidity gradient above the skin surface that is proportional to the SC water loss

TEWL are stated as grams of water per square meter per hour.

TEWL can be measured using an open-chamber device, an unventilated-chamber device, or a condenser-chamber device. Because of the sensitivity and variability in measurement of TEWL, usually three or more readings are taken to calculate a mean value.

Measuring principle

- The microclimate is determined by two moisture sensors and two thermometers positioned in a measuring head (open-chamber method).
  The system measures the water vapour flow density: JV= g/(m x h) (mass of water vapour (in g) per area (in m2) and time (in h).
- Each of the two sensors measures the partial pressure of the water vapour: the gradient between the two sensors is directly proportional to the rate of evaporation. The water vapour gradient can subsequently be converted into the TEWL value, taking into account the length and diameter of the open measuring cylinder.



Types of TEWL Devices

(A) OPEN-CHAMBER TEWL DEVICE.

A hollow cylinder is placed in contact with the skin, and water vapor diffuses through the open chamber. Spatially separated temperature and relative humidity sensors detect the humidity gradient.

(B) UNVENTILATED-CHAMBER TEWL DEVICE.

The upper end of the chamber is closed, resulting in water vapor collecting in the chamber. The temperature and relative humidity sensors detect the rate of increase of relative humidity.

(C) CONDENSERCHAMBER TEWL DEVICE.

The upper end of the chamber is closed by a condenser that removes water vapor from the chamber, enabling continuous

Measurement of Skin Color

Biological Determinants of Skin Color

- The pigments **Carotene**, **Hemoglobin**, and **Melanin** are involved in skin color
- Carotene, the least common skin pigment results in a yellowing of skin
  - –Results primarily from the over-consumption of carotene containing foods (like carrots)
  - –This pigment is significant almost exclusively in pathological or abnormal skin coloration

Hemoglobin

- Hemoglobin is the complex molecule responsible for transport of oxygen throughout our bodies
  - It is the primary protein constituent of Red Blood

- Oxygenated hemoglobin has a reddish hue
  - Produces a pinkish tint to lightly pigmented skin
- Deoxygenated hemoglobin has a purplish color
  - Produces the bluish tint to lightly pigmented skin that is characteristic of oxygen deprivation and suffocation

Melanin

The primary determinant of variability in human skin color is the amount, density, and distribution of the pigment melanin

Melanin has a dark brown/purple/black color that is intensified by denser compaction of the melanin granules in the cells of the upper layers of the skin

Reflectance Spectrophotometer

A Reflectance Spectrophotometer shines a light of a specific wave length, using a filter, and measures the intensity of light reflected by the skin

The technique involves alcohol wash of the skin on the inner upper arm. It allow time for local circulation to return to normal and shine light and measure reflectance.

MEASUREMENT OF SKIN COLOUR

REFLECTANCE SPECTROPHOTOMETRY

- The light reflectance data from the skin are converted into indices or colorimetric values for the estimation of chromophores in the skin.
- Therefore, mainly a combination of three colour values (L *(white-black, brightness),
- a* (red-green) and
- b* (blue-yellow) are used to and described in the CIE colour space (“CIELAB” or CIE 1976 L *a*b*) o
- r the ITA° is calculated with the formula:
- ITA° = [arc tan(L*−50)/b*] 9180/3.14159.
- Based on the ITA° value, skin colour types are classified into six groups, from very light to dark skin.

METHODS FOR EVALUTION OF SKIN COLOR AND RELATED PARAMETERS

- The reflectance data for the skin obtained throughout the wavelength of visible light are difficult to handle practically, as they contain too much information.
- The data are usually converted **into colorimetric values or indices** for estimating chromophores in the skin. There are formulae defined by CIE to convert them into tristimulus values and the CIE-L*a*b* values may be the most commonly used for quantification of skin color.

METHODS FOR EVALUTION OF SKIN COLOR AND RELATED PARAMETERS

INSTRUMENTS

1. Chromameter, Minolta, Osaka, Japan, is a colorimetric instrument, which contains a xenon lamp as a light source, photodetectors, a microcomputer, and colored filters which closely match the CIE colorimetric Standard Observer curves.

2. DermaSpectrometer, Cortex Technology, Hadsund, Denmark, is an indexcalculating, narrow-band spectrophotometric instrument composed of LEDs, which emit light in two narrow-wavebands corresponding to red and green, photodetectors, and a microcomputer.

METHODS FOR EVALUTION OF SKIN COLOR AND RELATED PARAMETERS

- Color values in accordance with the CIE color systems (Chromameter) or erythema and melanin indices (DermaSpectrometer) are calculated automatically with these instruments.
- Erythema and melanin indices obtained from the DermaSpectrometer are different from those which are derived from full-spectrum spectrophotometric data, but similar to those of the measurement principle. In both instruments, to obtain data the probe head is placed.
- One deficiency of these spectrophotometric or colorimetric instruments is that the color of an object smaller than the opening of the probe head cannot be measured exactly.

METHODS FOR EVALUTION OF SKIN COLOR AND RELATED PARAMETERS

Color values obtained with software for image analysis are not absolute, but should be considered as relative data which are comparable only with those obtained using the same system and under the same situations.

Therefore, color information from digitized images must be carefully processed in order to express it in terms of the values of an authorized color system.

Corneometer

What is a Corneometer used for?

- The Corneometer **indicates the hydration level of the superficial layers of the skin (stratum corneum) via measurement of skin dielectric properties**.

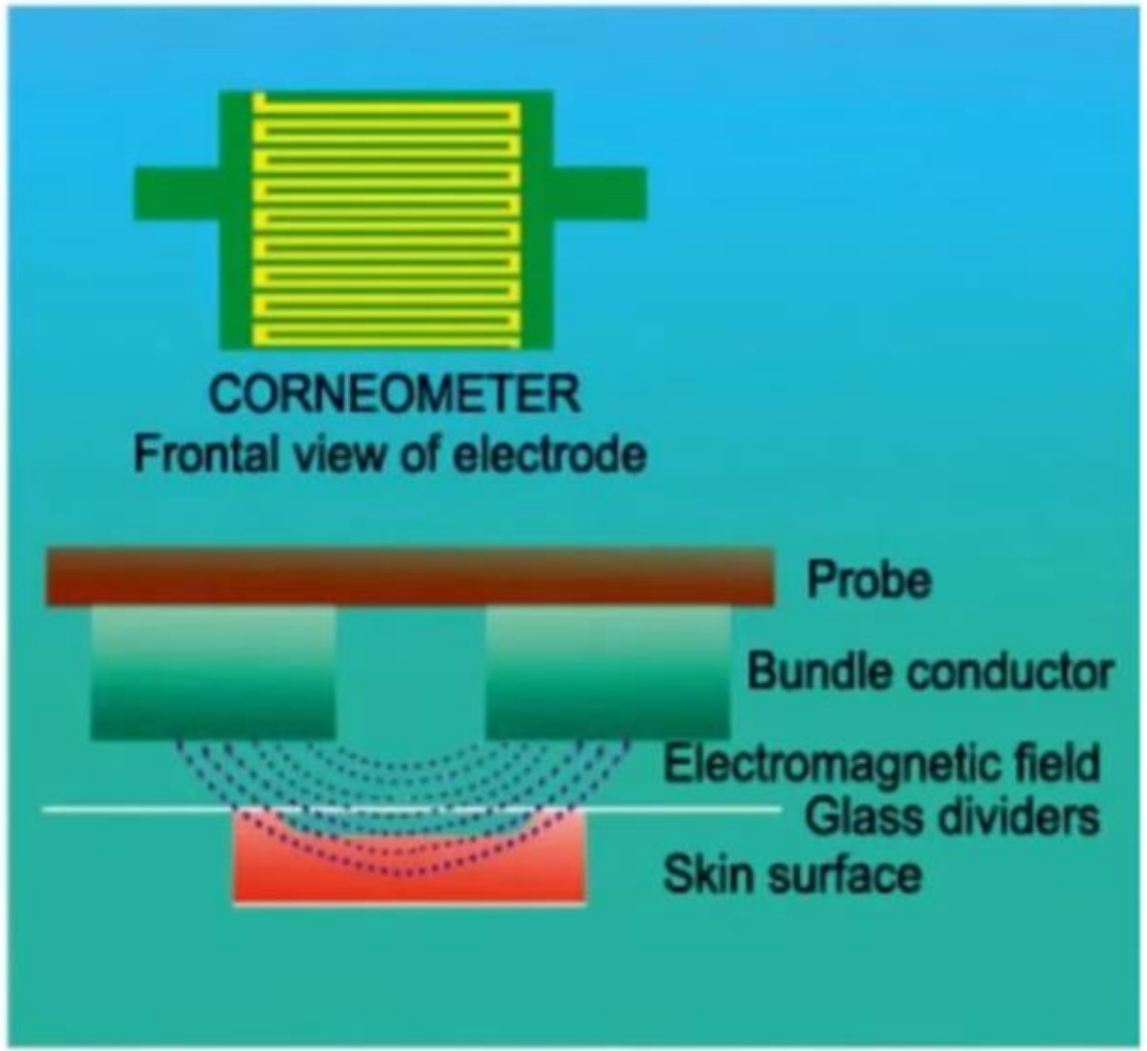
- Reproducible and accurate measurement of skin hydration since 1980
- Quick measurement time
- Constant pressure for exact reproducible measurements not influencing the skin
- Easy measurements on all skin sites
- Individual and continuous measurements possible
- Does not require frequent, complicated and time consuming recalibration
- Calibration data stored in the probe
- Check calibration to ensure accuracy of measurements
- Small measurement depth

MEASUREMENT PRINCIPLE

- measurement is based on capacitance measurement of a dielectric medium
- The dielectric constant of skin will change with water content. This allows for any changes in skin hydration to be measured by the precision measuring capacitor. These changes in water content of the stratum Corneum are converted into arbitrary units of hydration. On the probe head there is a fine piece of glass to ensure that only the capacitance changes due to water content are identified. Even small changes in water can be detected. The measurement time is short at only 1 second minimising occlusion effects. The depth of the measurement is 10-20µm, the stratum Corneum, ensuring that deeper skin layers do not influence the measurement.

Principles of Corneometer

- The methods used to determine the skin hydration are based on the measurement of **electrical capacitance, impedance and conductance** (TAGAMI, 2006).
- By definition**, impedance is related to the electric opposition suffered by the skin when exposed to an alternating current.**
- This kind of measure is of the most used methods for the evaluation of the hydric content.
- **The water has a high dielectric constant and the stratum corneum is considered a dielectric medium that when hydrated leads to changes in dielectric properties.**
- Thus, the capacitance changes proportionally as a function of the degree of skin hydration.



Principles of Corneometer

The integrity of the stratum corneum of the epidermis influences the passage of water to the external environment and, consequentially, determines the water retention which will contribute to the skin elasticity.

The water binds with the stratum corneum by soluble metabolites, structural proteic components and sebum components. The water evaporation from the skin surface is prevented by ceramides and intercellular lipids present in the stratum corneum and sebum (R. DARLENSKI, 2011).

The lipids and the natural moisturizing factor (NMF) maintain the skin hydration. This factor acts like a "sponge" that keeps water in stratum corneum providing to the skin a soft sensation.

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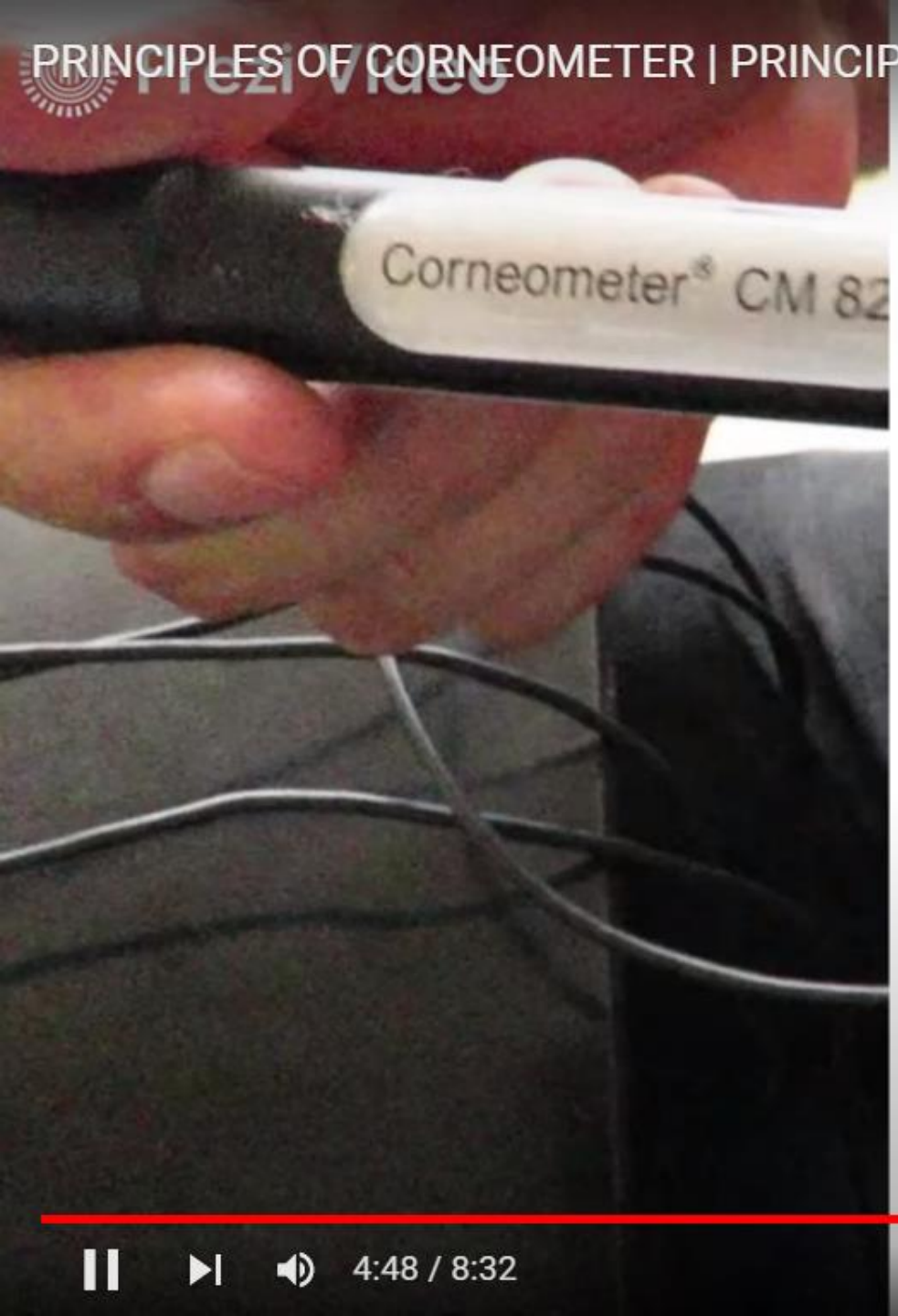

Corneometer

- The Corneometer consists of electrodes interdigitated on a grid and covered with a thin layer of vitrified low dielectric constant insulation.
- During measurement, an electric field penetrates the surface layers of the skin (stratum corneum), by a probe applied vertically on the skin, and the dielectric constant is measured.
- The measure of capacitance is obtained 1 second after application and converted in arbitrary units (a.u.) from 0 to 130.
- **Values of hydration below 30 a.u. correspond to very dry skin; between 30 and 40, dry skin; and higher than 40, normal skin**.
- The capacitance results are affected by many factors as the age, sex, body area (palms and forehead are the most hydrated areas and inferior members and abdomen are the less hydrated areas), the environment (22ºC e 50±5% for temperature and humidity, respectively).

Prezi Video

Principles Of CORNEOMETER

Another method used to evaluate the dynamic evolution of the skin hydration is the **Raman spectroscopy.**

A probe is applied to the skin emitting a laser on it and detecting the scattered light (the majority of the scattered light is of the same frequency as the excitation source) (InPhotonics, 2012).

This method has been applied for measurement of the depth profiles of different molecular concentrations of elements, e.g. water and free amino acids, in the skin in vivo, allowing to characterize and quantify the natural moisturizing factors (Egawa & Tagami, 2007) (CROWTHER & Et. Al., 2008).

This technique has shown promising results comparing to the previous techniques, like near-infrared (NIR) that only obtain viable values in the most superficial layers of the skin.

HAIR COMBING PROPERTIES

- Consumers are demanding healthier, shinier hair with a more natural look and feel. Hair fixatives can modify hair by imparting a permanent set and by increasing the stiffness of a fiber assembly.

- Consumers want hair fixatives that hold without being sticky, stiff or unnatural to the touch.

- Texture Analysis provides the ability to measure all of the physical properties of hair and haircare products.