PROVING FOR EFFICACY: LASER PROFILOMETRY

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Introduction

Surface roughness is an important criterion for assessing the health status of the skin. Changes in roughness occur, among other things, in the case of congenital keratinization disturbances, environment- and job-related skin irritations (toxical and allergic eczema), infectious skin diseases and age-related defects. Such changes to the skin cannot be objectively registered by classical examination methods such as palpation diagnosis or visual assessment.

The computer-aided laser profilometry is a system for quantitative analysis of the skin's surface structure. Evaluation is performed by a contact-free laser scanning on silicon-based skin impressions. This method allows exact measurement of the skin parameters as called for by DIN Standards 4768 ff.. Different parameters of roughness are determined and completed by mathematical and statistical processes such as Fourier transformation and an autocorrelated function. These processes are related to the digitally stored three-dimensional profile of the skin surface.

Materials and Methods

Skin impression: The material used for taking the impressions (plastic silicon precision-moulding compound) has a silicon base (polysiloxane condensation-linking), is highly viscous, and is in accordance with DIN 13 913 A 2, ISO 4823, Type 1 Cat. B, colour: white. The physical characteristics are as follows: deformation under pressure: 1 to 4 %, residual compressive set: less than 2 % (as per DIN 13 913), dimensional change: less than -0.45 % (as per DIN 13 913 and ISO 48 23).

The compound for making the impression is produced immediately before use and bases on a method as described in Kassenbeck and Neukirchner [1]. 2.5 cm universal paste hardener are added to 12 ml plastic silicon. After a mixing time of 45 seconds, the compound is applied evenly and without pressure to the skin area, where it hardens within 2 to 3 minutes. This impression, which is now elastic, is carefully removed from the skin and attached flat onto a glass plate with a layer of solvent-free adhesive.

Measuring principle: The heart of the UB 16 optical measuring system is a semi-conductor laser (780 mm) with a measuring point diameter of 1 µm. The bundled beam is focused by an adjustable objective lens onto the surface of the skin impression and reflected from there.

Two program-controlled step motors move the measuring bench with the silicon impression under the beam. A half-silvered mirror guides the reflected beam through a prism onto two photodiodes. These register every defocus of the measuring point caused by the surface profile, and activate the electronic adjustment of the objective lens until the beam is refocused on the surface. At the same time, the position of the lens is measured and stored as a digital value.

With appropriate selection of the point density for the x and the y axis, the computer program generates a true-to-life, three-dimensional image of the skin relief on a colour monitor.

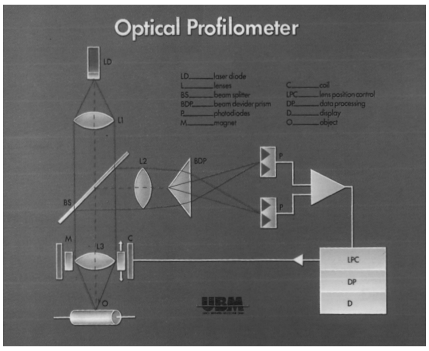

Fig.1 Optical measuring principle of the laser focus and microfocus sensors

Measurement method: The field of measurement is limited by the movement of the measurement bench and can be up to 100 mm x 100 mm, with a maximum measurement density of 800 points per square millimetre. Practice has shown that for qualitative structural investigation purposes, a field of measurement with dimensions between 2 mm x 2 mm and 5 mm x 5 mm should be chosen and that for a definition of 100 points per square millimetre the rate of measurement should be restricted to 150 Hz. The quantitative determination of roughness parameters pursuant to the criteria of the German DIN standard must be in accordance with the measured distances it stipulates, which can be up to 40 mm depending on the roughness of the structure. The direction of measurement can be freely chosen, but the once-chosen direction of measurement will ensure consistency of results [2].

Cosmetics and laser profilometry

Which importance does laser profilometry have for the cosmetic industry? For the first time it is possible with laser profilometry to measure and control exactly the efficacy of cosmetics on the structure of the skin surface. Statements like “fold reduction”, “skin smoothing” or “skin tightness can now scientifically justified and compared. Within the field of dermatology laser profilometry is developing and becomes established as a method of therapy controlling in the case of Psoriasis vulgaris and other skin changes.

To evaluate the improvements in skin roughness by testing a skin care product usually laser profilometry is carried out twice before and after a period of 4 weeks using the product. For the subject investigation, 20 test persons are examined. Figure 2 shows two graphics demonstrating the improvement of skin roughness after treatment with a skin care product.

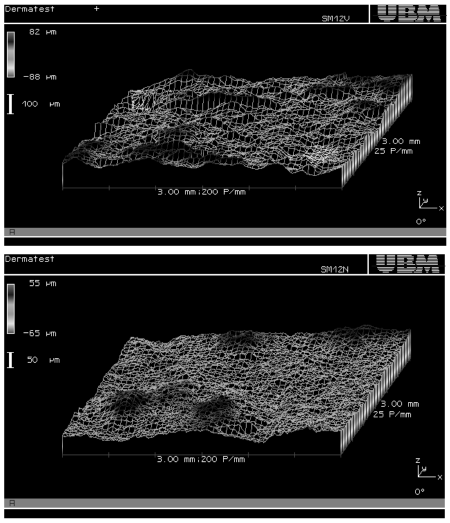

Fig.2 Three-dimensonal graphics of the skin surface before treatment (above) and after treatment (lower graphic).

Summary

1. The contact-free measurement of silicon replicas with laser profilometry allows the reproduction of any measuring results.
2. Skin surface structure is quantitatively characterised by calculating standard values of roughness (DIN).
3. Analysis of any skin area is possible because of integrated mathematical functions, e.g. “filtering” of those profile components, which represent form and waviness of the surface.
4. Laser profilometry is objectively a quantitative analysis method for evaluating the efficacy of topical drugs and cosmetics.
5. The computer-aided laser profilometry produces results of high optical quality.
6. The three-dimensional pictures of the skin relief (before and after treatment) provide useful graphics for marketing strategies.

References

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