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Basic investigation of skin under Plasma treatment

BP 8.7

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1. Motivation

The lipids of the stratum corneum loom large for the barrier function of human skin. Recently several important findings related to mutations of the fillaggrin-gen and according to this, diseases like ichthyose and atopic dermatitis were made but not yet completely understood. Cold plasma treatment on e.g. skin diseases causes in an abatement of diseases by the assured disinfected effect of plasma [1].

Here, we present our first results on the basic investigation of skin, studied with X-ray photoelectron spectroscopy. Furthermore we have investigated the change in plasma treated skin samples to understand the basic effects of plasma treatment of biological systems.

2. Experimental

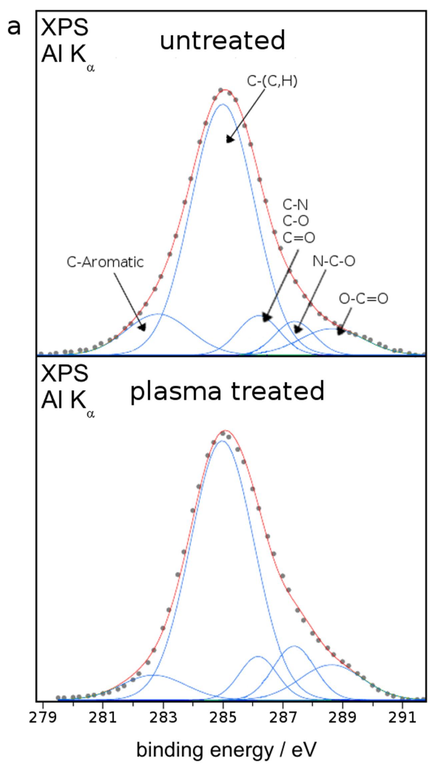
The skin lipid sample were prepared by stripping off skin lipids from the inside of the forearm . Therefor a stainless steel sample holder with a droplet of cyanoacrylate skin glue was pressed onto the arm. The sample holder was stripped off. Part of the skin barrier lipids were subjected to plasma treatment before transferring them into a vacuum chamber for XPS analysis.

Plasma treatment: 45 sec., distance adjusted to 1 mm
peak-to-peak voltage of 15 kV
voltage pulse duration of 70 µs
repetition rate of 300 Hz
plasma power was determined to be 150 mW

3. Basic investigation on untreated and plasma treated skin

The interpretation of XPS data for skin lipids is quite challenging due to the large number of components. In addition to cholesterol, the basic structure of the stratum corneum lipids consists of ceramides and free fatty acids. We correlated these three components with the binding states of the lipid probes under the prediction that we only detect these three components and compared our measurements to previous works [2,3,4,5]. Based on these procedure we were able to fix binding energies, distances between the Gaussian's curves and also full widths of half maximum (FWHM) for all following measurements which finally led to considerably reproducible results.

C(1s)

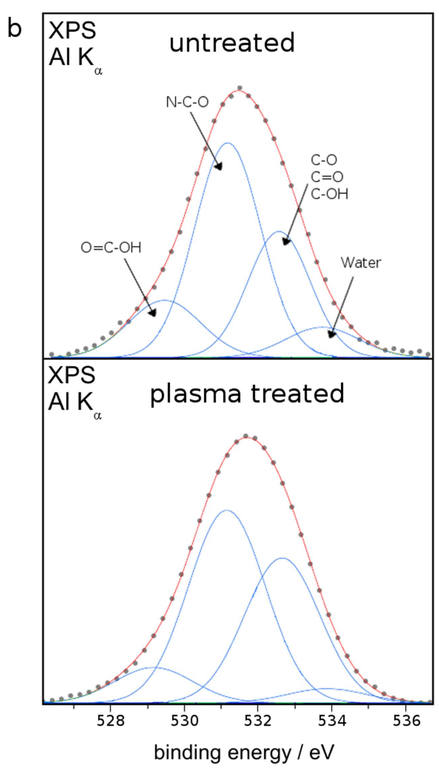


After plasma treatment the C-C bonds in the carbon spectra were reduced, whereas at the same time the C-O and C=O bonds increase.

The global stoichiometrical portion of the C-O and C=O in the oxygen O 1s spectra rose from 3% to 6%.

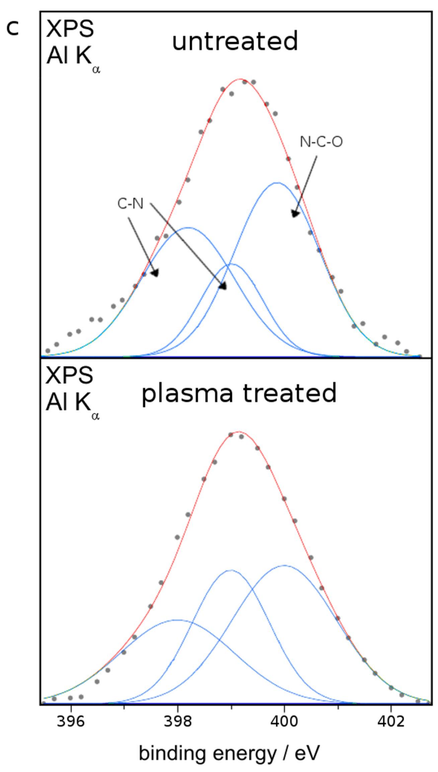
A possible explanation for this increase of the oxygen global stoichiometry is that carbon bonds broke related to the integration of oxygen radicals during the plasma treatment.

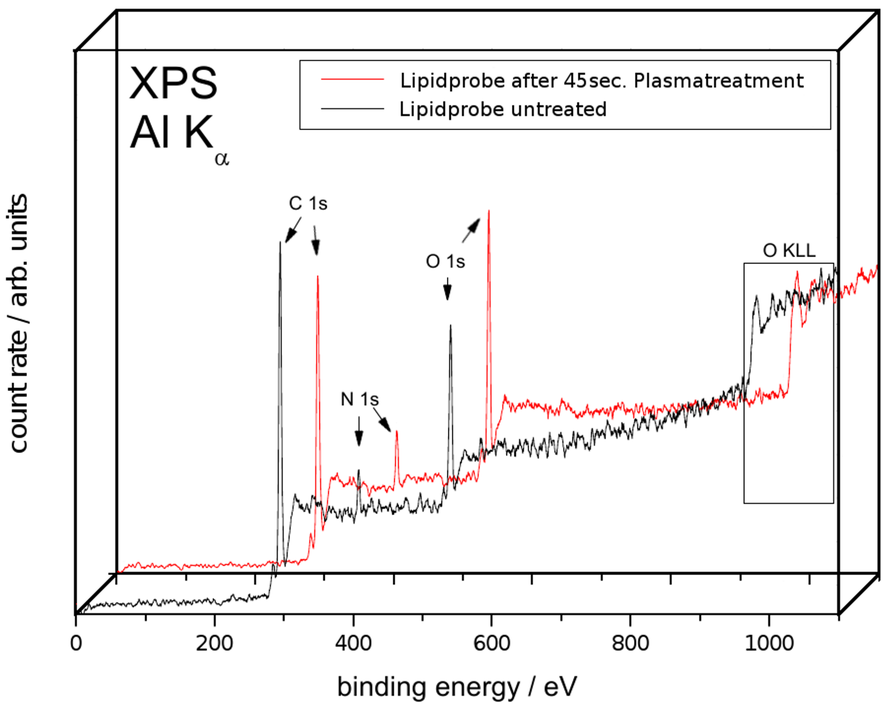
O(1s)



After plasma treatment we also found a small increase of the nitrogen N 1s structure in combination with an increase of the N-C-O portion in the carbon and in the nitrogen detail peaks. This may be explained by enrichment of nitrogen at the outer side of the lipid sample. An integration of nitrogen from outside due to plasma discharge can be excluded as referenced by L. Wegewitz et al. [7].

N(1s)





After cold plasma treatment under atmospheric conditions the XPS survey spectrum showed a strong increase in oxygen as well as a decrease in carbon in the samples investigated.

stoichiometry		
	Untreated	45s plasma treated on air
C(1s)	84.4 %	76.7 %
O(1s)	10.8 %	16.5 %
N(1s)	4.8 %	6.8 %

Generally, the stoichiometry of the untreated physiological skin barrier lipid composition that we observed was in good agreement with previously published results from Goddard et al. and Chen et al. [2,6].

4. Summary

- We identified for the first time a fundamental and reproducible influence of dielectric barrier discharge plasma treatment on the human skin lipid barrier system as can be especially derived from the clear structural changes in the oxygen detailed spectra.
- Our experimental setting and results pave the way for more detailed fundamental analyses of the effects of plasma treatment on the human skin lipid barrier deciphering effects on each of the three main lipid components.
- Especially plasma-induced distinct changes in the ceramide composition would be interesting to investigate as this composition is disturbed in ichthyosis and atopic eczema patients and may be reverted by plasma treatment.

5. References

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6. Acknowledgment

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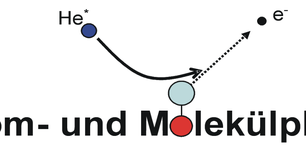

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