

STUDY OF ATMOSPHERIC PLASMA INTERACTION WITH SKIN TO ENHANCE PERMEABILITY

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(課程博士・様式7) (Doctoral qualification by coursework, Form 7)

学 位 論 文 要 旨

Abstract of Doctoral Thesis

専 攻 :

Course : Optoelectronics and Nanostructure Science

氏 名 :

Name : Kristof Jaroslav

論文題目 : 大気圧プラズマ作用による経皮吸収向上性の研究

Title of Thesis : STUDY OF ATMOSPHERIC PLASMA INTERACTION WITH SKIN TO
ENHANCE PERMEABILITY

論文要旨 :

Abstract :

The thesis is composed of an abstract, a list of figures, a list of tables and seven chapters. The first chapter is the “*Introduction*” which introduces plasma transdermal drug delivery and experiment which were realized in this thesis.

The second chapter is dedicated to skin structure and mainly to stratum corneum which is the main barrier for transdermal drug delivery methods. The structure of stratum corneum and also its main components such as corneocytes, ceramides, fatty acids, cholesterol, their function and structure are described in the subchapters. It is also possible to find information regarding their influence on the permeability of the skin and how it can be increased or decreased.

The third chapter describes the main methods of drug delivery such as oral drug delivery, injection drug delivery and transdermal drug delivery. Their advantages and also disadvantages are briefly mentioned. The following text characterizes the basic principle of the most well-known transdermal drug delivery methods. Drug delivery using plasma is mentioned at the end. Drugs and methods successfully used for penetration through the skin are specified.

As the plasma is medium with various active particles, ions, electrons and radiations, each aspect of the plasma and possible or observed effect on skin is characterized. Chapter four starts with a description of argon and helium ions that can cause “physical sputtering” of surfaces (skin in our case). As the skin treatment is usually realized in atmospheric air, it is necessary to consider the influence of air particles such as oxygen, nitrogen or hydrogen released from hydrocarbon skin surface. This demonstrates that chemical sputtering because of the presence of radicals created

in plasma can be present during skin treatment. Three subchapters describe the influence of the mentioned gases. The following subchapters characterize primary effects of plasma such as heat, UV radiation, acidifying of the skin and damage of skin by plasma. Secondary effect of lipid peroxidation receives also some dedicated space.

Chapter five entitled “*Experimental techniques and methods*” characterizes the techniques used in this thesis. The principles of XPS, FTIR, HPLC, PCA, contact angle measurement, pharmacokinetic modeling and basic information about analysis of data are mentioned.

Chapter six is the largest chapter of the thesis and includes measurements and results. It is composed of six subchapters: Plasma discharges, Interaction of plasma and skin surface, Plasma treatment of lipids, Plasma treatment of the skin, Permeability of plasma treated skin and Pharmacokinetics.

The section “*Interaction of plasma and skin surface*” interprets skin surface activation through water angle measurement using different gasses or distances from plasma source. X-ray photoelectron spectroscopy helped to determine the concentration of surface atoms and created bonds. Histological skin sections show roughness and change of thickness of the stratum corneum.

The section “*Plasma treatment of lipids*” characterizes changes of isolated lipids after plasma treatment by Fourier transform infrared spectroscopy and X-ray photoelectron spectroscopy.

The section “*Plasma treatment of the skin*” characterizes the skin surface mostly by FTIR, change of lipid fluidity or packing density of the lipids in the lipid matrix.

The section “*Permeability of plasma-treated skin*” is dedicated to the experiments which investigate the ability of the skin to be permeable for molecules such as H₂O and Cyclosporine A.

The section “*Pharmacokinetics*” analyzes the amount of drug (Cyclosporine A) in blood after successful permeation through the skin. There is determined treatment area and concentration of drug for successful medical application.

Chapter seven entitled “*Conclusion*” summarizes the results of all experiments mentioned in the thesis.

In the last section, a list of publications is displayed.