

# Cold Atmospheric Plasma for Skin Treatment (低温大気圧プラズマを用いた皮膚疾患治療への試み)

## 概要

近年、ほぼ室温で適用可能な低温大気圧プラズマが殺菌、細胞増殖、止血などの効果があることが知られてきており、生体への応用が期待されている。プラズマによって生成される活性種と生体間との相互作用が、さまざまな効果の原因と考えられている。本稿では、ドイツ Max-Planck-Institute for extraterrestrial physics を中心として行われている、低温大気圧プラズマを用いた、主に慢性創傷に対する臨床試験について紹介する。



Figure 1

Clinical device, MicroPlaSter, for wound treatment. This device contains a microwave plasma torch at the end of a flexible arm.

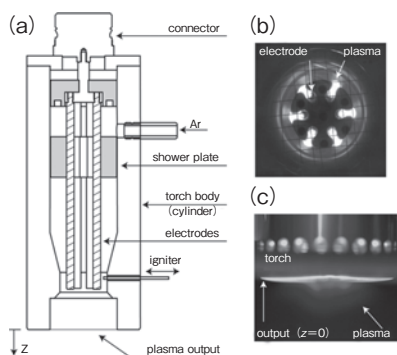


Figure 2

Plasma torch and plasma discharge. (a) sectioned view of the plasma torch, (b) plasma between the electrodes and the cylinder, (c) plasma below the plasma torch from the side.

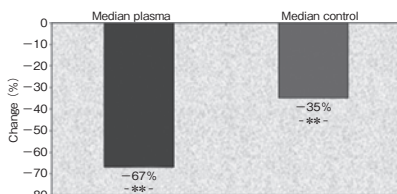


Figure 3

Changes in bacterial load in plasma-treated wounds compared to the controls (non-treated wounds).

## 1. Introduction

In the past few years the research topic of using cold atmospheric plasmas in medicine and hygiene has been investigated intensively. This is due to the fact that plasmas provide many species, e.g. reactive species, charged particles, UV photons, etc., which are relevant for diverse biomedical effects<sup>(1)</sup>. In 2005 a clinical study on patients was started in a joint effort between the Max-Planck Institute for Extraterrestrial Physics and the Department of Dermatology, Allergology and Environmental Medicine in Hospital Munich Schwabing. Here, we would like to show one of our studies using cold atmospheric plasma for the disinfection of chronic wounds<sup>(2)</sup>.

## 2. Plasma device

The plasma device used in this study-called MicroPlaSter-was developed and tested (fig. 1) in cooperation with the company Adtec Co. Ltd. This device contains a microwave plasma torch as shown in fig. 2<sup>(3)</sup>. The plasma discharge is generated in the plasma torch by applying microwave power of approximately 85 W with an argon gas flow of 2 slm. The torch is placed at the end of a flexible arm and can be moved to the desired area. Due to the arrangement of six electrodes (fig. 2b) large areas of approximately 5cm in diameter can be treated with the plasma torch below the threshold of thermal damage. The produced agents by the plasma are delivered from the plasma torch to the desired region following the argon gas flow.

## 3. Clinical study

Bacterial colonization of chronic wounds can impair healing. Furthermore the treatment of chronic wounds has become more challenging due to the rapid increase of resistance to antibiotics and allergic reactions. The objective of this study was to examine the safety and efficiency of the cold atmospheric argon plasma

device by decreasing the bacterial load as a new medical treatment.

Before starting a phase II study (clinical study on patients), a phase I study was carried out to show safety parameters and the optimum bactericidal dose for the relevant bacteria in wounds. Having this information the clinical study on patients was approved by the Bavarian State Association for Medical Issues.

More than 150 patients with chronic infected wounds were treated in a randomized phase II study. In addition to the standard wound care, the patients received a 5-min cold argon plasma treatment as an add-on therapy. The analysis of 291 treatments demonstrated, that there was a highly significant ( $\sim 34\%$ ,  $P < 10^{-6}$ ) higher reduction in bacterial count in plasma-treated wounds compared to the controls (non-treated) (fig. 3). No side-effects or allergic reactions were reported and the treatment was very well tolerated.

## 4. Summary

We showed that cold atmospheric argon plasma provides a safe and painless treatment option for chronic infected wounds regardless of the bacterial species and the resistance level. We believe that cold atmospheric plasma will play an important role in many areas of health care.

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## ● References

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