Skin Treatment: Sterilization and Drug Delivery by Microplasma

Ahmad Guji Yahaya, Aoshima Tomomichi, Fatima Mustafa, Jaroslav Kristof, Marius Blajan, and Kazuo Shimizu

Shizuoka University, Nakaku, Johoku, Hamamatsu, 432-8561, Japan

e-mail: goojy_93@yahoo.com, shimizu@cjr.shizuoka.ac.jp

Introduction

Skin infections are very common throughout the world and bacterial skin infections are the most common type of skin infections. In two separate experiments, we investigated on the sterilization effects of Argon gas microplasma on Staphylococcus epidermidis bacteria and Yucatan micropig's skin to improve transdermal drug delivery.

Methods

1. Experimental setup

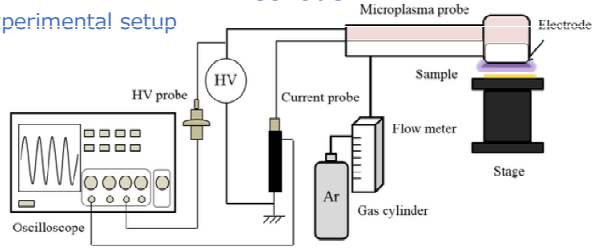

Fig. 1A Experimental setup for DBD microplasma.

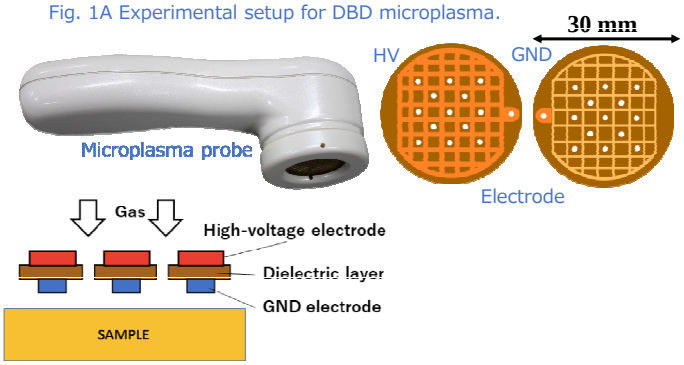

Fig. 2 Geometry of DBD microplasma electrode.

2. Experimental conditions

Tab.1 Experimental conditions for microplasma treatment of Yucatan micro-pigs Skin and *Staphylococcus Epidemis.*

Target	Skin	Bacteria
Discharge voltage	950 V peak to peak	950 V 0 to peak
Carrier gas	Argon	Argon
Treatment time	5 min	60, 90, 120 and 150s
Gas flow rate	5 L/min	5 L/min
SIN frequency	25 kHz	25 kHz
Distance between skin and electrode	0 mm	2 mm

Bacterial Sterilization

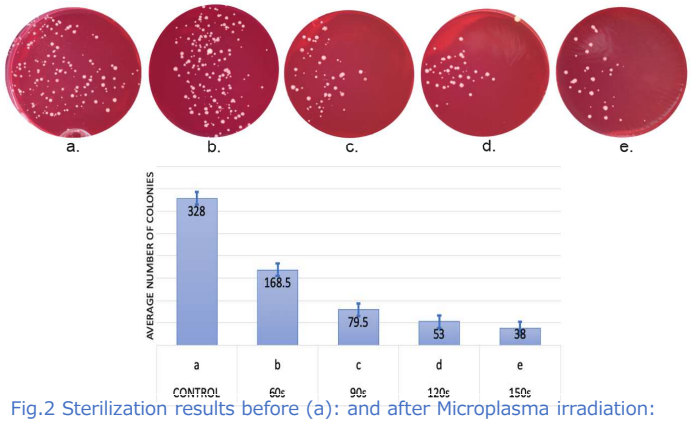

Fig.2 Sterilization results before (a): and after Microplasma irradiation: (b) 60s, (c) 90s, (d) 120s, (e) 150s

Temperature safety

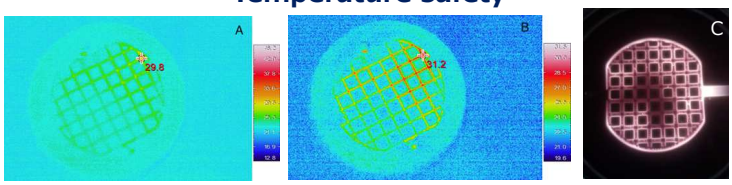

Fig. 3 (A and B) Temperature of electrodes at an Argon gas flow rate of 2.5 & 5.0 L/min after 5 minutes of treatment. (C) Image of Argon gas microplasma.

Skin permeability enhancement

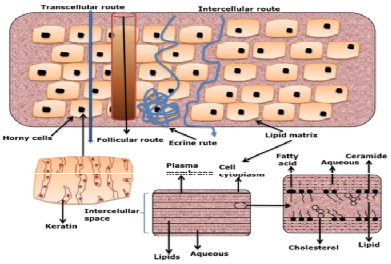

Fig. 4 Transdermal drug delivery route through a skin

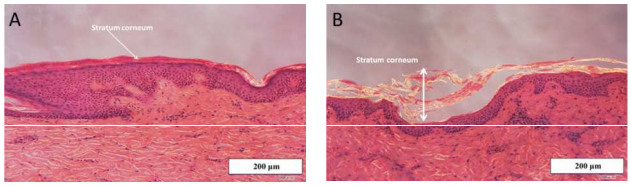

Fig. 5 Images of a skin (A) before and (B) microplasma treatment

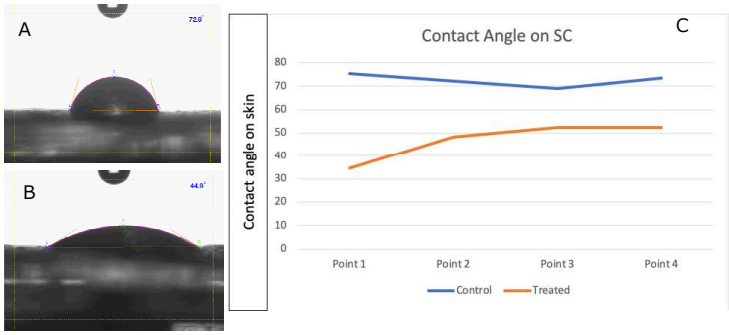

Fig. 6 Contact angle of water droplet on dried Yucatan micro-pig skin (A) before and (B) microplasma treatment.

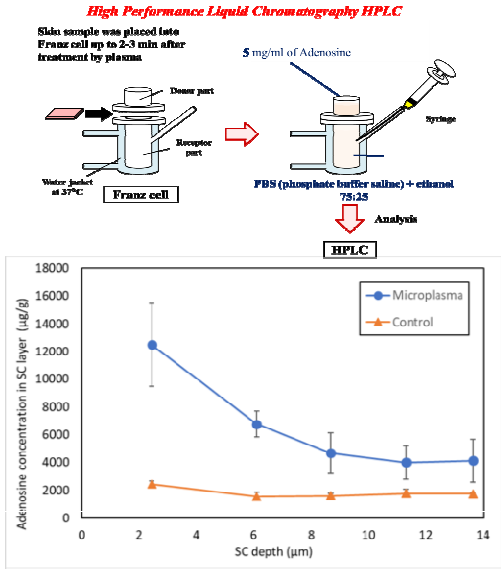

Fig. 7 Adenosine (267.2 Da) Drug concentration in the stratum corneum layer.

Conclusions

- Microplasma can sterilize bacteria on the surface of the skin as well as increase permeability of the skin.
- Applying of Ar gas microplasma increases the wettability of the skin.
- Ar gas microplasma skin treatment is safe with no heat damage.