Surface Modification of Medical Polymer Films by Remote Microplasma

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INTRODUCTION

This study introduces the surface treatment of polymer sheet developed for medical use by using microplasma. This sheet is fabricated for the medical use, and the adhesive force is important when is applied on wounds. Microplasma treatment was used in order to improve the adhesive force which is related to the hydrophilic property of the sheet.[1]

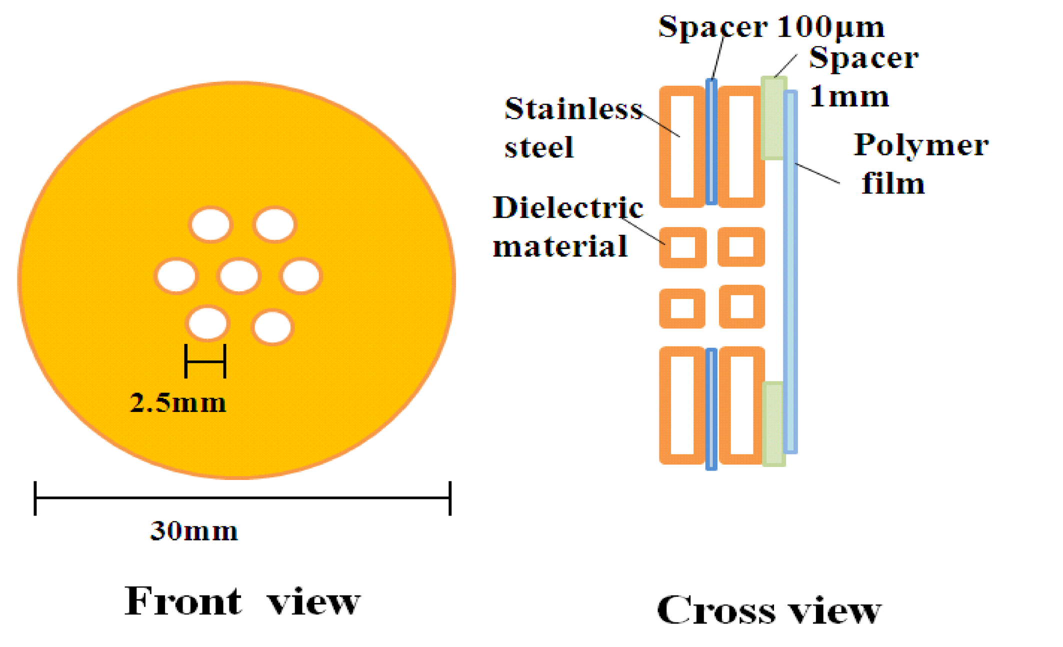

Fig. 1 Microplasma electrodes.

Perforated metal plates covered with dielectric layer were used as a electrodes.
A spacer with a hexagonal hole with 7mm side was inserted between electrodes in order to increase a gas flow and to secure the desired gap length(Fig. 1).

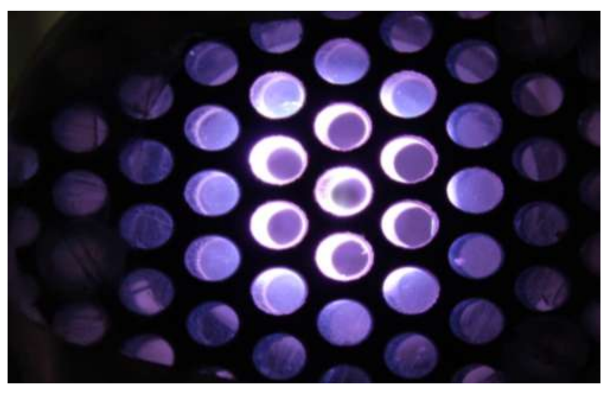

Fig. 2 The image of microplasma electrodes during discharge

(2) Experimental Setup

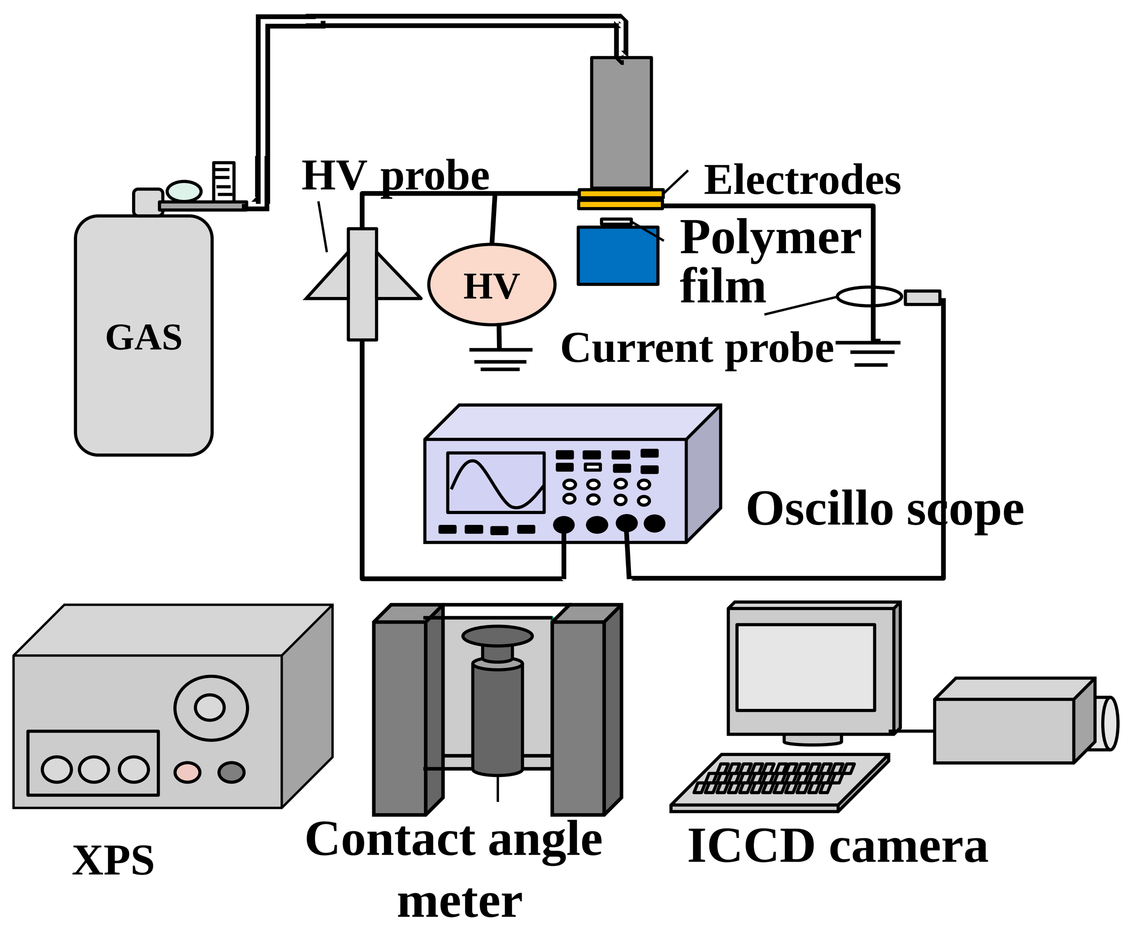

Fig. 3 An experimental setup for surface treatment of polymer sheet.

A neon transformer was used as an AC high voltage power supply. Treated polymer film surface modifications were estimated by using XPS, emission spectrometer and a contact angle meter(Fig. 3). These condition are shown in Table 1.

Table 1 An experimental condition

Gas flow late [L/min]	5
Process gas	Ar, N_2, Air
Distance of between electrodes and polymer sheet [mm]	1

RESULTS

(1) Emission Spectroscopy

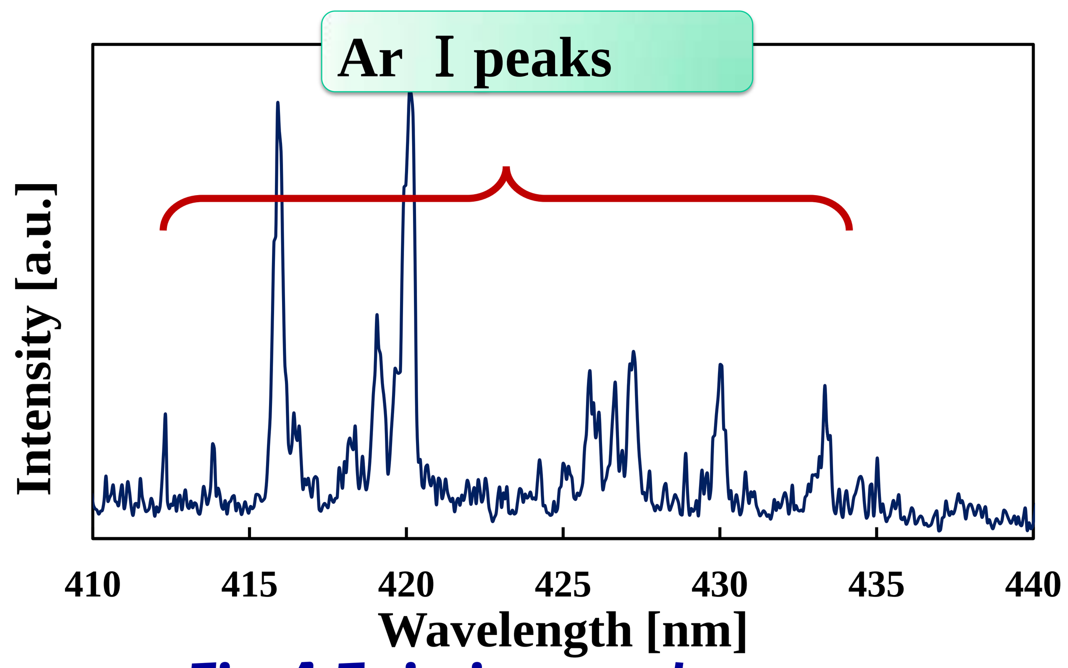

Fig. 4 Emission spectroscopy (Process gas: 1% N_2 in Ar).

Ar I peaks were observed by emission spectroscopy using an ICCD camera(Fig. 4). These active species cut surface bonds and contributed to make new surface bonds.

(2) Relation of Treatment Time and Contact Angle

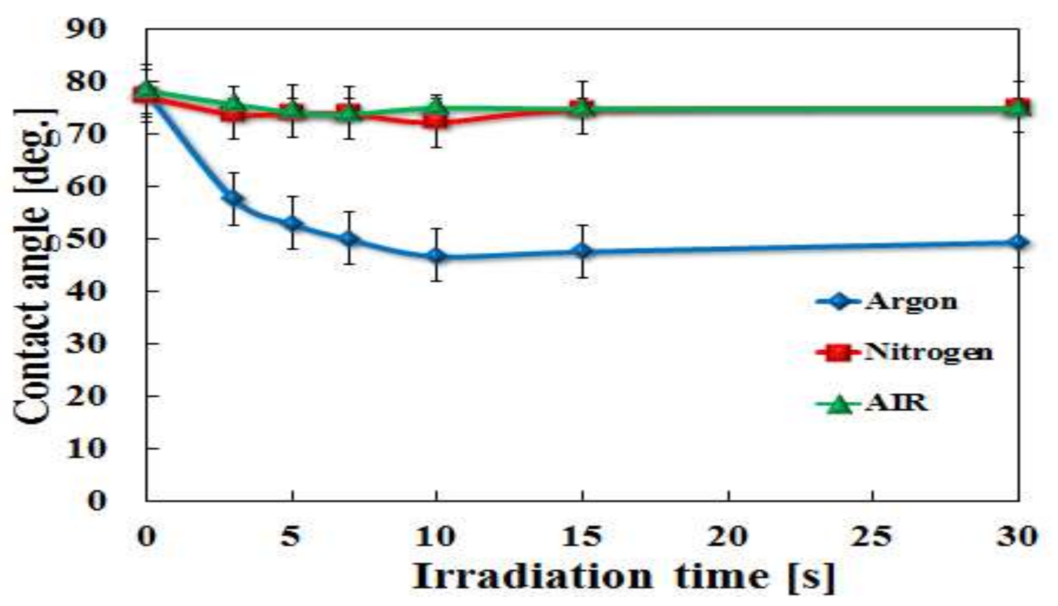

Fig. 5 Treatment time versus contact angle(Using gas is Ar, N_2, room air).

Contact angle was reduced to 30° in 10 seconds using Ar as shown in Fig. 5. Air and N_2 microplasma did not affect compared with using Ar.

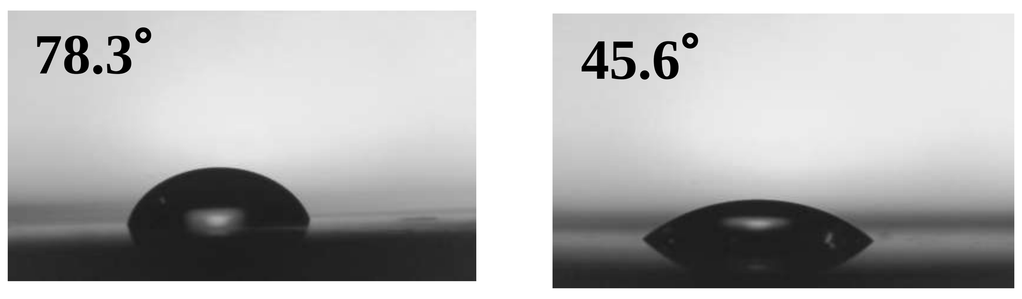

Fig. 6 Image of water droplet on the film.

The water droplet on the surface of treated polymer film changed to a more elongated shape without plasma treatment as shown in Fig. 6.

(3)Surface Analysis by XPS

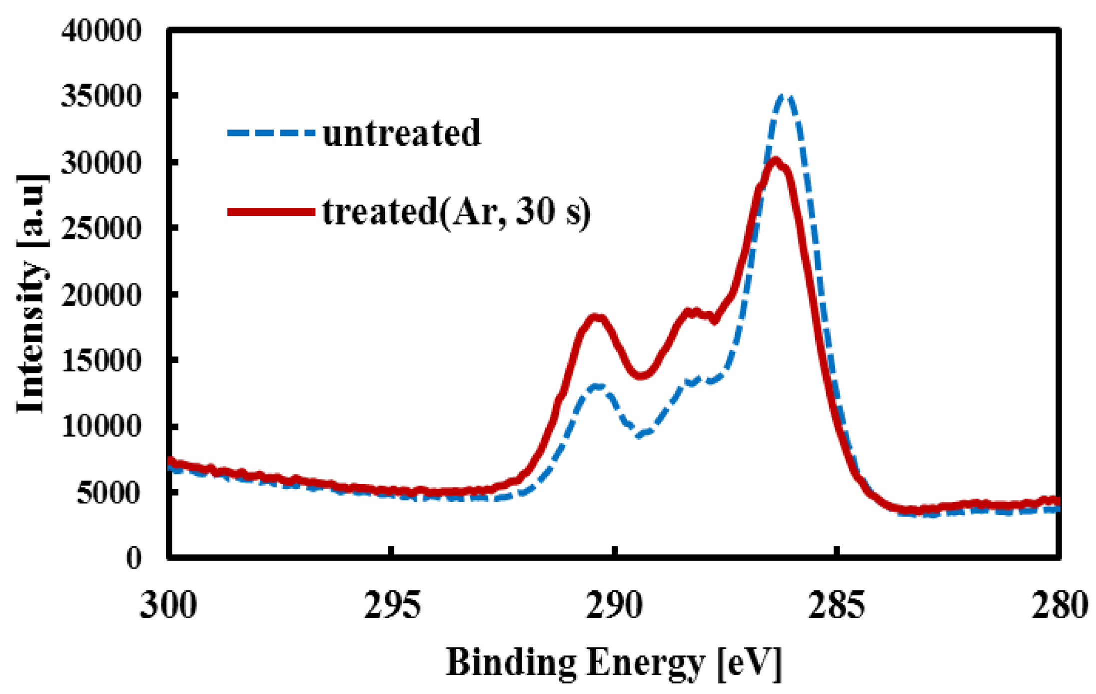

Fig. 7 The XPS spectra of the C1s component (Blue line: Untreated, Red line: Ar plasma treatment).

The C-C, C-H bond decreased and C-O, C=O bonds decreased compared with untreated polymer films (Fig. 7).

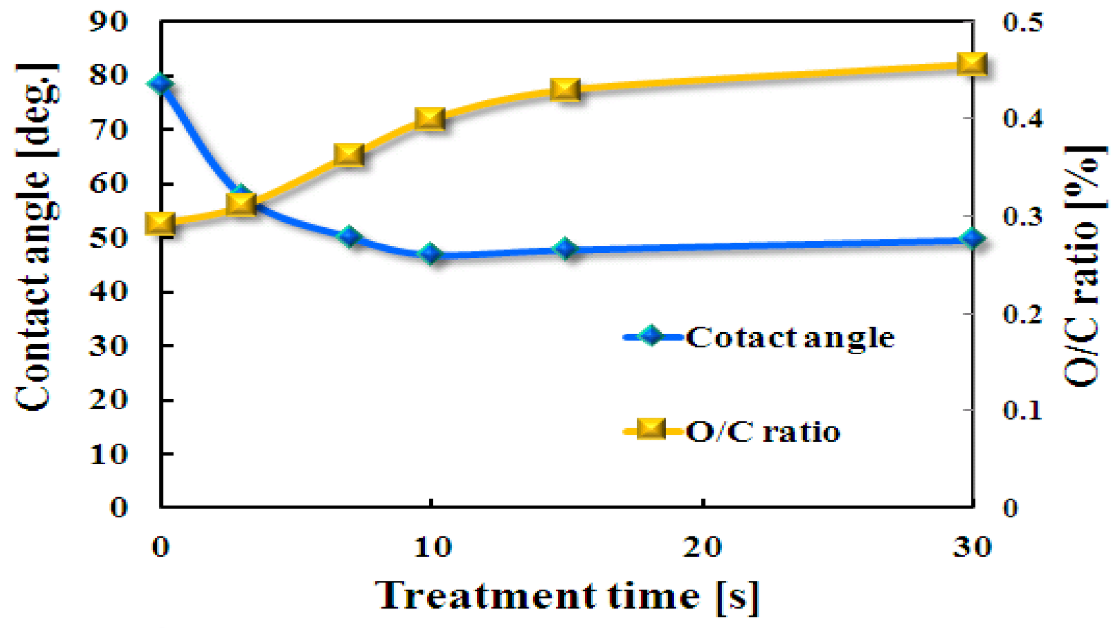

Fig. 8 O/C ratio of surface analysis by XPS.

Increase of C/O ratio corresponding the contact angle degreased was observed as shown in Fig. 8.

(4) The depth of treatment by microplasma

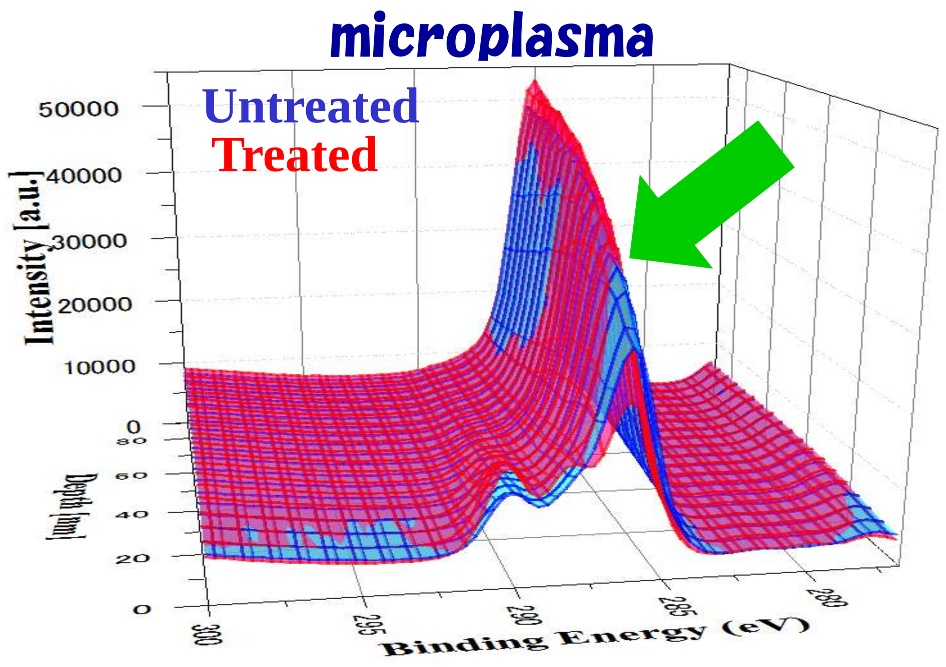

Fig. 9 The depth of modification using microplasma (Process gas: Ar, Treatment time: 15 s, Applied voltage: 0.9 kV).

The depth of surface treatment was measured by XPS. The arrow on the Fig. 9 shows the point which untreated C-C bonds and treated C-C bonds intersect. According to this result, surface treatment have ended in this point and its depth was about 20 nm.

(5)The damage of polymer films After microplasma treatment

The Fig. 10 shows the damege image of polymer surface taken by SEM.
Surface of treated polymer become harsher compared with untreated polymer surface.

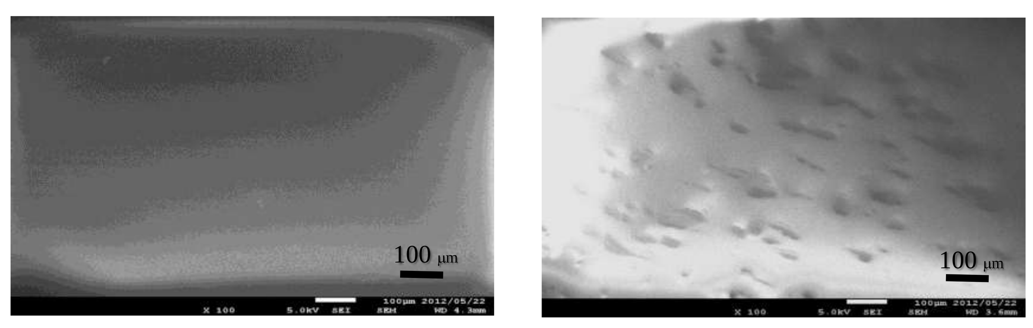

Fig. 10 The SEM Image on the polymer film. (The left photo: untreated, The right photo: Ar plasma treatment) Treatment time: 7 s Applied voltage: 0.9 kV.

CONCLUSIONS

1. The minimum contact angle decreased to about 45° after Ar plasma treatment.
2. Hydrophilic group increased and the hydrophobic group decreased after microplasma treatment.
3. The depth of treatment was about 20 nm measured by XPS analysis.

Reference

[1] K. Shimizu, A. Umeda , M. Blajan, Jpn. J. Appl. Phys.50, 08KA03, 2011.