Basic Study of Surface Modification for Film Dye Sensitized Solar Cells using Microplasma

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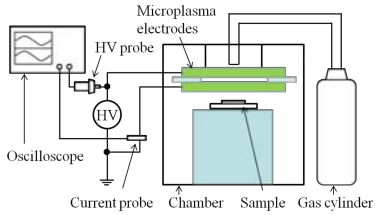
1. Introduction

The film dye sensitized solar cells (Film DSSCs) are well known as cost-effective technology and high designability devises. Although many advances have been made in film DSSCs fabrication of late years, their conversion efficiency remains still lower than the glass substrate DSSCs. This poster introduces improvement of conversion efficiency of film DSSCs using atmospheric pressure microplasma as a low damage process.

2. Experimental setup and Target

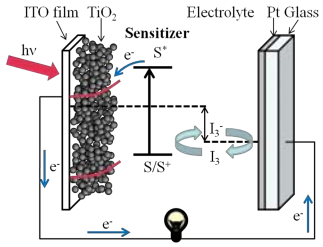


The experimental set up for surface modification

The advantages of Microplasma process

- Remote and damage less process
- No need for vacuum chamber

Process gas : Oxygen and Argon
Irradiation distance: 1.0 mm
Gas flow rate : 5.0 L/min.
Chamber volume : 1.0 L
Treatment time : 15 min
Applied voltage (O_2) : 1.6 kV
Applied voltage (Ar) : 0.6 kV
Power consumption (O_2) : 3.8 W
Power consumption (Ar) : 2.6 W



The construction of film dye sensitized solar cells

Target: Binder free Titanium oxide
Calcining temperature : 120 ˚C
Calcining time : 15 min
Dye : N719 dye
Immersion time : 22 h

Advantages

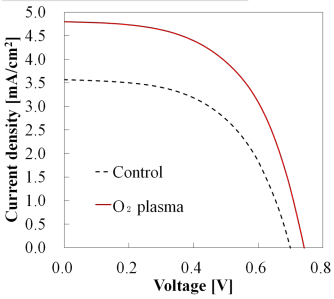
- **Low cost material**
- **Simplified manufacturing**
- **High designability**

Disadvantage

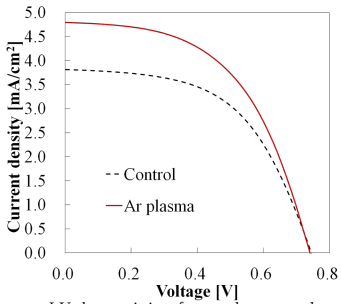
- **Low conversion efficiency**

3. Result and discussion

I-V characteristics



I-V characteristics of oxygen plasma sample

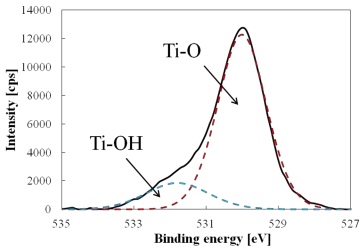


I-V characteristics of argon plasma sample

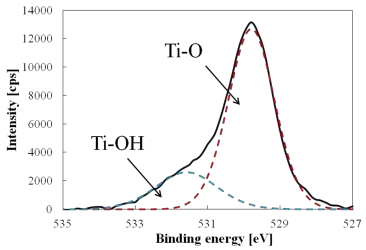
Control
Current density : 3.56 mA/cm²
Conversion efficiency : 1.37%
Oxygen microplasma
Current density : 4.80 mA/cm²
Conversion efficiency : 1.99%

Control
Current density : 3.81 mA/cm²
Conversion efficiency : 1.53%
Argon microplasma
Current density : 4.79 mA/cm²
Conversion efficiency : 1.87%

XPS analysis



O1s peaks of control sample



O1s peaks of oxygen microplasma sample

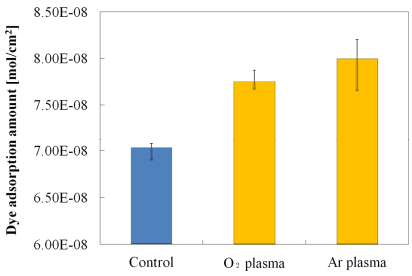
Atomic concentration of Titanium oxide surface

	Ti-OH	Ti-O
Control	16.4	83.6
O_2 plasma	21.3	78.7
Ar plasma	24.4	75.6

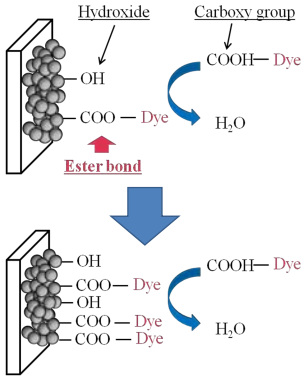
Ti-OH peak was increased after both microplasma treatment processes.

Introduction of hydrophilic groups on Titanium oxide surface was confirmed.

Dye adsorption amount

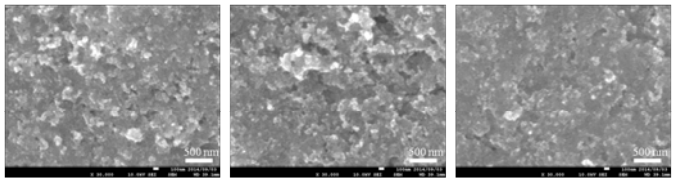


Dye adsorption amount of Titanium oxide surface



Dye adsorption amount was increased after both microplasma treatment. Dye adsorption consist of the ester bonds between hydroxide on Titanium surface and carboxyl group. After both plasma treatments, hydroxide was increased on Titanium oxide surface. Titanium oxide surface tend to make ester bonds. This change contributed to the increase of dye adsorption amount and current density.

SEM analysis



Control Ar plasma O_2 plasma

FE-SEM images of Titanium oxide surface

Magnification : 30000x
Treatment time : 15 min.

Significant changes between control sample and plasma treated sample were not obtained.

4.Conclusions

1. Conversion efficiency of plasma treated sample was increased with about 20 - 40% compare with control sample.
2. According to XPS analysis, OH bond was increased after both plasma treatments. The improvement of hydrophilicity on titanium oxide surface contributed to the increase of dye adsorption amount.
3. Significant changes on titanium oxide surface were not observed using SEM.