Surface Modification due to Solution Plasma

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Abstract

We succeeded in the generation of two types of solution plasmas: one was generated in the ultrasonic bubbles by feeding DC power or commercial AC 60Hz power for the etching of silicon substrate. The other plasma was generated by low frequency power for the film deposition inside tubes. Now we are optimizing the plasma generation condition for each application.

Keyword: solution plasma, etching, deposition, amorphous carbon film

Introduction

Solution plasma indicates plasma in liquid phase. This solution plasma is not widely utilized, in a comparison with regular plasmas in gas phase. Although nowadays it was utilized as water clarification, fabrication of nanoparticles, sterilization, and so on, we consider such applications were not sufficient. This is because we believe the possibilities of solution plasma were not fully utilized.

Then we expect one of the promising challenges is for material surface treatments, like plasma etching and plasma deposition using regular gas-phase plasma. Solution plasma has some advantages of the material processing: the experimental setup is very cheap. Furthermore, the solution plasma can be generated in a very small area. Then, it can be used for film coating and etching on a small area, with low cost. Especially it is suitable to the film coating on the inside area of fine tubes. The cheap tubes can be changed to high-value tubes, by coating the functional films inside the tubes. Moreover, the plasma can be generated in various solvents. Then, the film coating and etching techniques without hazardous acid or alkali solutions and hazardous or greenhouse gases will be developed: solution plasmas can help the establishments of the next-generation processes: they are required to be easy on the earth.

Experiments and Results

For silicon-surface etching, solution plasma was generated by applying DC power or commercial AC power to the electrodes with special configurations during the bubbles in pure water. The bubbles were generated with an ultrasonic homogenizer (produced by Kaijo); the ultrasonic homogenizer has a stainless steel horn of 30 mm in diameter. Its power can be changed to 600W; its frequency is 20 kHz. We confirmed silicon etching with microscope and profilemeter.

For coating the functional films inside the fine tubes, the solution plasma was generated in the inside tube with applying 10 kHz power, but without ultrasonic bubble. We can deposit the carbon film in side the tube. The film was analyzed with FT-IR.

We will show the detailed present study in this presentation.

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