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# Effects of the Oxygen Plasma Treatments on the Surface Morphology of the Ultra-high Molecular Weight Polyethylene Fiber

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## INTRODUCTION

The plasma treatment on the fiber surface makes various changes in chemical and physical states of it. This plasma surface modification has been used to improve the surface activities and enhance the interfacial adhesion of the composites. Many studies has been focused on that the chemical changes of the plasma treated fiber surface which can affect the interfacial adhesion of the composite mainly, while the physical changes were not considered as an important factor of it. However the physical bonding, mostly mechanical interlocking, may play an important role in the interfacial adhesion of UHMWPE(ultra-high molecular weight polyethylene) fiber composites. In this study, the morphological changes in the UHMWPE fiber surface with the plsama treatment were observed and characterized which can control the mechanical interlocking of the composite interface.

## RESULTS AND DISCUSSIONS

The surface of UHMWPE fiber was modified with the oxygen gas plasma treatment. The changes in the surface morphology of the fiber were observed with scanning electron microscope(SEM) and atomic force microscope(AFM). To obtain the quantitative information for morphological change, the pore area of the fiber was measured with the mercury porosimeter as the plasma treatment condition varied in power and time. By the oxygen plasma treatment, a number of pit-shaped pores were produced on the fiber surface perpendicular to the fiber axis direction, and they were changed with the plasma treatment level. In AFM images, the surface morphology was altered from a somewhat smooth feature to the more rough and

complex one as the condition of plasma treatment.

The root mean square heights, extracted from AFM images, of the plasma treated fiber show the tendency of increase with the plasma treatment level and the saturation of the tendency at the strong treatment level of 150W. From the results of the mercury porosimetry, the changes of the pore generation by the plasma treatment took placed in below the pore-diameter of 1μm. Especially micro-pores below the pore diameter of 300Å were affected mainly by the plasma treatment. However the higher level of the plasma treatment of 150W also cause the larger scale pores over the pore diameter of 300Å to 0.8μm on the fiber surface which was attributed to the annexation between the micro-pores by the severe etching effect. As a consequence, total pore area of the fiber was increased with the relatively low treatment level and decreased with the higher level of treatment power of 150W after showing a maximum value.

Because a number of micro-pores give the more effect on enlarging the pore surface area than the some large scale pores do, the treatment condition should be adjusted to generate the micro-pores in the range of 20Å-300Å mainly. The results of porosimetrical experiments indicate that the plasma treatment should be controlled in the proper level for generating the micro-pores and enlarging the pore surface area of the fiber effectively. The plasma treatment condition of 100W for 5minutes is the optimal condition for the largest pore area which can offer the high value of the interfacial shear strength in relation to the mechanical interlocking. The results of single fiber pull-out test show the some relation between the pore surface area and the interfacial shear strength. But the most severe treatment condition of 150W for 10minutes makes a rapid decrease of the interfacial strength with the ease of the fracture at the fiber surface. It can be attributed to the considerable peeled-off of the outer surface which was degraded by the severe plasma treatment.

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