Fabrication of the Carbon Paper by Wet-Laying of Ozone-Treated Carbon Fibers with Hydrophilic Functional Groups

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Fuel cells are electrochemical conversion devices that convert chemical energy to electrical energy without pollutant emissions [1]. The gas diffusion media in fuel cells play important roles in H_2 and O_2 transport, catalyst support and providing electrically conductive pathways. In general, carbon papers (CPs), which are composed of carbon fibers (CFs), have been used as gas diffusion media because of their high electrical conductivity and gas permeability [2-3]. To improve the gas permeability and electrical conductivity of CPs, CFs should be well separated with pores and connected to each other by conductive materials. Otherwise, the gas permeability and electrical conductivity will be low because of the pore blockage and the disconnection of the conductive pathway. Among the various methods available for preparing nonwoven webs, the wet-laid process in water provides individual separation of CFs in a carbon web. The low dispersion of CFs in water, however, should be addressed to facilitate the preparation of carbon webs by the wet-laid process [4].

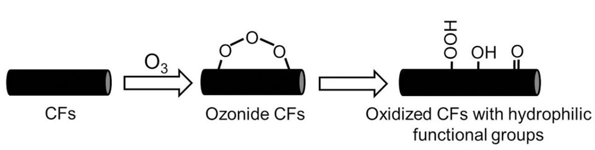

Figure 1. Ozonolysis reaction of CFs

Ozonolysis involves the cleavage reaction of unsaturated hydrocarbons with ozone to generate oxidized functional groups such as alcohol, carbonyl and carboxylic acid (**Figure 1**) [5]. The ozonolysis reaction of carbon materials with graphitic surfaces has been widely used to modify their properties. Regarding the oxidation of CFs, an atmospheric plasma treatment and ozone treatment was used to modify the surface properties of CFs to increase the wettability to hydrophilic molecules [5]. Such hydrophilic modifications prompted us to study the oxidation of CFs by the ozone treatment for the dispersion of CFs in water, which is important for developing CPs by the wet-laid process. Herein, we report the surface modification of CFs by the ozone treatment and the preparation of the CP by the wet-laid process **(Figure 2)**. Such CP showed a high gas permeability and electric conductivity for fuel cell applications.

The surface of the ozone-treated CFs contains hydrophilic functional groups such as C-O, C=O and O-C=O, which have been characterized by X-ray photoelectron spectroscopy. The negative charge of CFs determined by zeta potential was significantly increased after the ozone treatment, and the value was linearly decreased upon increasing ozone-treated time. Since ozone-treated CFs were better dispersed in aqueous solution than bare CFs, the CP prepared by a wet-laying process of ozone-treated CFs have higher porosity and gas permeability than that from bare CFs. In detail, the in-plane and through-plane gas permeability of the CP from ozone-treated CFs are superior to those of CPs from bare CFs and commercial products. I-V curve performance of the single cell revealed that the CP from ozone-treated CFs has higher power density than that from bare CFs. Therefore, we believe that the CP prepared from ozone-treated CFs to serve as the gas diffusion media will contribute to improving the performance of fuel cells.

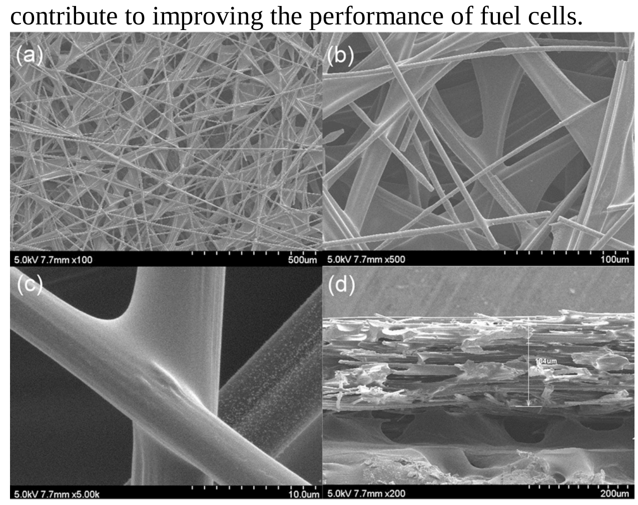

Figure 2. SEM images of the CP prepared from ozone-treated CFs for 30 min. (a) and (b) top views, (c) tight-knit CFs produced by pyrolysis of phenolic resin and (d) side view showing the thickness of the CP.

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