ST-P014

Water Repellency on a Nanostructured Superhydrophobic Carbon Fibers Network

Tae-Jun Ko[1,2], Eun Kyu Her[1,2], Bongsu Shin[2,3], Ho-Young Kim[3], Kwang-Ryeol Lee[2], Bo Ki Hong[4], Sae Hoon Kim[4], Kyu Hwan Oh[1], Myoung-Woon Moon[2]*

[1]Department of Materials Science and Engineering, Seoul National University, [2]Institute for Multi-disciplinary Convergence of Materials, Korea Institute of Science and Technology, [3]School of Mechanical and Aerospace Engineering, Seoul National University, [4]Eco-Technology Center, Hyundai-Kia Motors

For decades, carbon fiber has expanded their application fields from reinforced composites to energy storage and transfer technologies such as electrodes for super-capacitors and lithium ion batteries and gas diffusion layers for proton exchange membrane fuel cell. Especially in fuel cell, water repellency of gas diffusion layer has become very important property for preventing flooding which is induced by condensed water could damage the fuel cell performance. In this work, we fabricated superhydrophobic network of carbon fiber with high aspect ratio hair-like nanostructure by preferential oxygen plasma etching. Superhydrophobic carbon fiber surfaces were achieved by hydrophobic material coating with a siloxane-based hydrocarbon film, which increased the water contact angle from 147^{o} to 163^{o} and decreased the contact angle hysteresis from 71^{o} to below 5^{o}, sufficient to cause droplet roll-off from the surface in millimeter scale water droplet deposition test. Also, we have explored that the condensation behavior (nucleation and growth) of water droplet on the superhydrophobic carbon fiber were significantly retarded due to the high-aspect-ratio nanostructures under super-saturated vapor conditions. It is implied that superhydrophobic carbon fiber can provide a passage for vapor or gas flow in wet environments such as a gas diffusion layer requiring the effective water removal in the operation of proton exchange membrane fuel cell. Moreover, such nanostructuring of carbon-based materials can be extended to carbon fiber, carbon black or carbon films for applications as a cathode in lithium batteries or carbon fiber composites.

Keywords: Carbon fiber, Plasma treatment, nanostructure, superhydrophobicity