Abstract #2305, 224th ECS Meeting, © 2013 The Electrochemical Society

Electrophoretic Deposition of Polymerically Stabilized Silica Nanoparticles for Anti-wetting Fabrics

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There is a strong demand for anti-wetting fabrics modified by nanoparticles due to the useful functionality that can be achieved. [1-5] However, it is very challenging to maintain intrinsic fabric characteristics such as flexibility, color, and breathability after the modification. To achieve these demands, various coating methods have been investigated. Spraying, bar-coating, and dip-coating processes have been considered as simple methods, but are plagued by weak and uneven coatings. [4-6] In addition, electrostatic self-assembly techniques have shown uniform and durable anti-wetting fabrics. [7-9] However, these methods are considered to be ineffective for mass-production due to their long process time.

In this work, a technique employing electrophoretic deposition (EPD) was used for fast modification of polyester fabrics using nanoparticles. Previously we've shown the fabrication of superhydrophobic surfaces by EPD using poly-dimethylsiloxane (PDMS) modified SiO_2 nanoparticles on steel plates. [10] To date, EPD has been generally utilized on electrically conductive substrates due to the necessity of an electric field perpendicular to the deposition substrate. EPD has been attempted on non-conductive substrates such as ionically conductive polymers, but weak adhesion, cracks, and irregularity have limited these systems. [11-13]

Polyester fabric modified with out process shows high static contact angles and low contact angle hysteresis, as shown in Figure 1, while maintaining its original color, breathability, and flexibility. Increasing EPD time enhances the static contact angle and reduces the roll-off angle. The maximum contact and minimum roll-off angle of 160° and 2°, respectively, were achieved within 90 seconds.

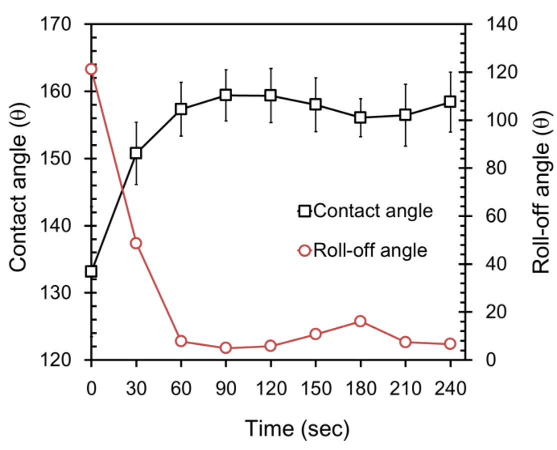

Figure 1. Contact angles and roll-off angles of water droplets on polyester fabrics coated with poly-dimethylsiloxane modified SiO_2 nanoparticles as a function of electrophoretic deposition time. Water droplets show high contact angles and low contact angle hysteresis on the fabrics produced by electrophoretic deposition after only 90 sec.

SEM images show SiO_2 nanoparticles uniformly deposited on the polyester fibers coated by EPD after a deposition time of 90 seconds (Figure 2). Comparable nanoparticle layers have been observed on fabric modified by electrostatic self-assembly techniques only after multiple immersion processes requiring several hours. [7-9] This result reveals that our EPD process can produce desirable nanoparticle coatings on fabric after minimal processing time.

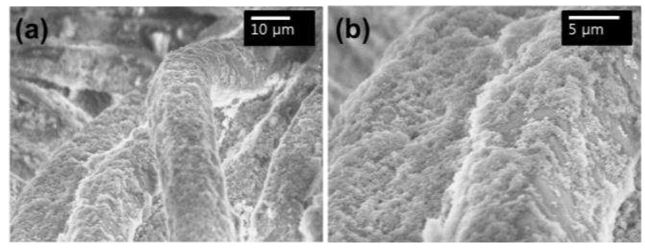

Figure 2. SEM images of fabrics modified by electrophoretic deposition (EPD) with the deposition time of 90 seconds. The original polyester fabric has twill weave patterns, and the fabric fibers are uniformly coated with SiO_2 nanoparticles after EPD.

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