Plasma-Generated Nanostructured Paper for Control of Fluid Interactions

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Coating and surface modification techniques are commonly used in the paper industry to control surface properties and wetting. Most recently, there has been extensive interest in fluid resistant coatings. Water absorption greatly reduces paper strength, a critical property in applications like packaging and sensors. To address such issues, superhydrophobic paper surfaces have been created that not only prevent water penetration, but also resist contamination from bacteria. Further progress in the control of fluid –solid interface interactions has been directed towards the repellency of oils and other low surface tension fluids in an attempt to generate superomniphobic surfaces. The advantageous capabilities of plasma enhanced etching and CVD show great promise for the development of these fluid resistant paper products. Previously, we have demonstrated that etching paper in an oxygen plasma creates nanostructured cellulose by selectively etching the amorphous phase. These nanostructured fibers establish the necessary surface structure for high water repellency due to roughness on both micro- and nanoscales. Subsequent coating of the nano-roughened paper fibers with a low-surface energy thin film, establishes surfaces that are highly resistant to fluids. Through the use of various PECVD precursor gases, different surface chemistries have been obtained that enable us to manipulate fluid interactions.