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Creation of superhydrophobic wood surfaces by plasma etching and thin-film deposition

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ABSTRACT: Superhydrophobic wood has been created using a combination of O_2 plasma etching and plasma deposition of thin films to achieve the necessary combination of surface roughness and chemistry. Inherently hydrophobic fluorocarbon films (from pentafluoroethane (PFE) precursor) and hydrophilic diamond-like carbon (DLC) coatings (from acetylene precursor) were both used to create highly water repellent substrates. The effect of O_2 plasma etching on surface roughness was investigated using Scanning Electron Microscopy (SEM) and Laser Scanning Confocal Microscope (LSCM) profilometry. The wetting behavior of the resulting wood was determined by static water contact angle and droplet sliding angle measurements. Wood samples subjected to O_2 plasma etching prior to fluorocarbon deposition exhibited "roll-off" superhydrophobicity with low sliding angles; the sample in this study with the most extreme wetting properties has the highest water contact angle and lowest sliding angle reported to date for modified wood substrates (WCA 161.2°±1.5° and sliding angle ~ 15°), without affecting visual appearance of the wood. Due to our ability to control roughness, etched samples that were coated with hydrophilic DLC films displayed superhydrophobic behavior (WCA), although the surface was "sticky" in that water droplets did not slide or dislodge from vertically-held substrates.

Keywords: Wood; Water repellency; Plasma etching; Plasma deposition; Fluorocarbon film; Diamond-like carbon (DLC) film; Superhydrophobic surface