Water-Repelling Coating Qualification Using Portable Contact Angle Meter

Let us consider the ubiquity of water-repelling products that we utilize every day. Everything from clothing and upholstery, to plastic and glasses could all have water-repelling (or hydrophobic) properties. The reasons for why they need water-repelling properties can vary, but each reason is important for their specific application. Clothing and upholstery can be made water repelling to resist discoloration due to food, mud, or sweat stains. Plastics can be made water repelling to decrease friction and drag when moving through water (e. g. hull of a boat). Glasses can be made water repelling to give it a streak free appearance after getting wet. Having a streak free car windshield window for example is extremely important in terms of driving safely in bad weathers. When light rain becomes a heavy downpour, visibility through car windows decreases due to streaks of water pooling together and obstructing the driver's line of sight. Applying a hydrophobic coating to the windows can reduce, or even eliminate, streaks because the increased hydrophobicity discourages water from sticking to the window surface. This in turn increases the visibility and clarity through the windows and makes it easier for the driver to operate the vehicle safely through inclement weathers.

The best qualification technique for a water repelling product is the water contact angle measurement, normally carried out on a contact angle meter or a goniometer stationed in a lab environment. To qualify a coating or a product in the field or on a production floor, the handheld, portable contact angle meter will have its advantages over the lab benchtop models. Typically, a portable contact angle meter can perform functions similar to benchtop contact angle meters but with the benefit of being in an extremely portable package. The portable contact angle meter is fully automatic and can take quick measurements on parts still on the production line. The other advantage of the portable contact angle meter is that it can not only be used to test traditional coupon specimens, it can also be used to take measurements on specimens that are either too large to fit within a typical contact angle meter or too impractical to ship offsite to a separate testing location. Besides, the portable contact angle meter has built-in software and hardware to work with flat, rounded, or any other shapes of specimens. The flexibility and ease of use makes the portable contact angle meter a good choice for water repelling coating testing and qualification anywhere that it is needed.

For this application demonstration, Ebatco's Nano Analytical and Testing (NAT) Lab measured the contact angles of water on a glass substrate before and after being coated with a hydrophobic coating. In Figure 1, the image on the left is a water droplet on the original glass surface and the image on the right is a water droplet on the coated glass surface. It can be seen that without the applied coating, the droplet spreads out and occupies a larger area on the substrate than the droplet on the coated surface does. This larger contact area between the droplet and the surface indicates the droplet is wetting the surface very well and results in a lower contact angle, an angle between the liquid/air and solid/liquid interfaces. Matters with water contact angles larger than 90˚ are considered hydrophobic, and matters with water contact angles less than 90˚ are

considered hydrophilic. Using this definition, the uncoated glass has a water contact angle of 33.8˚ and is considered hydrophilic. This hydrophilic quality of uncoated glass will tend to have water stick to it and could create potential hazard when the uncoated glass is being used for car windows.

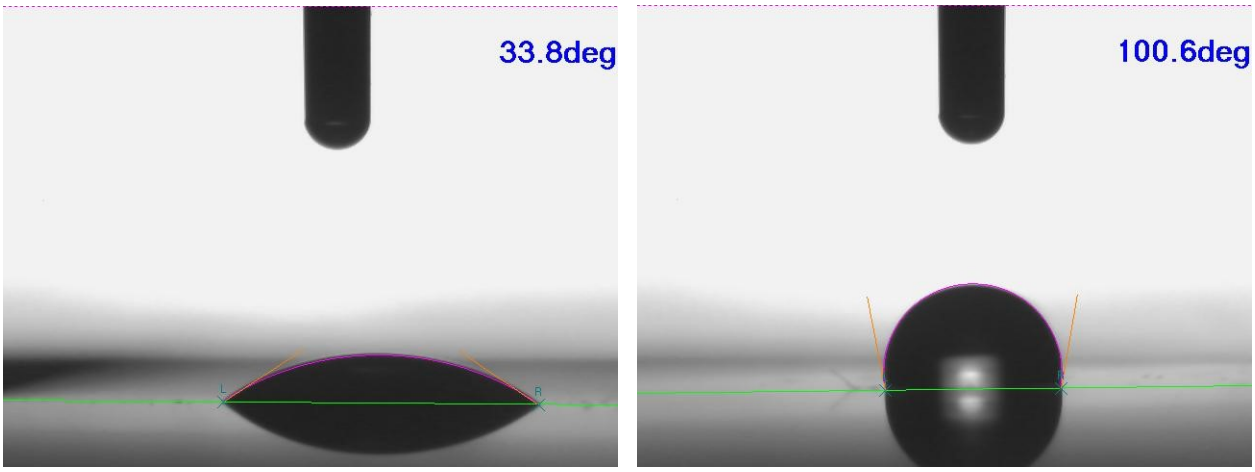

Figure 1. Contact angle measurements of a water droplet on an uncoated glass surface (left) and water-repelling coating treated glass surface (right). The green line represents the base line, or the solid/liquid interface, and the red lines are the imaging software's contact angle drop-shape-curve-fitting lines. The bottom portions of the pictures are the mirrored images of the water droplets due to glass surface reflection. The measured contact angle is displayed in the upper right area of the images.

The water-repelling coating on the glass surface produces a much higher contact angle than that of the uncoated glass. The measured water contact angle on the coated glass is 100.6°, which indicates the coated glass surface has become hydrophobic. This increase in hydrophobicity weakens the adhesion between the water and coated glass surface; which forces the water to bead up and drain away fast instead of pooling. This beading up effect decreases water streaking on the windows when the car with the coated windows is being driven through rains, and allows the driver to see more clearly.

A water-repelling coating like this should last quite a while when applied on a windshield, but road driving conditions like heavy construction dusts or ice buildup scraping could affect coating integrity with time. The portable contact angle meter would become handy and useful to allow for quick and easy contact angle measurements on a variety of surfaces to ensure the quality and efficacy of the coated surfaces.