



Degradation Diagnosis of Polymer Materials with Using the Hydrophobicity Measurements

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● Research Outline

Hydrophobicity Measurement

Hydrophobicity of polymer surface is one of the degradation indices of polymer insulator material and is usually evaluated by using an image of sprayed water on the sample surface, which is called STRI or spray method. In my laboratory, the effects of parameters to the evaluation of hydrophobicity of silicone rubber are studied. The parameters include surface roughness, measurement temperature, water absorption, weight percent of ATH filler and surface treatment of fillers such as ATH and silica. Hydrophobicity is evaluated by using the image analysis of sprayed water, the dynamic drop test and also the contact angle of a water droplet.



Fig. 1. Image of sprayed water droplets on silicone rubber.

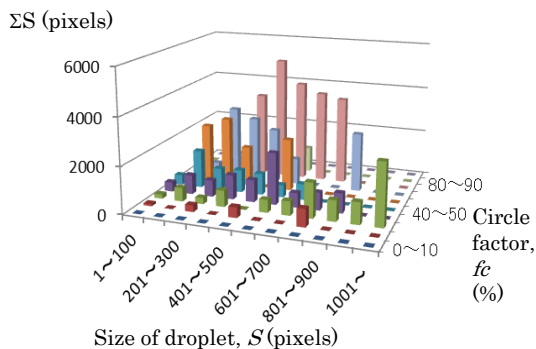
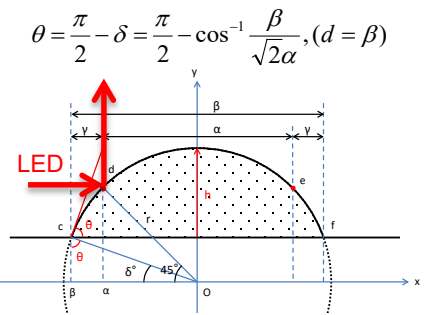
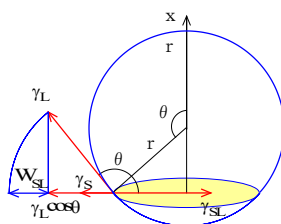


Fig. 2. Example of a 3D plot graph to evaluate the HC of Fig. 1.



$$\theta = \frac{\pi}{2} - \delta = \frac{\pi}{2} - \cos^{-1} \frac{\beta}{\sqrt{2}\alpha}, (d = \beta)$$

Fig. 3. Example of a water droplet, Goniometer, 3D laser microscope and reflected LED light point.

Diagnosis of Degradation of the Materials

In my laboratory, three measurement techniques of hydrophobic condition of polymer surface are studied. Parameters affect to the hydrophobicity of polymer insulating materials have the following effects:

Spray method can evaluate hydrophobic condition by the shapes of water droplets, such as the distribution of size, S , and circle factor, fc , of each water droplet. DDT method can evaluate it by both l_{max} and advanced contact angle, θ_a . Contact angle, θ , height, h , and diameter, d , of a water droplet are evaluated. They are measurable from the water droplet image with reflected LED light point.

Increasing of measurement temperature shows more hydrophobic indices by all three measurement techniques. Increasing of surface roughness enhances the hydrophobic property of silicone rubber samples.

Time relaxation process of hydrophobic condition appears at the 3D measurement of the shape of water droplet. Hydrophobic surface keeps the contact angle, and the ratio $d:h$ is almost constant during the evaporation of water droplet. When the surface becomes hydrophilic, residual contact angle becomes smaller compared to advanced contact angle. In this case, h shows faster decreasing compared to d .

Increasing of surface roughness also shows same time variation of 3D indices of a water droplet. At first, contact angle or h is larger for roughening surface; however, during the evaporation of water droplet, it decreases faster compared with the original (without roughening) surface.