INTRODUCING IMAGINARY CONTACT ANGLES FOR ANALYZING HYPERHYDROPHILICITY AND THE INVERSE LOTUS EFFECT ON ROUGH TITANIUM SURFACES

H.P. Jennissen[1], C. Seitz[2], S. Lüers[2], M. Laub[2]

[1]Institut für Physiologische Chemie, Universitätsklinikum Essen, Hufelandstr. 55, D-45122 Essen, Germany; [2]Morphoplant GmbH, Universitätsstr. 136, D-44799 Bochum, Germany, hp.jennissen@uni-due.de

ABSTRACT

The seminal work of Barthlott on the Lotus Effect [1] led an exponential growth of publications on superhydrophobicity at the beginning of the 21st century [2], initiating the "rediscovery" of the work of Cassie & Baxter and Wenzel [3,4] with the basic equations for classical contact angle measurements especially on rough hydrophobic surfaces. This development, applicable to metallic and non-metallic surfaces, ensued because analytical and mathematical tools were available for investigating contact angles above the physical limit on smooth surfaces (i.e. 119° [5]) and up to 180° on rough surfaces.

On the other side of the Wettabilty scale measurements of hydrophilicity are hampered by the zero degree limit in contact angles. Even if higher wettabilites are obtainable they cannot be measured, because dynamic contact angles according to $\cos\theta > 1.0$ are undefined. We have found a solution for this inequality in $\cos(i) = 1.543$, which has led to the radically new development of imaginary number based contact angles [6,7]. Thus mirroring the Lotus Effect on the hydrophobic side, we now have the Inverse Lotus Effect on the hydrophilic side with analytical and mathematical tools for measuring imaginary dynamic contact angles transgressing the previous mathematical limit. Although also valid for non-metallic surfaces, examples will primarily be shown for titanium surfaces with roughness values between Ra 3-30 µm yielding advancing and receding imaginary contact angles in the range of $\Theta \sim 2i°\text{-}25i°$ [8,9].

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