Beitrag ID: **32** Typ: **Talk**

Size-Dependent Wetting of Microscopic Low-vapor Pressure Droplets on Smooth Silane-Coated Substrate

Mittwoch, 6. Dezember 2023 15:50 (25 Minuten)

The static contact angle of a liquid droplet on a substrate is often used to describe its wetting properties, which are influenced by various factors such as the chemistry of the substrate, properties of the liquid, and environmental conditions. Our study shows that the wetting of a microscopic droplet can systematically depend on its size. This dependency can be described with consideration of surface roughness, surface forces, and liquid surface tension. A smooth silane coating was produced using solvent-based silanization coupled with various post-treatment methods. To prevent evaporation during AFM scanning, different low-vapor pressure liquids, including Polyethylene glycol 200, Ethylene Glycol, and glycerol, were selected as the liquid phase and all measurements were carried out in a nitrogen environment to avoid water uptake. The static microscopic Contact Angle compared with the macroscopic Contact Angle, measured via an optical method. The results showed that the static Contact Angle increases by increasing drop size up to a limit, which depends on droplet surface tension. In addition, the microscopic contact angle was smaller than the macroscopic counterpart, which indicates the dominance of roughness forces at the contact line.

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Sitzung Einordnung: Short Talks