Beitrag ID: **12** Typ: **Talk**

How friction develops during the sliding of drops

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Despite many experimental and theoretical studies, it is still impossible to predict dissipative forces, which act against the gravitational forces of drops sliding down an inclined plane. The dissipative forces, which resist drop motion, can be termed "friction force". In this work, we measured the velocity (U), width (w), length, advancing contact angle (θ_a), and receding contact angle (θ_r) of liquid drops sliding down inclined flat surfaces. By solving the equation of motion for sliding drops [1], we determined the friction force versus slide velocity for different hydrophobic surfaces. The friction force acting on moving drops of polar and non-polar liquids with viscosities ranging from 0.001 to 1 Pa s can empirically be described by $F_f(U) = F_0 + \mu w Ca^\alpha$ for the whole relevant velocity range. Here, $Ca = U\eta/\gamma$ is the capillary number, where η is the viscosity and γ is the surface tension of a liquid. The friction coefficient μ is in the range of 1-3 N/m for all liquid/surface combinations. For viscosities > 0.006Pa s, $\alpha = 1$. In these cases, bulk and wedge viscous dissipation fully account for the velocity-dependent friction force. For water and other liquids with $\eta \le 0.006$Pa s, we determined $\alpha \approx 0.8$. The latter implies that additional dissipative processes limit drop motion. We confirmed experimental results by numerical diffuse-interface simulations of the flow pattern inside sliding drops. We find that the Furmidge equation [2], $F = kw\gamma(\cos\theta_r - \cos\theta_a)$, describes sliding drops as well. The dynamic case, where k(U), ⊠(⊠), ⊠_⊠(⊠), and ⊠_⊠(⊠) depend on the slide velocity. ⊠ ⊠ 1 is a dimensionless shape factor. For the onset of drop sliding, we determine k experimentally to be 0.76.

[1] Li, X., Bista, P., Stetten, A.Z. et al. Spontaneous charging affects the motion of sliding drops. Nat. Phys. 18, 713–719 (2022). https://doi.org/10.1038/s41567-022-01563-6
[2] Furmidge, C. G. L. Studies at Phase Interfaces. I. The Sliding of Liquid Drops on Solid Surfaces and a Theory for Spray Retention. J. Colloid Sci. 1962, 17 (4), 309–324.

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Sitzung Einordnung: Short Talks