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Modeling and experimental characterization of the wrapping layer

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Abstract: Oil-impregnated surfaces have gained interest because of their demonstrated potential to improve numerous processes ranging from drag reduction to enhancing condensation. A major bottleneck of these nature-inspired hemi-solid hemi-liquid surfaces is lubricant depletion, the source of which is not fully understood to date. Past studies have shown that the wrapping layer, which is a very thin film of oil (~few nm thick) that encapsulates a water droplet residing on a textured oil-impregnated surface, contributes to lubricant depletion. While prior research from our own research has visualized and quantified the wrapping oil layer using planar laser-induced fluorescence (PLIF), the relationship between droplet volume and wrapping layer thickness remains poorly understood. In this work, we experimentally characterize and model the highly non-uniform wrapping layer thickness by varying the droplet radius, lubricant viscosity, and initial lubricant thickness. The anticipated outcomes from this study will improve our fundamental understanding of the wrapping layer dynamics and its contribution to oil depletion by pendant droplets.

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