Laser Speckle Drop Profilometry Validation and Measurement of Contact Angle Variation with Surface Roughness

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A non-intrusive technique has been developed that measures full-field instantaneous inter-
face shapes of unsteady droplets on rough surfaces. Illumination of a rough surface
by a collimated laser forms a speckle pattern at the solid surface that is subsequently
deformed by refraction at the drop interface, encoding information about the surface
height and gradient. Computer algorithms analyze the resulting images to identify
the interface shape, contact line location and contact angles about the contact line.
This is achieved through a minimization of the mean-squared error between the
measured speckle deformation and that of the reconstructed drop using simulated
annealing. Extensive validation efforts demonstrate the technique’s effectiveness on
aluminum, copper, and stainless steel surfaces when the surface roughness is mi-
cron scale. Preliminary experiments provide data on how contact angle variations
about a single drop’s contact line and between different droplets depends on surface
roughness on the various surfaces.