Detachment of liquid droplets from fibres-Experimental and theoretical evaluation of detachment force due to interfacial tension effects

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Abstract

The detachment of barrel-shaped oil droplets from metal, glass and polymer fibres was examined using an atomic force microscope (AFM). The AFM was used to detach the droplets from the fibres while measuring the force–distance relationship. A novel fibre–droplet interfacial tension model was applied to predict the force required to draw the droplet away from its preferential axisymmetric position on the fibre, and also to predict the maximal force required to detach the droplet. The model assumes that the droplet retains a spherical shape during detachment, i.e., that droplet distortion is negligible. This assumption was found to be reasonably accurate for small radius oil droplets (<10 μ m), however less accurate for larger droplets (>25 μ m). However, it was found that the model produced a good agreement with the maximal detachment force measured experimentally—regardless of droplet size and degree of deformation—even though the model could not predict droplet extension beyond a length of one droplet radius.

Key Words

Droplet; Fibre; Atomic force microscope (AFM); Interfacial tension; Capillary bridge.