

Soutenance bibliographique

BESSENG A IREH Guy Raymond

Université Paul Sabatier

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Shape and motion of drops sliding down an inclined plane
By NOLWENN LE GRAND, ADRIAN DAERR AND LAURENT
LIMAT

Dispositif expérimental

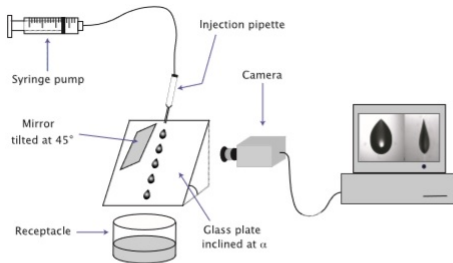


FIGURE 2. Description of the experimental setup

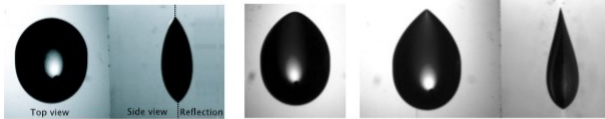
Label	Polymerisation degree n	Viscosity η (cP)	Density ρ (kg.m^{-3})	Surface tension γ (mN.m^{-1})
47 V 10	9	10.0 ± 0.2	936 ± 2	20.1
47 V 100	75	103.7 ± 0.2	964 ± 2	20.9
47 V 1000	338	1035 ± 5	970 ± 2	21.1

TABLE 1. Characteristics of silicone oils

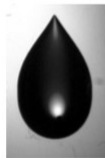
Condition de mouillage

- Fluoropolymère FC-725
- volume de la goutte : $V = (6.0 \pm 0.2) \text{ mm}^3$
- l'angle dynamique : $\theta_r < \theta < \theta_a$
- $50^\circ < \theta < 55^\circ$

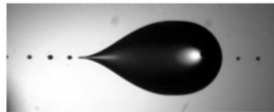
Différents régimes



(a) Oval drop $Ca = 2.85 \cdot 10^{-3}$ (b) Corner $Ca = 4.95 \cdot 10^{-3}$ (c) Corner $Ca = 5.14 \cdot 10^{-3}$



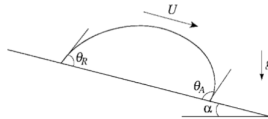
(d) Cusp $Ca = 7.07 \cdot 10^{-3}$



(e) Pearls $Ca = 7.19 \cdot 10^{-3}$

FIGURE 4. Top views (along with side views for (a) and (c)) of drops sliding down an inclined plate for increasing velocities, $\eta = 104$ cP. The motion is from top to bottom except for figure (e) where it is from left to right.

Bilan des forces



- Le poids : $\rho g V \sin \alpha$
- la force de frottement : $\eta U V^{1/3}$
- la tension de surface : $\gamma \Delta \theta = \gamma w (\cos(\theta_R) - \cos(\theta_A))$

Debut du glissement

- on a glissement pour $\alpha_c < \alpha$
- Pas de frottement à la limite du glissement donc

$$\rho g V \sin \alpha = \gamma V^{1/3} (\cos(\theta_R) - \cos(\theta_A))$$
- $V^{2/3}(\rho g / \gamma) \sin \alpha \simeq \cos(\theta_R) - \cos(\theta_A)$
- le nombre de Bond : $B_O = \frac{\text{effets gravitaires}}{\text{effets inertiels}} = V^{2/3}(\rho g / \gamma) \sin \alpha$
- $B_{O_c} = V^{2/3}(\rho g / \gamma) \sin \alpha_c = \cos(\theta_R) - \cos(\theta_A)$
- $$B_{O_c} = \left(\frac{24}{\pi}\right)^{2/3} \frac{(\cos(\theta_R) - \cos(\theta_A))(1 + \cos(\theta_A))^{1/2}}{(2 + \cos(\theta_A))^{1/3}(1 - \cos(\theta_A))^{1/6}}$$

Gouttes en mouvement

- U vitesse de la goutte, $\theta(U)$?
- Le nombre capillaire : $C_a = \frac{\text{effets visqueux}}{\text{effets inertiel}} = \frac{\eta U}{\gamma}$
- De Gennes : $\theta (\theta^2 - \theta_s^2) = \pm 6 \ln \left(\frac{b}{a} \right) C_a$
- Cox et Voinov : $\theta^3 - \theta_s^3 = \pm 9 \ln \left(\frac{b}{a} \right) C_a$
- Cinétique moléculaire : $(\theta^2 - \theta_s^2) = \frac{\nu N k T}{2\pi f L_m h} C_a$
- Linéaire : $\theta - \theta_s \propto \pm U$

Comparaisons avec des modèles

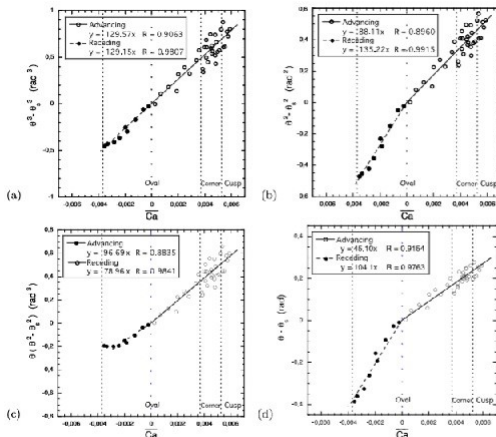


FIGURE 11. Comparing several models for the dynamics of wetting, $\eta = 10.0$ cP. (a) Cox-Voinov, (b) molecular-kinetic, (c) de Gennes, (d) linear. In this figure exclusively, in order to highlight the similarity or discrepancy between the slopes of the advancing and receding parts, the ordinates have been plotted versus the algebraic capillary number \overline{Ca} . \overline{Ca} is positive for the advancing branch and negative for the receding one.

Transitions entre régime

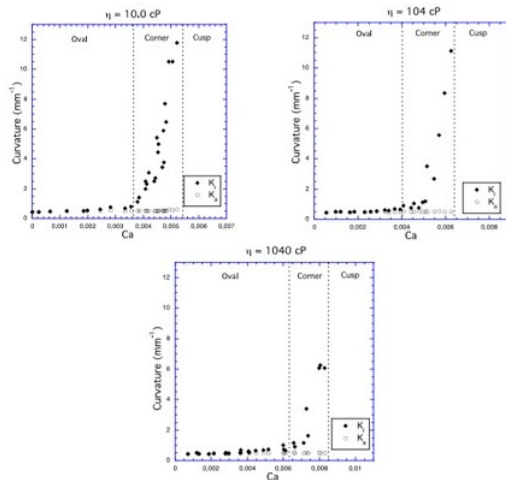


FIGURE 5. In-plane curvatures at the front K_a and rear K_r of the drops seen from above. The oval to corner transition is defined by the sudden variation of the angle φ that decreases from 90° , following a $1/Ca$ law (see figure 14). This also corresponds to the point for which K_r rises above K_a .

goutte en coin

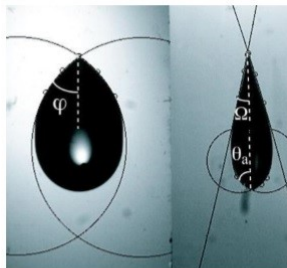


FIGURE 12. Measuring in-plane and out-of-plane opening angles of drops in the corner regime.

$$\sin \varphi = \frac{\theta_s^3}{9 \ln\left(\frac{b}{a}\right) C_a} \propto \frac{1}{C_a}$$

goutte en coin

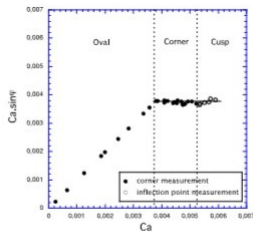


FIGURE 15. Non-dimensional normal speed of contact line at the drop rear versus drop speed (in terms of parameters $Ca \sin \varphi$ and Ca) for $\eta = 10.0 \text{ cP}$.

goutte en coin

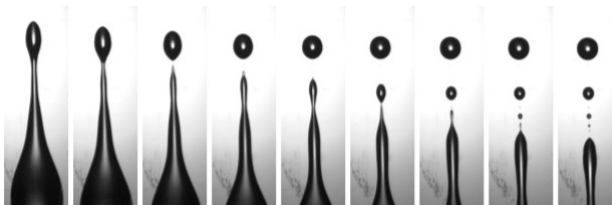
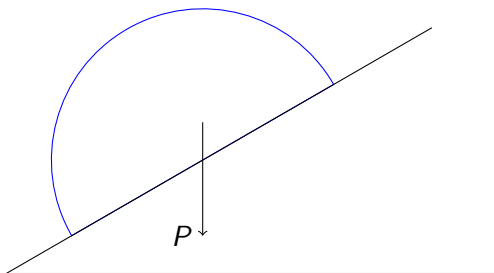


FIGURE 6. Pinching-off in the pearling regime and cascade of smaller drops deposited,
 $\eta=104$ cP, $Ca=15.10^{-3}$, 1/3 sec between two pictures.

Conclusion

- Dispositif expérimental
- Debut de glissement à α_c
- C_a a le même ordre de lors du changement de régime pour différente viscosité
- Le modèle de Cox - Voinov a été utilisé pour déterminer les angle φ et Ω
- L'émission des gouttellettes commence quand Ω prend ses valeurs les plus faibles (proche de zero)

Rapport avec le stage



Questions

Avez-vous des questions ?