

# Soutenance bibliographique

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Shape and motion of drops sliding down an inclined plane  
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LIMAT

# Dispositif expérimental

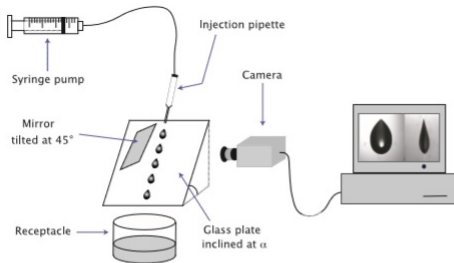


FIGURE 2. Description of the experimental setup

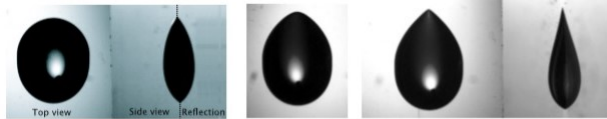
Label	Polymerisation degree $n$	Viscosity $\eta$ (cP)	Density $\rho$ ( $\text{kg.m}^{-3}$ )	Surface tension $\gamma$ ( $\text{mN.m}^{-1}$ )
47 V 10	9	$10.0 \pm 0.2$	$936 \pm 2$	20.1
47 V 100	75	$103.7 \pm 0.2$	$964 \pm 2$	20.9
47 V 1000	338	$1035 \pm 5$	$970 \pm 2$	21.1

TABLE 1. Characteristics of silicone oils

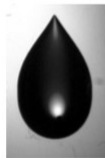
# Condition de mouillage

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

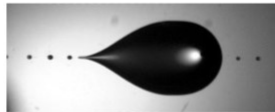
# Différents régimes



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



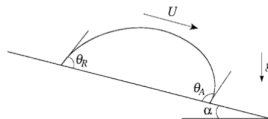
(d) Cusp  $Ca = 7.07 \cdot 10^{-3}$



(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 :  $C_a = \frac{\text{effets visqueux}}{\text{effets capillaire}} = \frac{\eta U}{\gamma}$
- 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

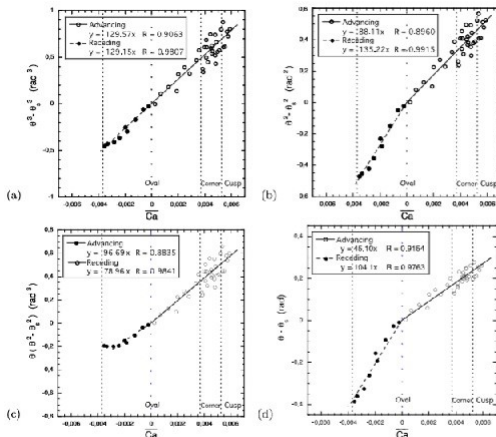


FIGURE 11. Comparing several models for the dynamics of wetting,  $\eta = 10.0$  cP. (a) Cox-Voinov, (b) molecular-kinetic, (c) de Gennes, (d) linear. In this figure exclusively, in order to highlight the similarity or discrepancy between the slopes of the advancing and receding parts, the ordinates 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

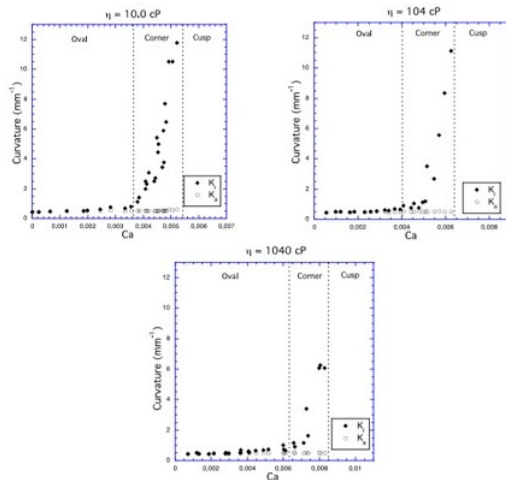


FIGURE 5. In-plane curvatures at the front  $K_a$  and rear  $K_r$  of the drops seen from above. The oval to corner transition is defined by the sudden variation of the angle  $\varphi$  that decreases from  $90^\circ$ , following a  $1/Ca$  law (see figure 14). This also corresponds to the point for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

## goutte en coin

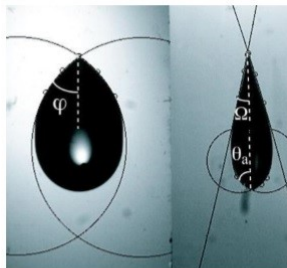


FIGURE 12. Measuring in-plane and out-of-plane opening angles of drops in the corner regime.

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

## goutte en coin

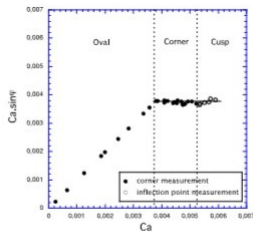


FIGURE 15. Non-dimensional normal speed of contact line at the drop rear versus drop speed (in terms of parameters  $Ca \sin \varphi$  and  $Ca$ ) for  $\eta = 10.0 \text{ cP}$ .

## goutte en coin

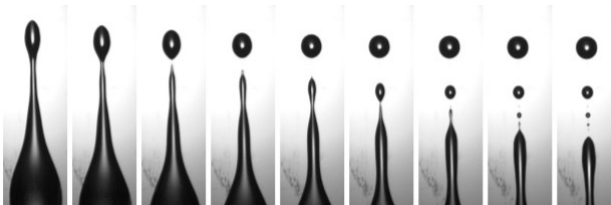
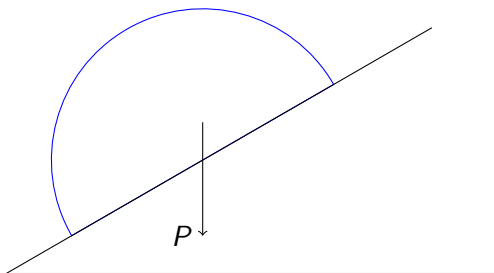


FIGURE 6. Pinching-off in the pearling regime and cascade of smaller drops deposited,  
 $\eta=104$  cP,  $Ca=15.10^{-3}$ , 1/3 sec between two pictures.

# Conclusion

- Dispositif expérimental
- Debut de glissement à  $\alpha_c$
- $C_a$  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  $\varphi$  et  $\Omega$
- L'émission des gouttelettes commence quand  $\Omega$  prend ses valeurs les plus faibles (proche de zero)

# Rapport avec le stage



# Questions

Avez-vous des questions ?