Study of instability of fluid layers/filaments on substrates with Basilisk/Gerris

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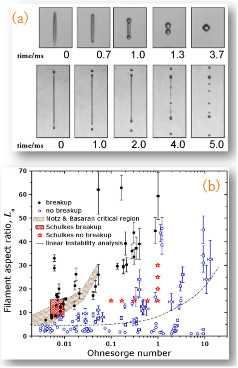
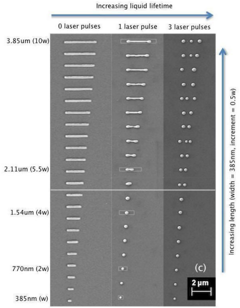
GERRIS: Instability of nanoscale liquid metal filaments

[PRL, 108, 074506, 2012]



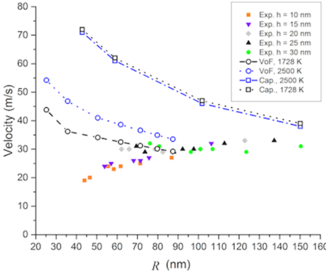
$$\mathrm{Oh} = \frac{\mu}{\sqrt{\rho\sigma R}}$$



θ (deg.)	σ (Nm^{-1})	μ (mPa s)	ρ (kgm^{-3})
69 ± 8	1.78	4.61	7905

[Hartnett et al., Langmuir, 2015]

Taylor-Culick velocities

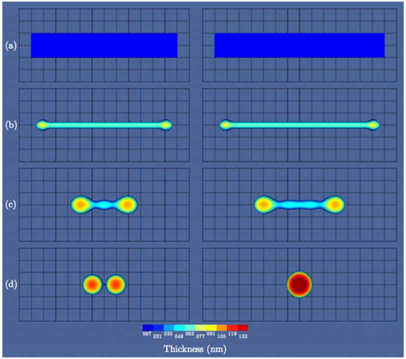


$$0.1 \leq \mathrm{Oh} \leq 0.18$$

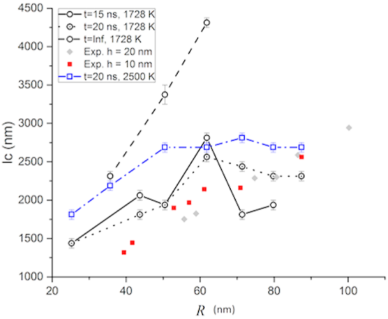
$$10 \leq L_0 \leq 18$$

GERRIS: Instability of nanoscale liquid metal filaments

[Hartnett et al., Langmuir, 2015]



VOF for a Ni filament with/without freezing



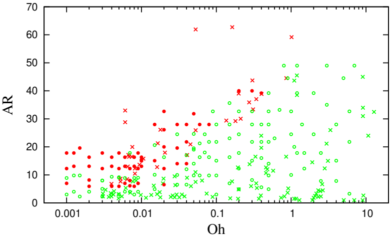
GERRIS with/without freezing compared to experimental results

slip-length $= 20$ nm

$\theta = 90^\circ$

GERRIS: Breakup of Finite Size Liquid Filaments Involving Substrate Effects

A. Dziedzic, M. Nakrani, B. Ezra, M. Syed, S. Popinet, EPJ E 2019

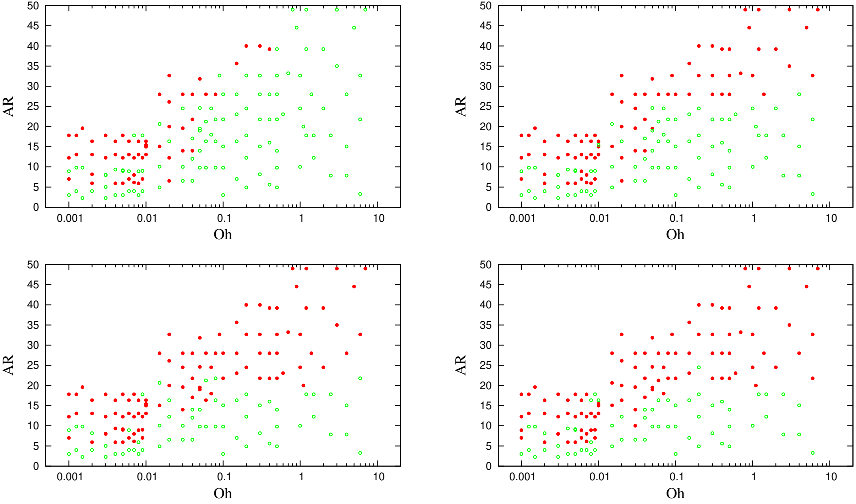


Breakup and no-breakup results compared to [PRL, 108, 074506, 2012]

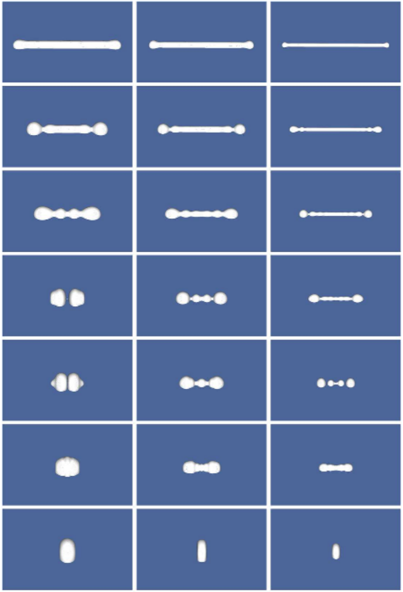
Photographic images of PDMS filaments

Oh $= 17$, $L_0 = 9 - 17$ mm

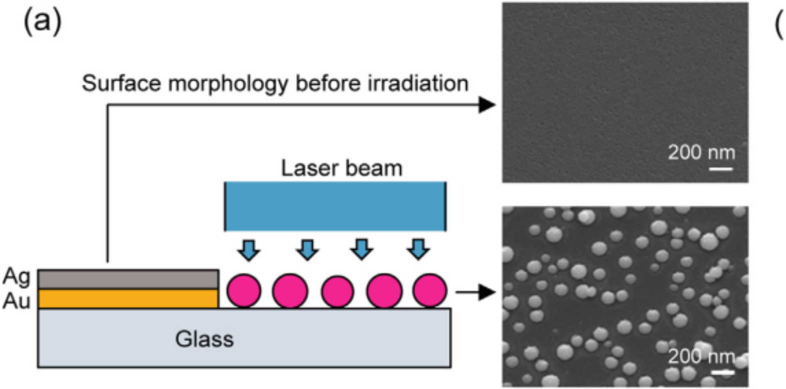
GERRIS: Breakup of Finite Size Liquid Filaments Involving Substrate; Slip Effects



GERRIS: Breakup of Finite Size Liquid Filaments Involving Substrate Effects



Instability of miscible liquid layers on substrates

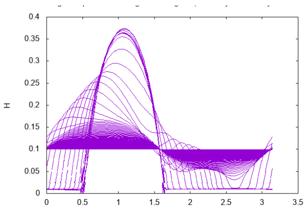


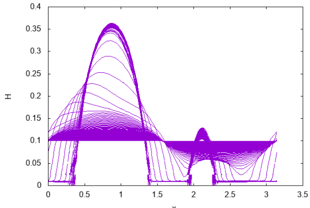
Oh et al., Applied Surface Science 434, 2018:
"The composition of the produced particles was controllable by changing the relative thickness of each layer"

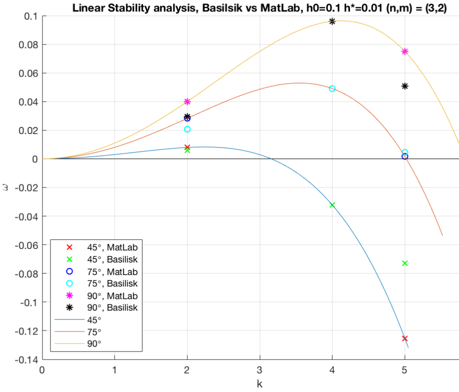
http://basilisk.fr/sandbox/popinet/dewetting.c

$$3\mu \frac{dh}{dt} + \frac{d}{dx}\left[\sigma h^3\left(\frac{d^3 h}{dx^3} + \frac{1-\cos\theta}{M h^*}\,\frac{d\,h}{dx}\left(\frac{m {h^*}^m}{h^{m+1}} - \frac{n {h^*}^n}{h^{n+1}}\right)\right)\right] = 0$$

$$\omega = -\frac{\sigma\, h_o^3\, k^4}{3\,\mu} - \frac{\sigma\,(1-\cos\theta)\, h_o^2\, k^2}{3\,\mu\, M\, h^*}\left(\frac{n\, {h^*}^n}{h_o^n} - \frac{m\, {h^*}^m}{h_o^m}\right)$$

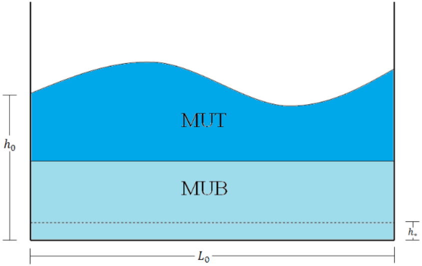


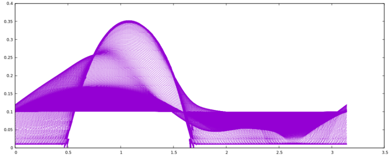




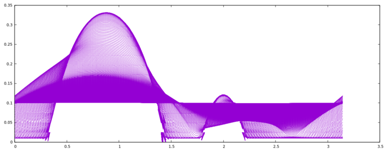
Instability of miscible liquid layers on substrates

L0=π
k = 2
h0 = 0.1
h*=0.01
N = 128





$\mu_{bottom} = \mu_{top}$



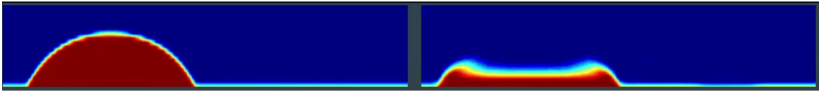
$\mu_{bottom} > \mu_{top}$

$\theta = 90^\circ$

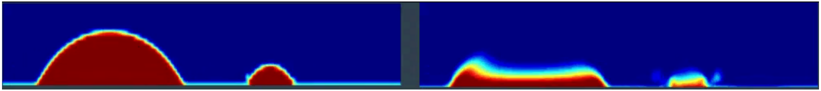
BASILISK: Instability of miscible liquid layers on substrates

$\theta = 80^\circ$

Concentration distribution
bottom layer

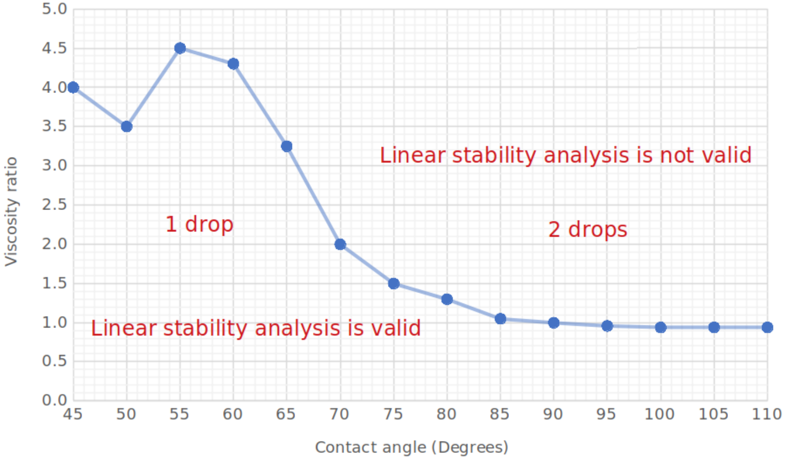


$\mu_{bottom} = \mu_{top}$



$\mu_{bottom} > \mu_{top}$

BASILISK: Instability of miscible liquid layers on substrates



Conclusions

- GERRIS: Breakup of Finite Size Filaments
  - We observe how substrate can strongly influence the no-breakup to breakup transition.
  - The results are considerably different from free-standing filaments that show no breakup for Oh>1 regardless of AR value.
  - A careful comparison of the retraction speed with experimental results will allow the calibration of the slip length: Future Work.
- BASILISK: Instability of (Miscible) Fluid Layers on Substrates
  - We show that for a two layer thin film system, the linear stability analysis is unable to provide a complete picture.
  - Mainly the emergence of length scales that are not predicted by the linear stability analysis.
  - The results are consistent with the experimental study in [Applied Surface Science 434, 2018], suggesting the size distributions of final particles depend on layer combinations.