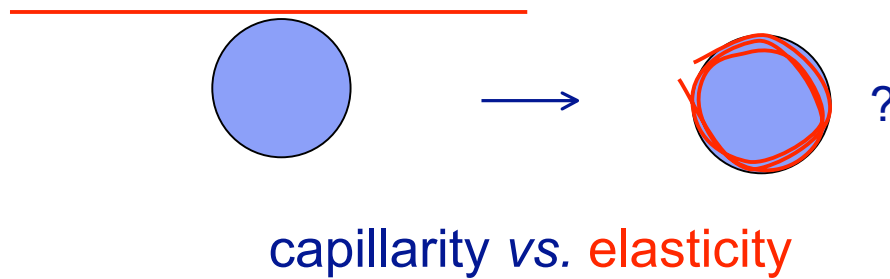
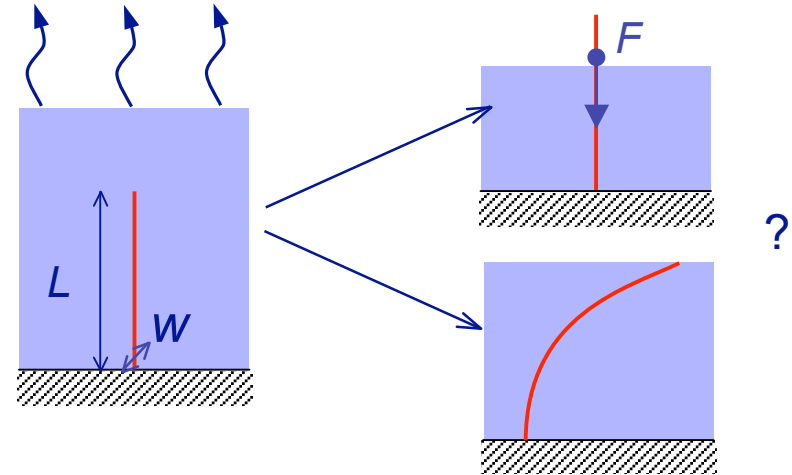
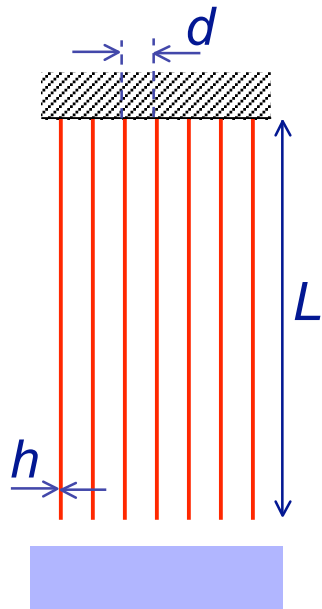


Capillary winding

José Bico & Benoît Roman
PMMH-ESPCI, Paris



Wet hairs



$$F = 2w\gamma$$

Euler buckling

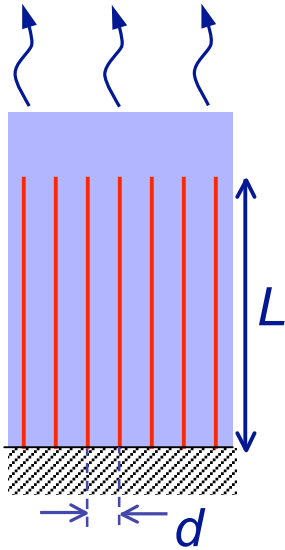
$$N_{max} \sim \frac{L^{4/3}}{L_{EC}^{2/3} d^{2/3}}$$

$$L_{EC} = \sqrt{\frac{Eh^3}{\gamma}}$$

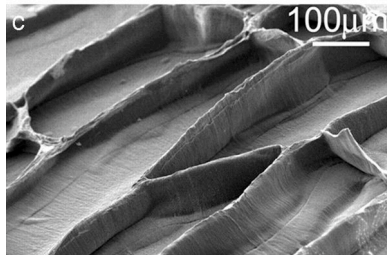
$$L_{crit} = \frac{\pi}{2} \sqrt{\frac{Eh^3 w}{F}} \sim L_{EC}$$

with Arezki Boudaoud, Charlotte Py, Renaud Bastien & Sébastien Neukirch

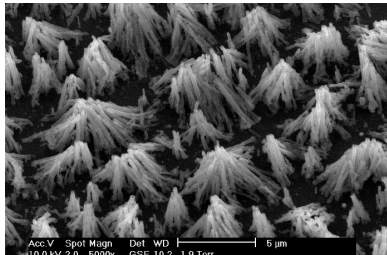
Inverted brushes



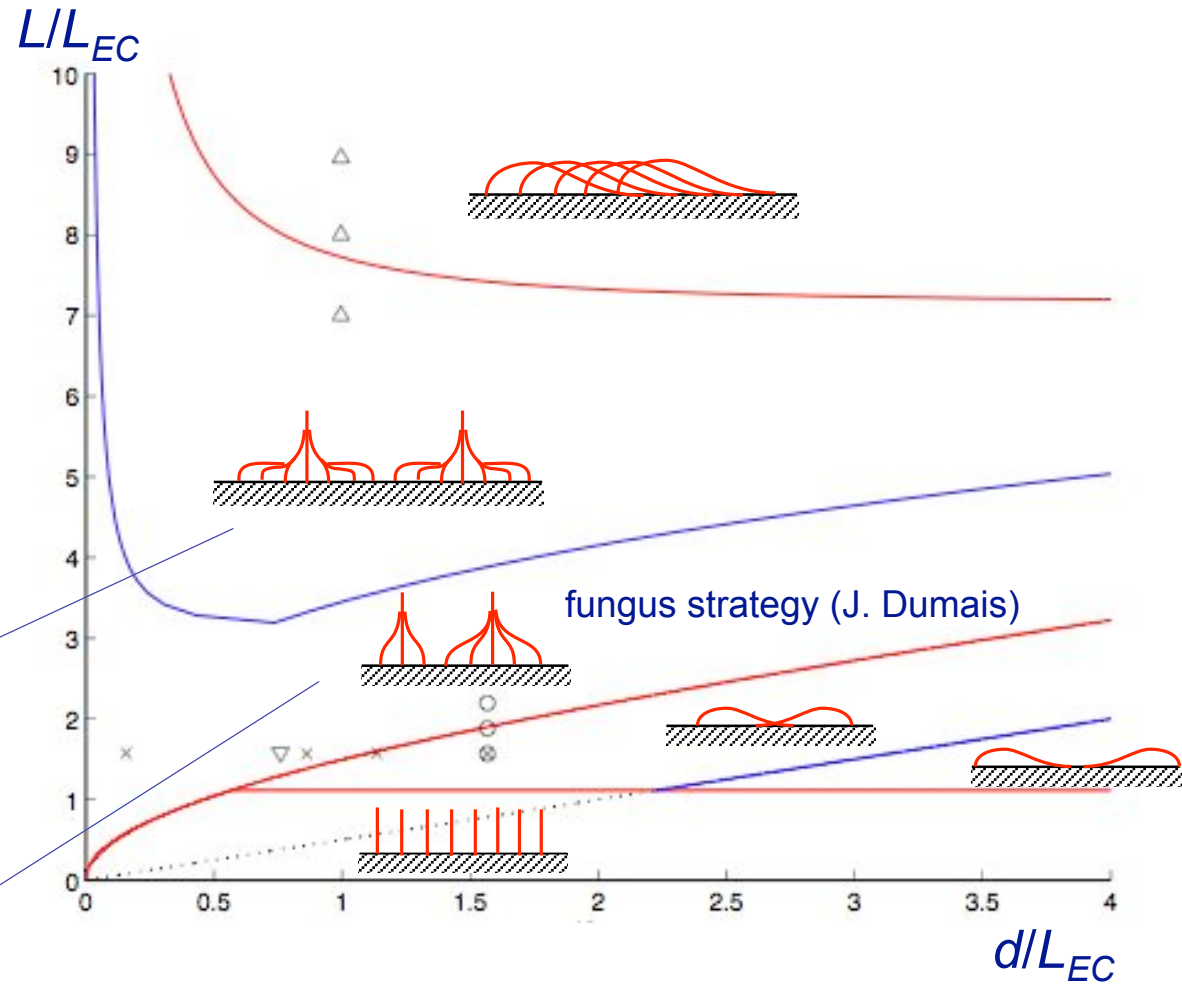
nanotubes forests



Chakrapani et al. 2004

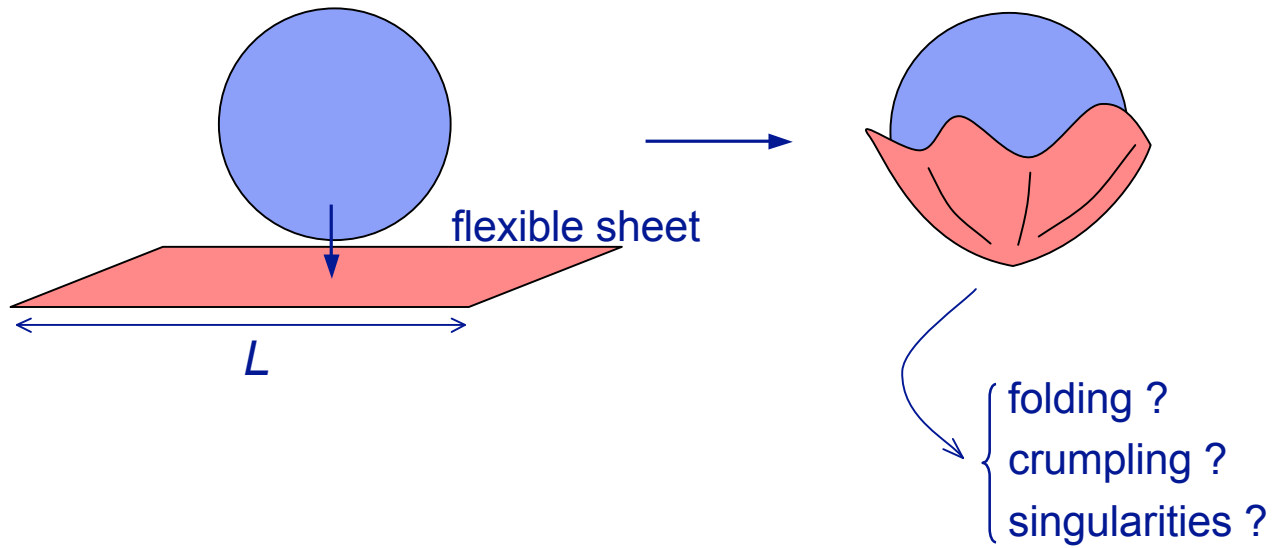


Lau et al. 2003



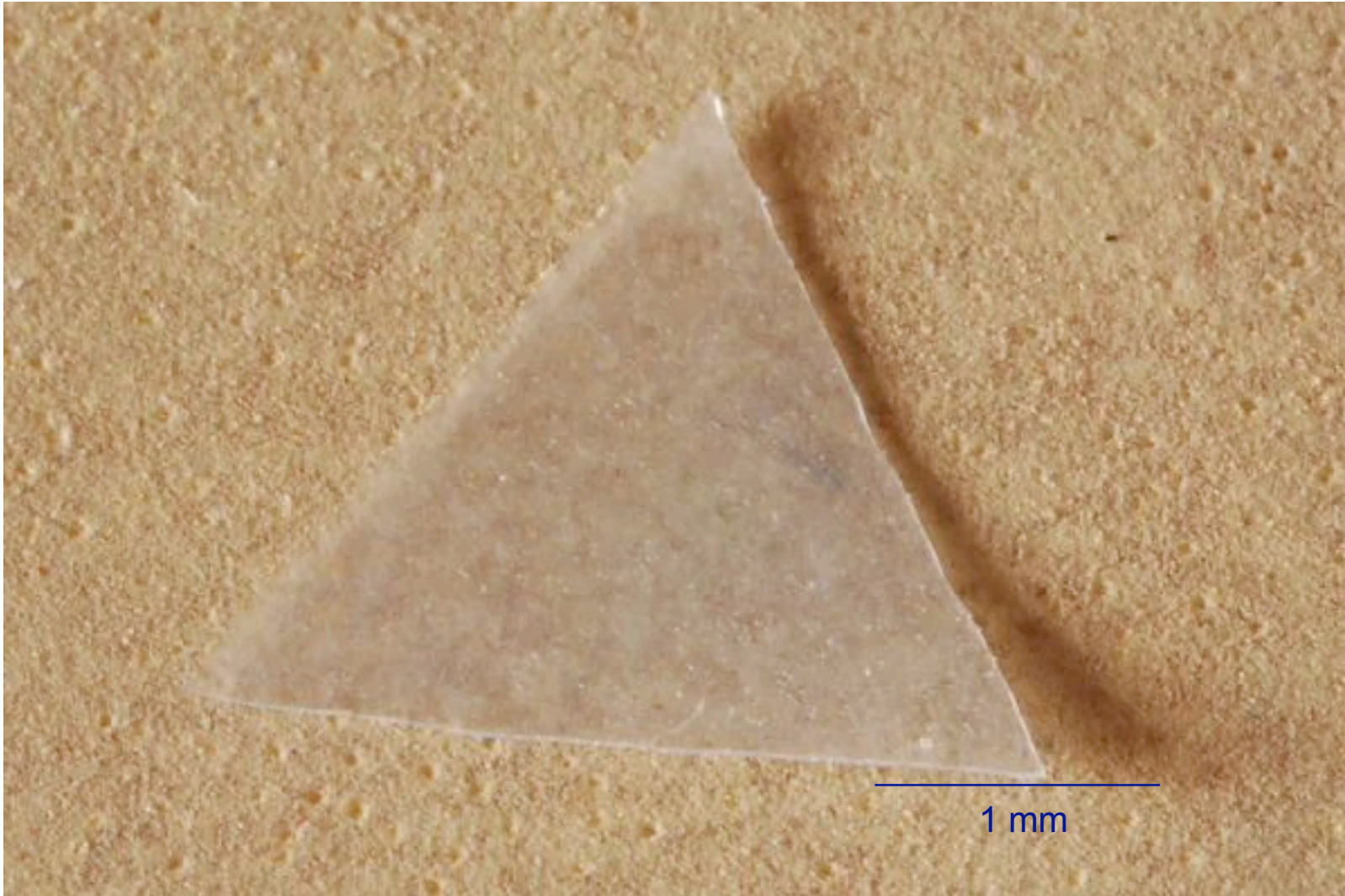
with Filippo Chiodi

Capillary wrapping



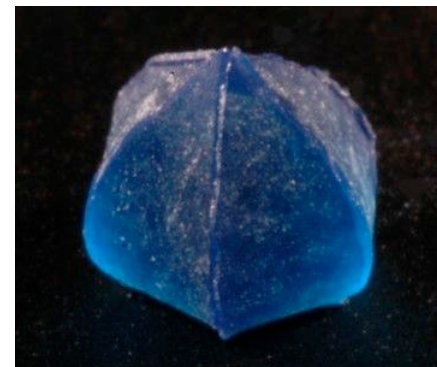
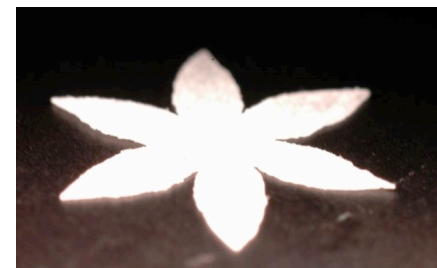
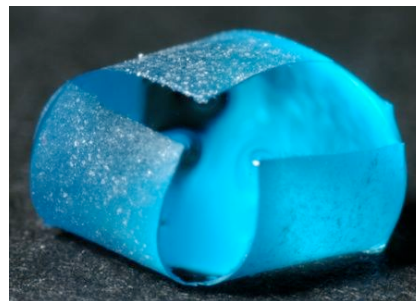
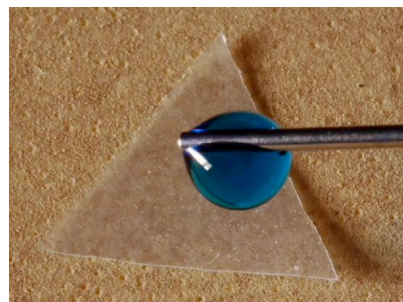
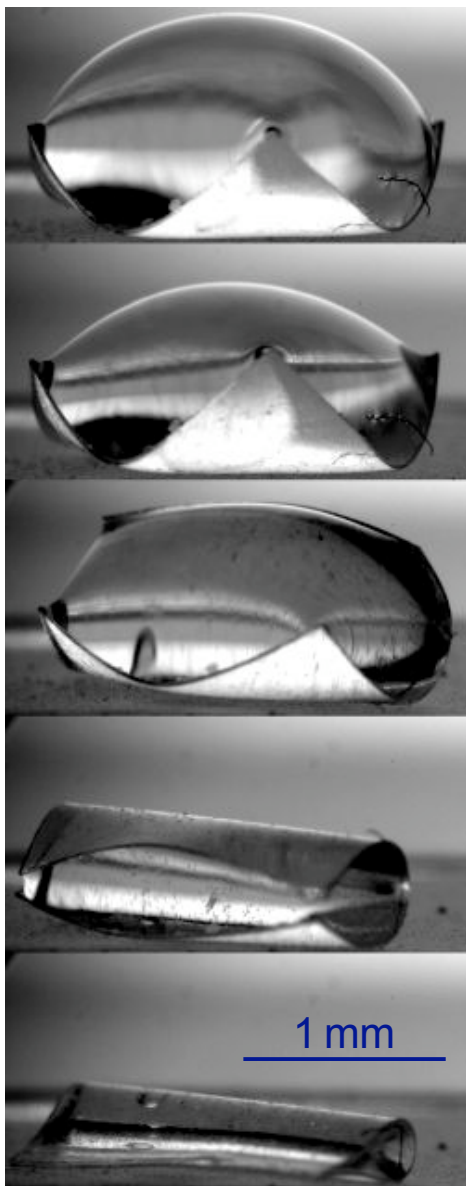
with Charles Baroud & Charlotte Py

Pyramids



Tayloring the 2D template

$$L \gg L_{EC}$$



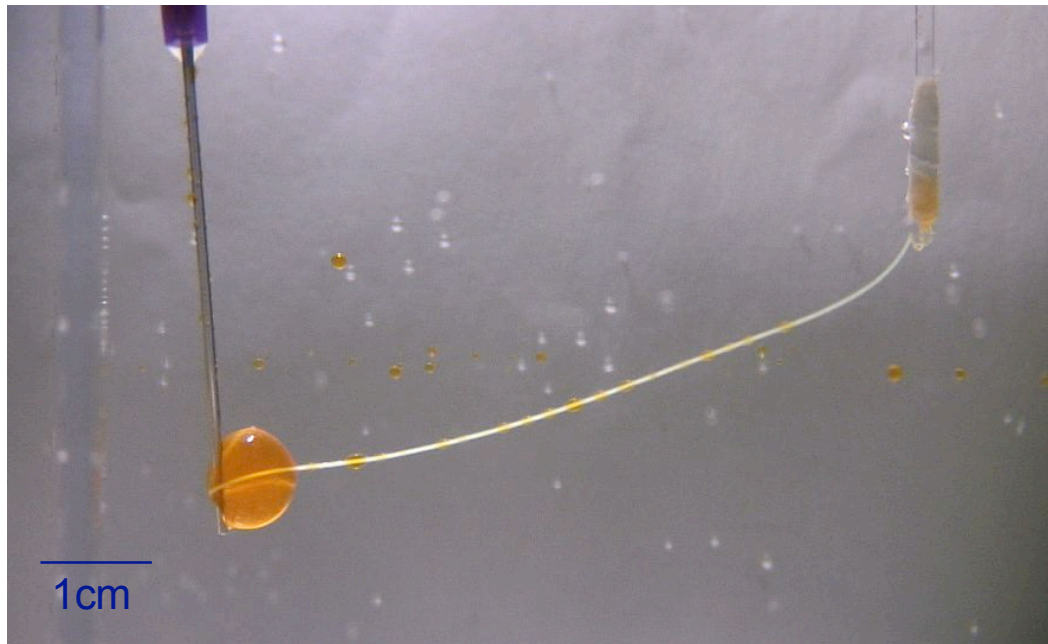
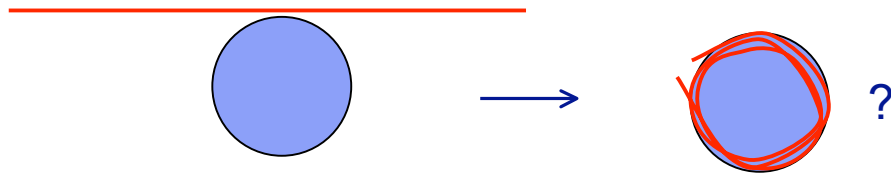
Spider webs



Life in the Undergrowth, BBC

also Vollrath, Nature (1989)

Thread winding

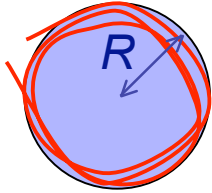


ρ_-
 ρ_+



with Sunny Sunghwan, Christophe Clanet, John Bush

Critical radius



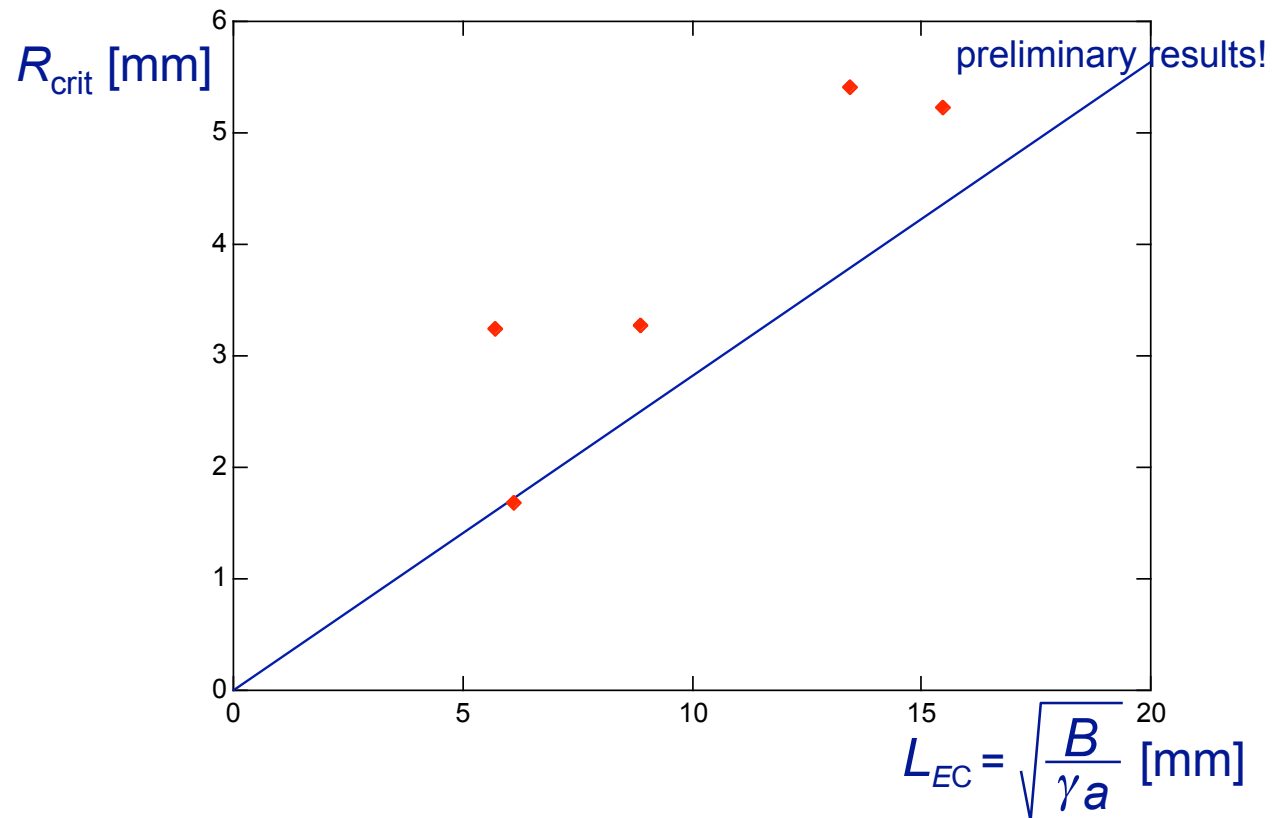
elastic energy

$$E_{el} = \frac{1}{2} \frac{B}{R^2} L$$

surface energy

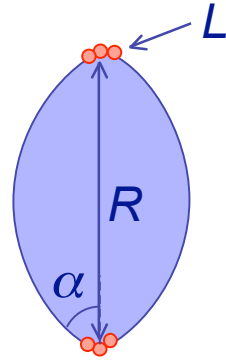
$$E_s = 2\pi a \gamma$$

$$R_{crit} = \frac{1}{2\sqrt{\pi}} \sqrt{\frac{B}{\gamma a}} \sim L_{EC}$$





Lenses

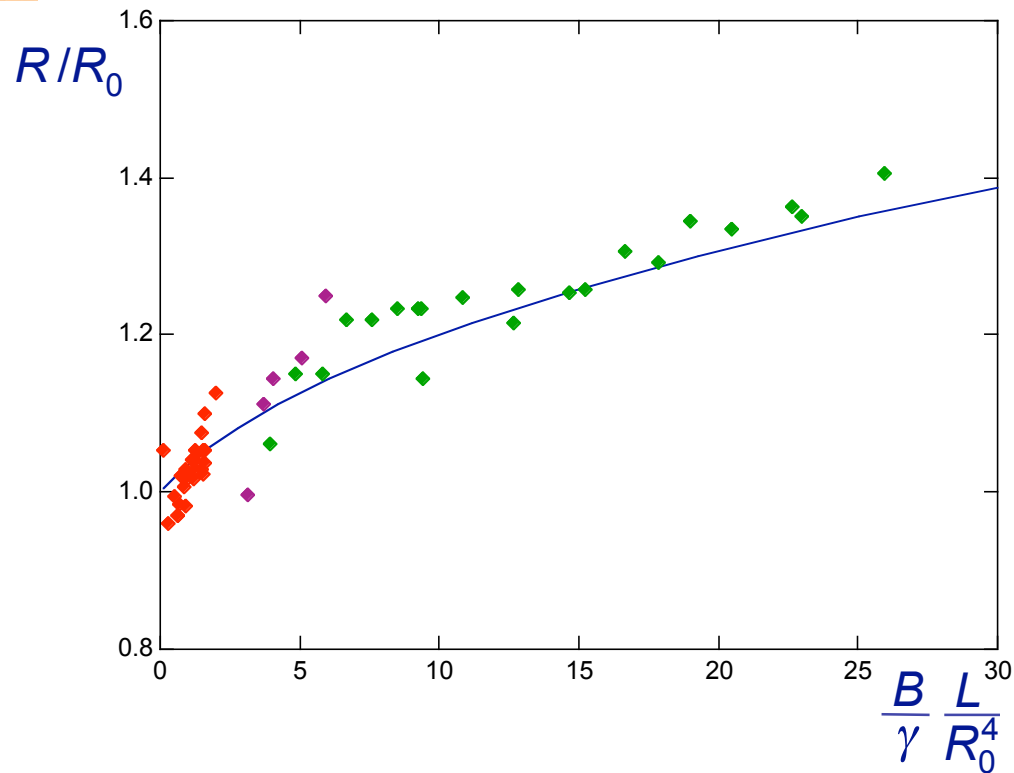


$$E = E_s + E_{el} = S\gamma + \frac{1}{2} \frac{B}{R^2} L$$

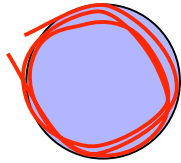
minimization at constant volume $\frac{4}{3}\pi R_0^3$:

$$\cos\alpha = \frac{1}{4\pi} \frac{B}{\gamma} \frac{L}{R^4}$$

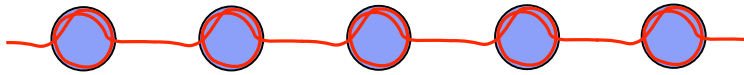
$$L_{EC}^* = \left(\frac{B}{\gamma}\right)^{1/3}$$



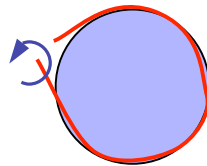
Open questions



maximum packing ?



multiple droplets ?



twist ?