Columnar bubble chains

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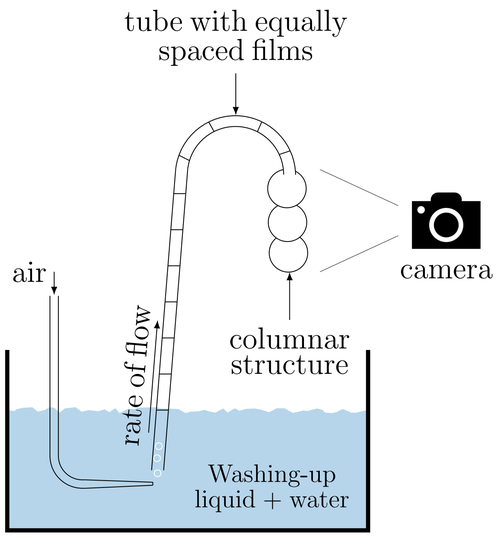
Experimental set-up



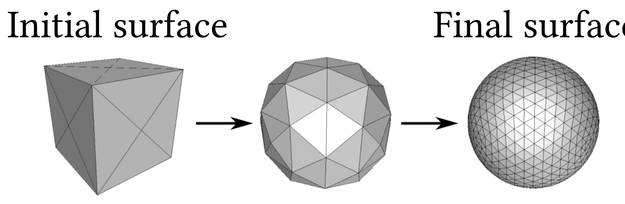
Schematic set-up of experiment

Experimental procedure

1. Hose is filled with equal-sized bubbles
2. Addition of bubbles pushes bubbles out at the top
3. these crystallise spontaneously into complex ordered structures
4. type of structure depends on rate of flow

[1] Mann, Stephens. "Bubble formation in glass tubes", *Phil. Mag.*, Vol. **15**, pp. 143–146, (1933)
[2] Tobin, Barry, Meagher, Bulfin, O'Rathaille, Hutzler. "Ordered polyhedral foams in tubes with circular, triangular and square cross-section". *Colloids Surf. A*, Vol. **382**, pp. 24–31, (2011)

Surface Evolver Simulations



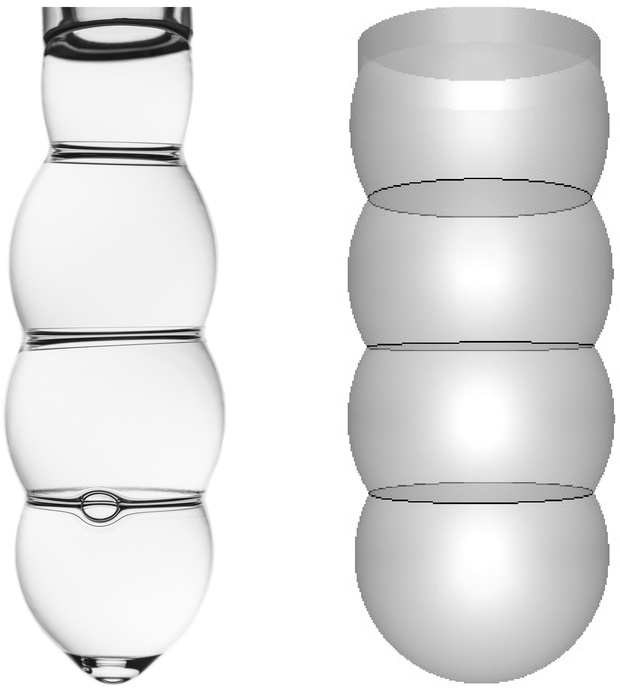
Example of surface minimisation in Surface Evolver by triangular tesselation

- We use *Surface Evolver* to investigate the emergence of such structures
- Initial surface is a confined columnar foam structure inside a tube
- **Modifications** to initial surface before surface minimisation:
  - Cylindrical walls are removed
  - Bubbles at the top are fixed
  - Gravity in vertical direction is added
- Gravity and fixing the sphere at the top stretches the structure

[3] Brakke. "The Surface Evolver". *Experimental Mathematics*, Vol. **1**, pp. 141–165, (1992)

We present experimental results and *Surface Evolver* simulations of ordered columnar bubble packings. Different to previous findings in [1, 2] the structures do not require cylindrical confinement. The arrangement are reminiscent to biological structures.

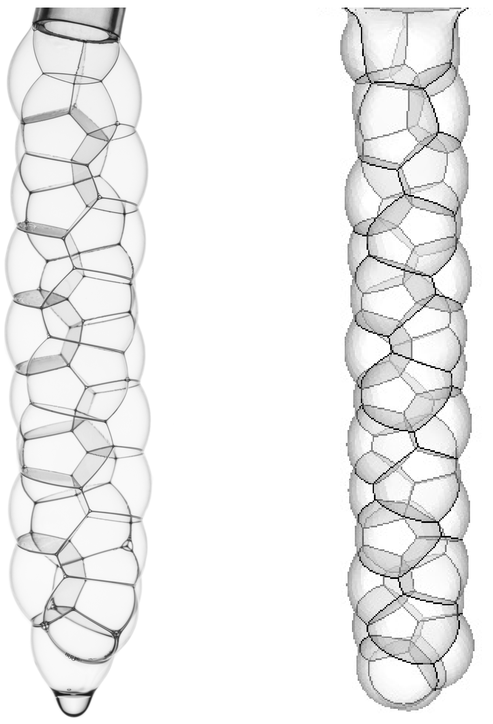
(1, 1, 0) Bamboo structure



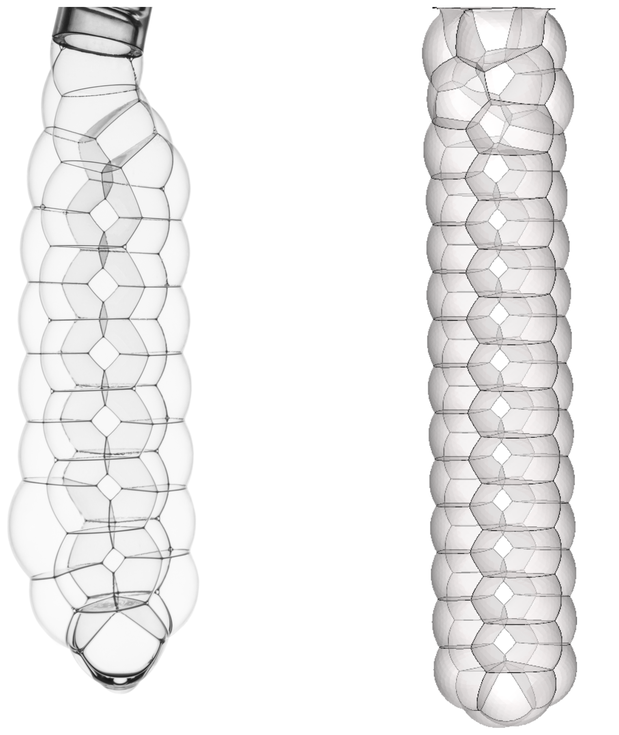
[4] Flickr user "Brissy Girl – Jan Anderson". (2009) https://www.flickr.com/photos/40132175@N06/4181373100/

(6, 3, 3) Kelvin cells structure

(3, 2, 1) Chiral structure



(4, 2, 2) Double staircase structure



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