

“Curling Dynamics of Thin Elastic Sheets”

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Stored elastic curvature energy leads to curling instabilities. We describe experimentally and theoretically three examples:

1. The bursting of asymmetrical polymersomes, where one leaflet is photosensitive, induced by light illumination. The dynamics of the hole opening is described by a transfer of the gain of curvature energy into viscous dissipation on the curled rim surrounding the hole [1].
2. The curling of a tracing paper sheet gently deposited at water surface. A quasistatic elastic model describe the evolution of the curvature of the sheet as a function of the imbibition thickness e increasing as the square root of time [2].
3. The rolling of a bilayer thin long stripe made of tracing paper stuck on a scotch tape immersed in water while fully stretched and released at $t=0$ in bath of oil. We observe the rolling of the paper starting from the free end. The balance of the driving force, which decreases as the roll increases, and the friction force on the roll leads to two regimes: rolling at constant velocity V at short time and a slow down ($V-t^{1/2}$ at long times). This allows us to interpret the second regime of the dynamics of bursting of polymersomes observed at long time [3].

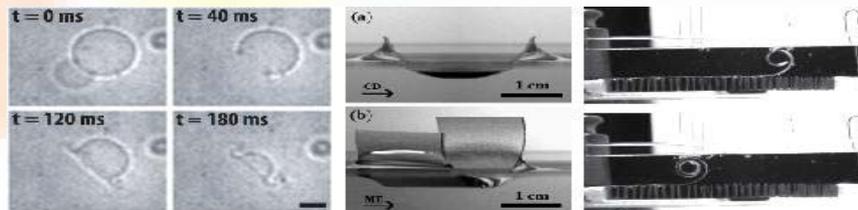


Fig. 1: three examples of curling from left to right : light sensitive asymmetrical polymersome (scale bar=5 μ m), tracing paper on water interface, paper-tape bilayer previously embedded.

References

- [1] E. Mabrouk, D. Cuvelier, F. Brochard-Wyart, P. Nassoy, M.-H. Li “Bursting of sensitive polymersomes induced by curling” *Proceedings of the National Academy of Sciences* 106 : 7294-7298 (2009)
- [2] S. Douezan, M. Wyart, F. Brochard-Wyart, D. Cuvelier « *Curling instability induced by swelling* » *Soft Matter*, 7 : 1506-1511 (2011)
- [3] L. Tadrist, F. Brochard-Wyart, D. Cuvelier « *Bilayer Rolling in viscous fluid* » to be submitted

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