Pressure-driven actuators based on dry-films lamination

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LAAS-CNRS, Université de Toulouse, CNRS, Toulouse, France
Contact: vincent.raimbault@laas.fr

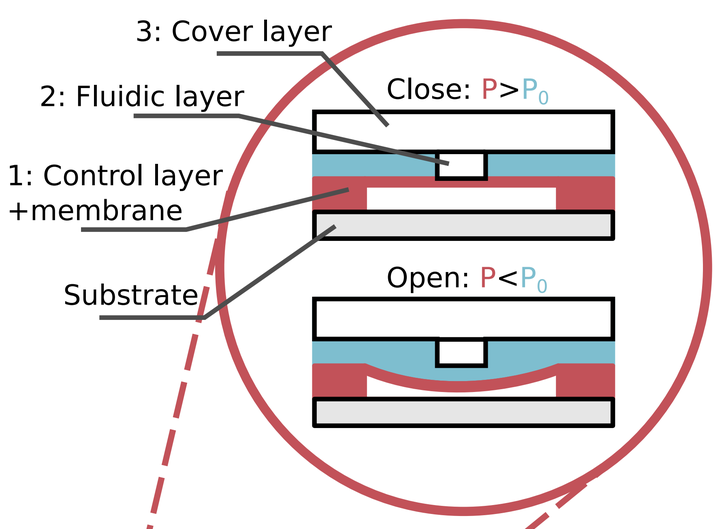
From prototyping to **mass production**

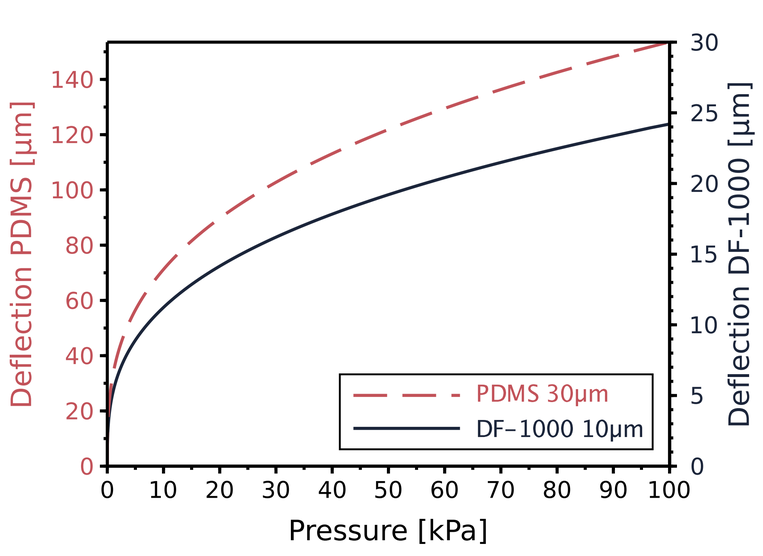
- **Pressure-driven microfluidic valves** have been extensively used since their apparition in 2000, mainly using PDMS as their constitutive material.
- While PDMS valves processing is well suited to rapid prototyping, it is not optimal for large-scale manufacturing.

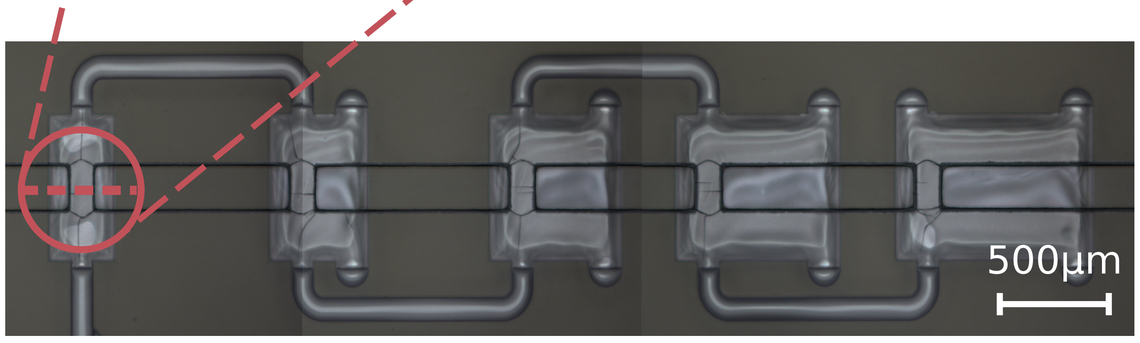
- We offer an alternative approach based on the **double exposure** of **laminated** DF-1000 Series **dry-films**.
- Every layer is processed by **conventionnal photolithography**.
- It allows **excellent alignment** precision and a **mass-production compatible workflow** at the wafer scale level.

Proof of concept: peristaltic micropump

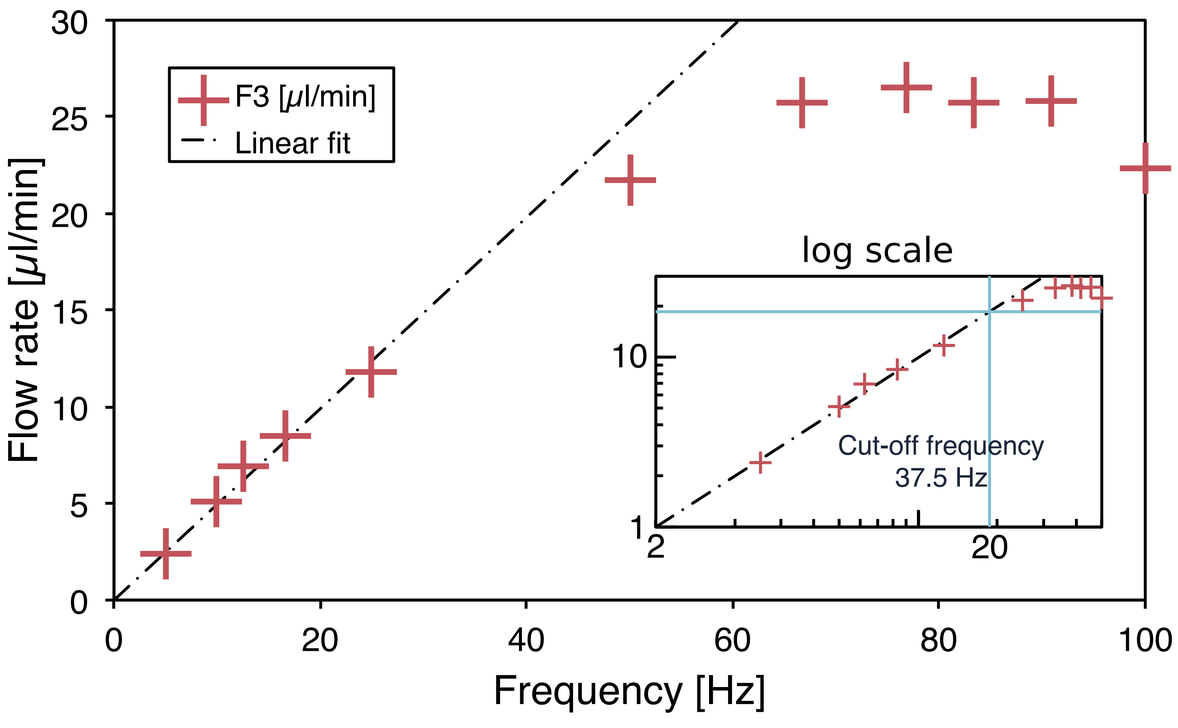
- In order to demonstrate the potentialities of this method, several common microfluidic components taken from the literature have been realized, including normally-closed valves, diodes, single-stroke peristaltic pumps, suspended herring-bone mixers ...
- While the relatively high Young modulus of dry-films vs. PDMS impose higher pressure to obtain enough deflection of the membranes, its **gas-tight nature** allows **thinner membranes** to be used.



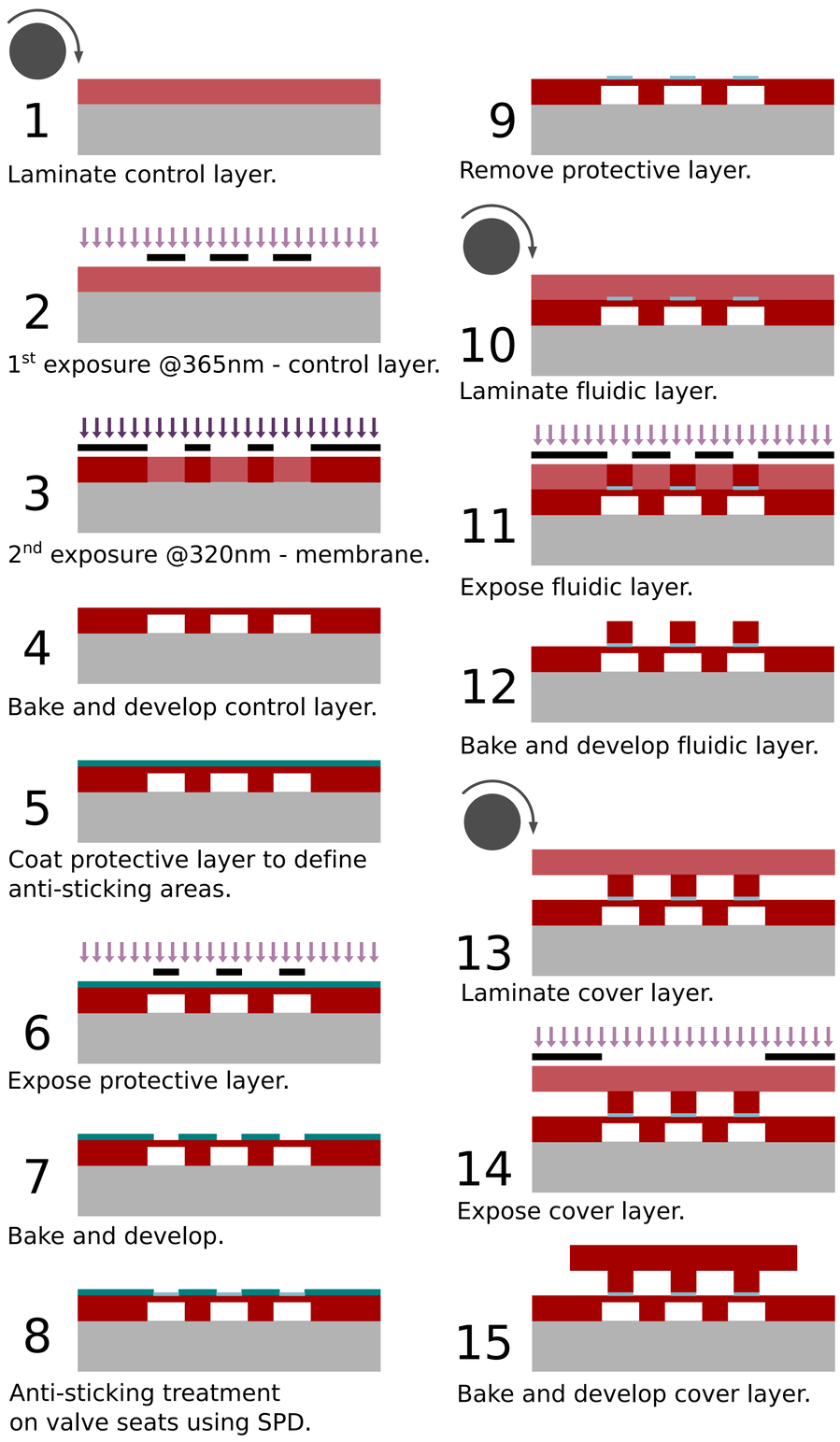


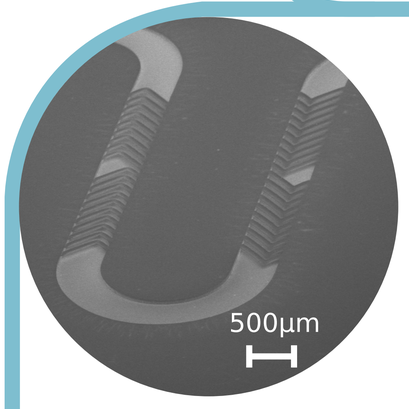


- This combination of properties leads to **faster response time** of the dry-film membranes, which translates to a **larger actuation bandwidth** in the case of peristaltic pumps.
- A single-stroke peristaltic pump, based on the design from *H. Lai, A. Folch 2011, Lab on a Chip 11 336–42*, and without optimization of its geometry for dry-films offers a **cut-off frequency approx. 4 times higher** than its PDMS counterpart.



Step-by-step workflow: DF-1050 negative photoresists dry films from EMS are laminated with a Shipley 3024 laminator. Membrane thickness is adjusted by exposure dose at step 3. The workflow can be **extended to other photosensitive dry-films** by tailoring processing parameters.





Key features of laminated dry-films for microfluidics

Material properties: biocompatible, resistant to most organic solvents (tested against ethanol, isopropanol, acetone, DMSO).

Processing: cheaper and faster to process than making SU-8 molds and casting PDMS.

No more manual steps: the workflow is compatible with wafer-scale collective manufacturing enabling integration of fluidic functions on microsensors.

Opens up new possibilities: using the ability to produce suspended features of controlled thickness, passive flow-sensors, mixers, or microcantilevers can be easily integrated.

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