Direct on-chip storage and release of liquid reagents for diagnostic lab-on-a-chip devices

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Introduction

→ On-chip reagent storage¹ is essential for the commercialization of lab-on-a-chip (LoC) platforms, e.g. storage in glass ampoules² or stick packs³.
→ Since these concepts implicate manufacturing complexity, direct on-chip storage of liquid reagents in reservoirs is preferable.
→ Here, we present a direct on-chip storage of reagents. Reservoirs are made of high barrier polymers⁴ (e.g. PP, PE, COP, COC) and sealed with a standard barrier film.
→ Reagent release is realized by braking up the barrier film through a deflection of a flexible membrane. Stored reagents get displaced in a sample chamber for further processing.

Reagent storage in a polymer multilayer stack

Pressure inlet
pneumatic layer
barrier film (rated break points)
flexible membrane
reagent reservoir
venting channel
fluidic layer
sample chamber

Predetermined rated break points in barrier film

→ Implementation of rated break points by laser ablation
→ Barrier properties of the aluminium layer remain unaffected

Operation mode of reagent release

Initial state (top view)
barrier film (flexible barrier film is not shown)

Initial state (cross section)
• No pressure applied

Pressure actuation
• Deflection of flexible membrane

Breaking up the barrier film
• Tearing starts at rated break points of the barrier film

Reagent release
• Stored reagent is transferred to sample chamber for further microfluidic processing

Results

→ Test device including 3 adjacent reagent reservoirs
→ Reagent: water (V = 500 µl)
→ Pressure actuation of the membrane with P_a = 2 bar
→ Reagent release and collection in sample chamber after 5 s
→ Efficient recovery of prestored volume due to highly elastic properties of the membrane

Conclusions

The presented concept provides a robust solution for reagent storage. It can be easily implemented into pressure driven LoC-platforms.
→ Reduction of manufacturing complexity: Direct on-chip reagent storage enables lean LoC production lines
→ Footprint reduction: Required space shrinks to a minimum compared to other LoC-storage concepts
→ Long-term storage: Using high barrier polymers combined with standard barrier films enables long-term storage of liquids