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SelfSys RTD 2009

FNSNF

Fluidic Strategies for Assisted Self-Assembly

csem centre suisse d'électronique et de microtechnique

J Wienen[1], H F Knapp[1]

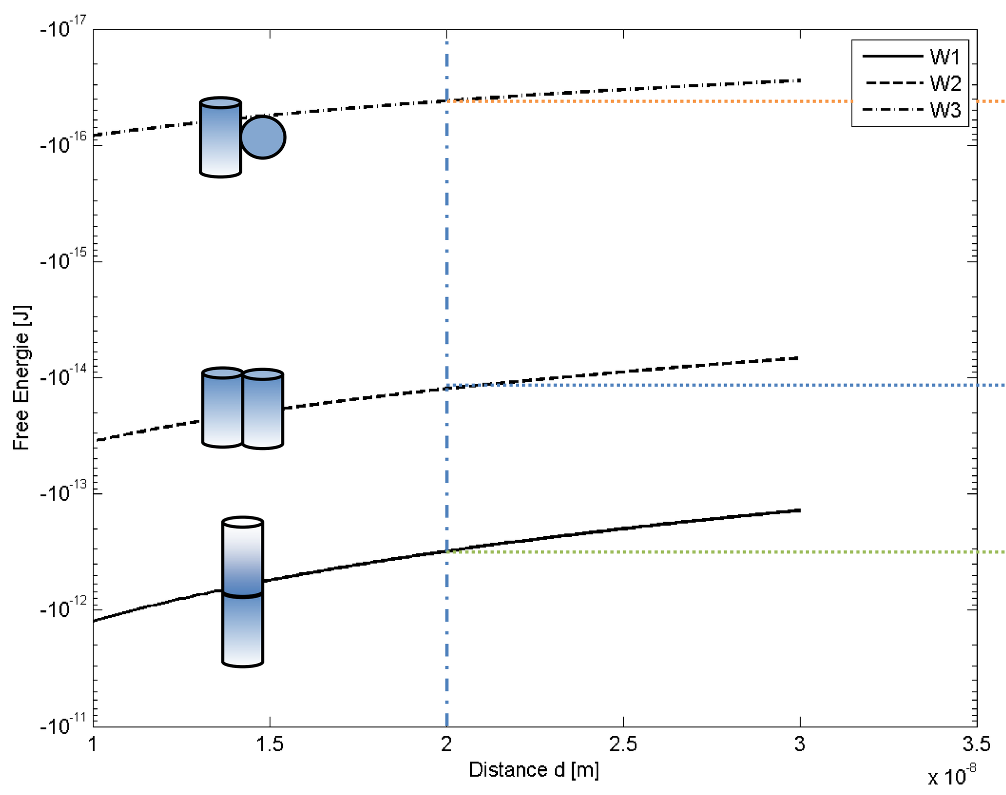
[1]*Centre Suisse d'Electronique et de Microtechnique, Alpnach Center, Switzerland*

Theoretical Background

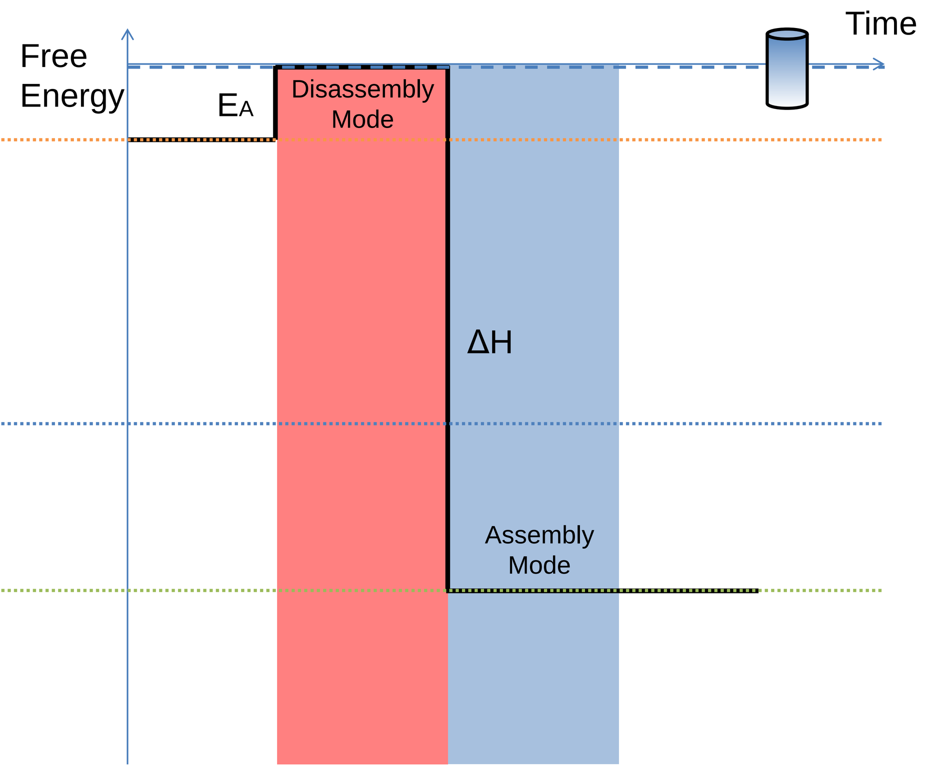
Goal:

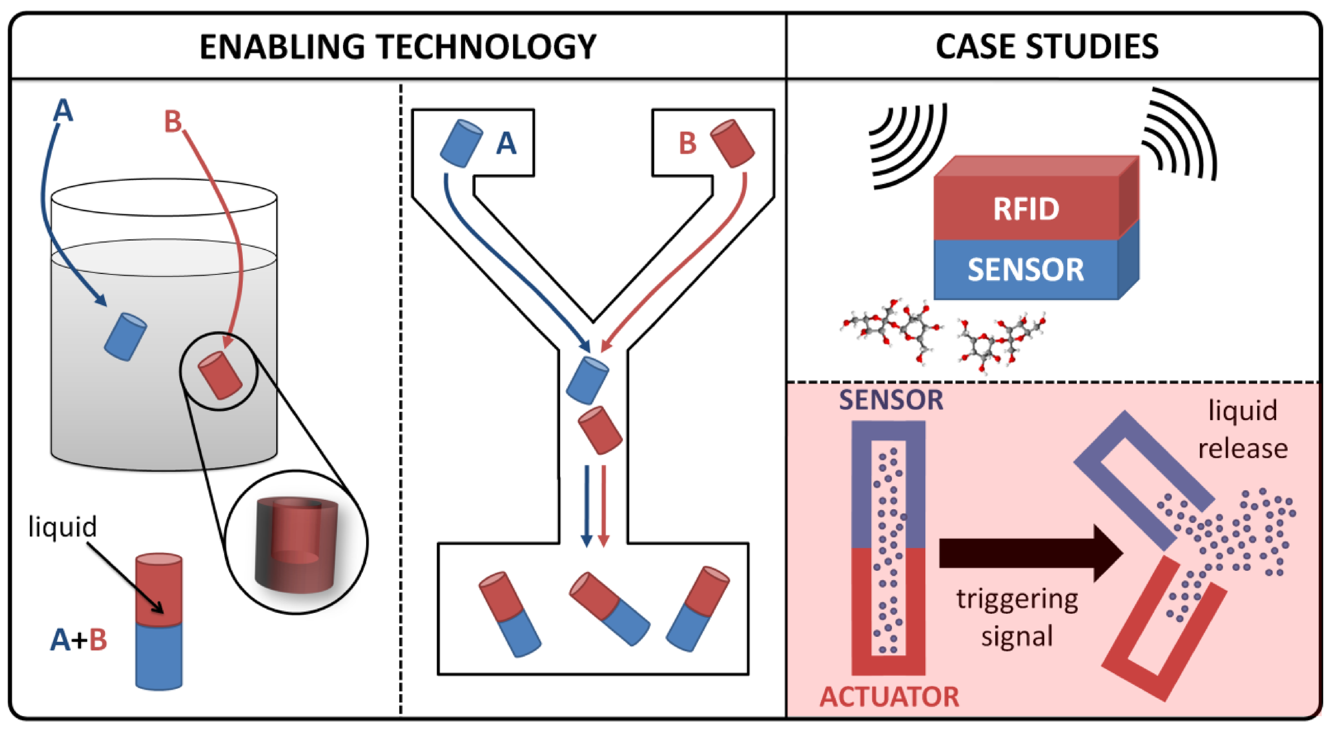
- **Self-assembly** of MEMS components in **bulk liquid**
- Enabling strategies for assisted self-assembly (preparation, assembly and sorting)
- Case study: Cylindrical MEMS **encapsulating** a functional fluid
- Pre-study: Full SU-8 cylinders

Estimation of non-retarded van der Waals interaction free energies of SU-8 cylinders in water



Assembly cycle of cylindrical MEMS components





Source: Internal SelfSys meeting

Desired criteria for reasonable self-assembly,

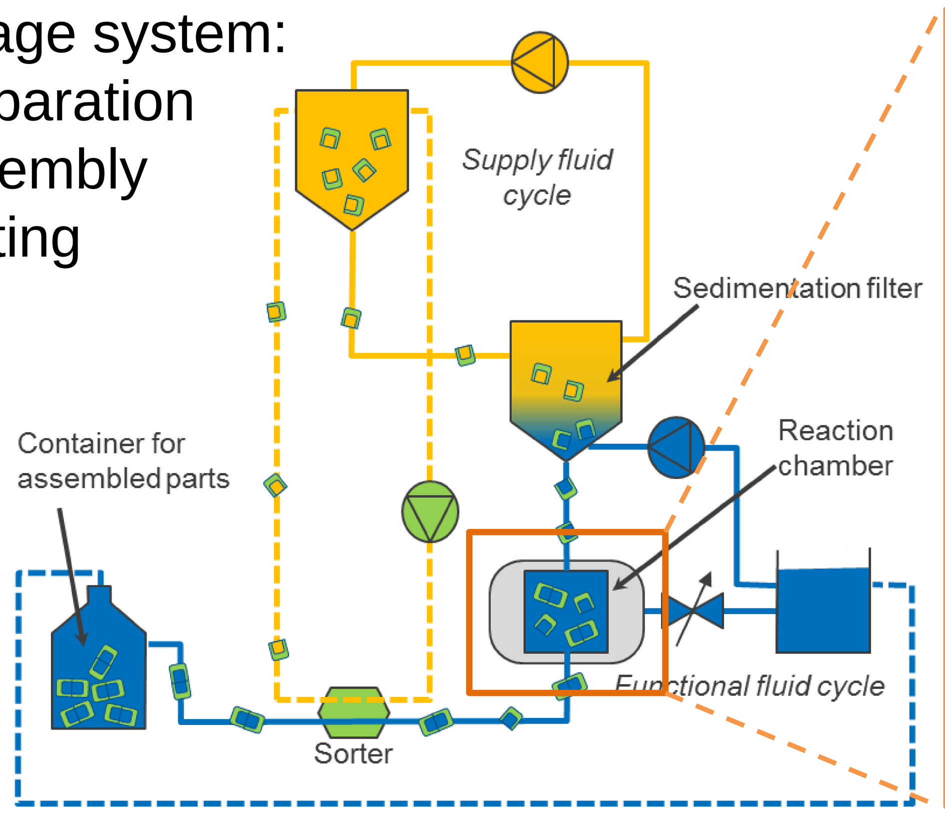
- a **minimum of energy** must be achieved for the assembly condition ✔
- the **energy barriers** have to be **small** in order to reach the energy minimum ✔
- **random energy** (e.g. a vibration of the system) must be introduced to the system in order to achieve the assembly ✔

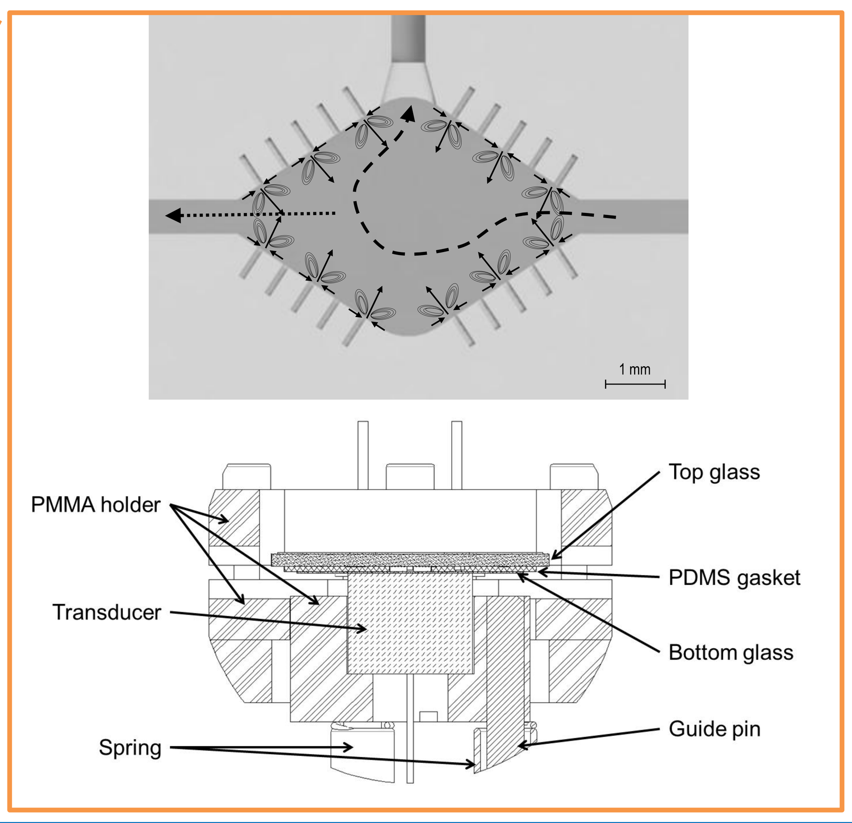
Source: Cohn, M.B: „Microassembly Technologies for MEMS", Univ. of California, Berkeley, 2004

Experimental Setup

Three stage system:

- Preparation
- Assembly
- Sorting





Assembly

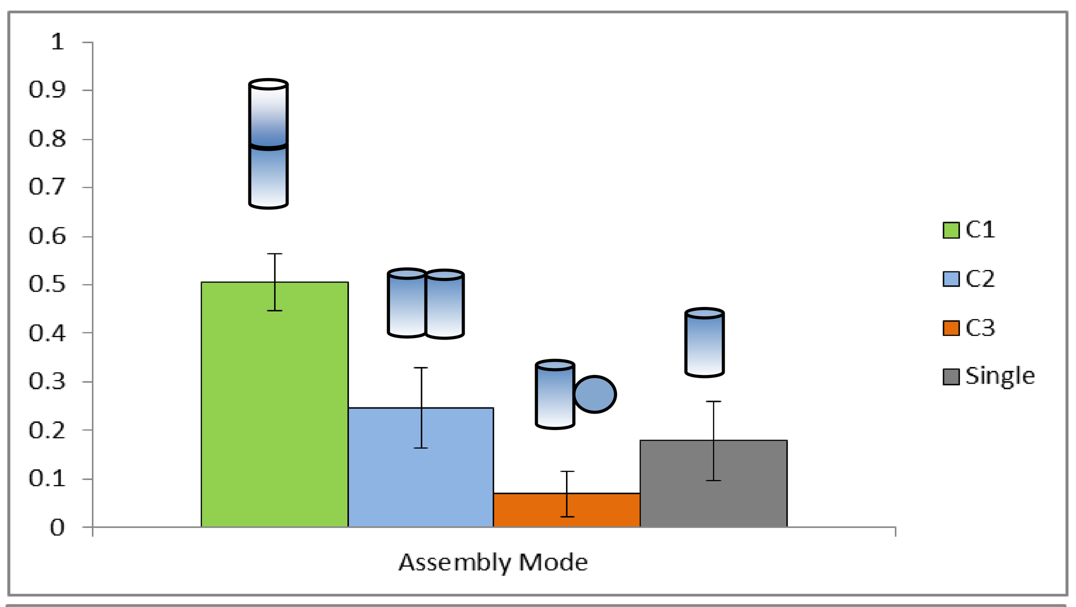
Piezo driven, bubble mediated introduction of random energy:

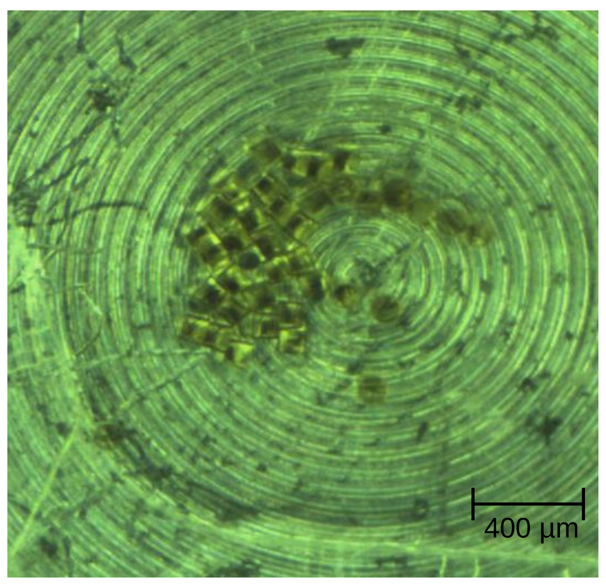
- **Strong mixing** even in microfluidic systems
- Almost turbulent streaming inside the chamber
- **Friction** of MEMS at the bottom of the chamber is **reduced** due to ultrasonic agitation
- Energy barriers (EA) can be overcome

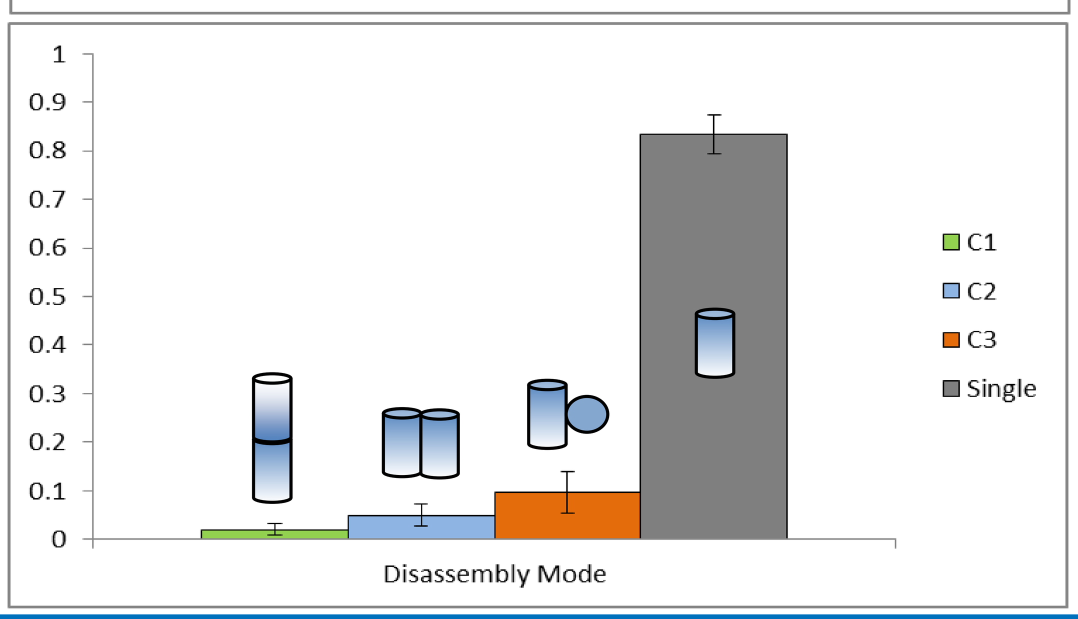
Integrated system for particle handling:

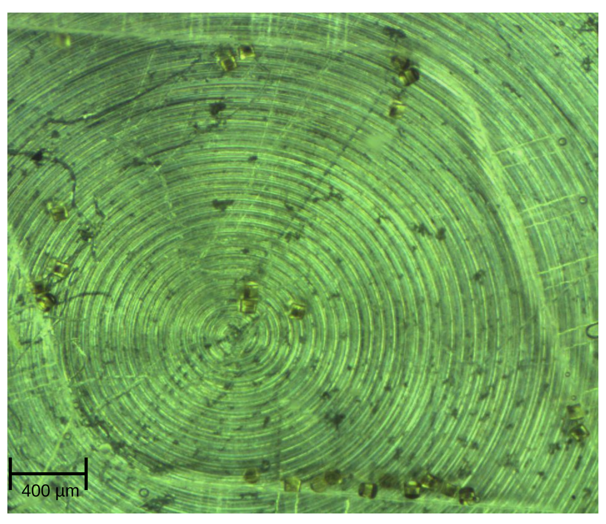
- Integrated PDMS **valves close to chamber** core (cm range)
- **Integrated filter** for particle loading

Results









Two major modes can be applied to MEMS inside the chamber:

1. Assembly Mode:
   - Agitation values: 60 kHz, 150 Vpp
   - **Agglomeration** of MEMS in the center of the chamber
   - After 10sec approx. 50% of the MEMS have assembly state
2. Disassembly Mode:
   - Agitation values: 45 kHz, 100 Vpp
   - **Dispersion** of MEMS to sidewalls of the chamber
   - After 10sec approx. 85% of the MEMS do not have any connections to other parts

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