A Calibration-free, Disposable, Non-contact Reagent Dosing Cartridge for the Sub-µl Range

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Motivation

Challenge:

Dispensing systems are required to handle a wide range of rheological properties of e.g. IVD reagents:

Viscosity:	**1 – 17 mPas**
Surface tension :	**30 – 71 mN/m**

↳ Commercial liquid handling devices need to be calibrated to the specific reagent properties.

Solution:

We have developed a disposable cartridge (self dosing cassette) which **dispenses liquids** with various rheological properties **calibration-free**. A **non-contact sensor monitors and controls** the dispensing process.

Working principle

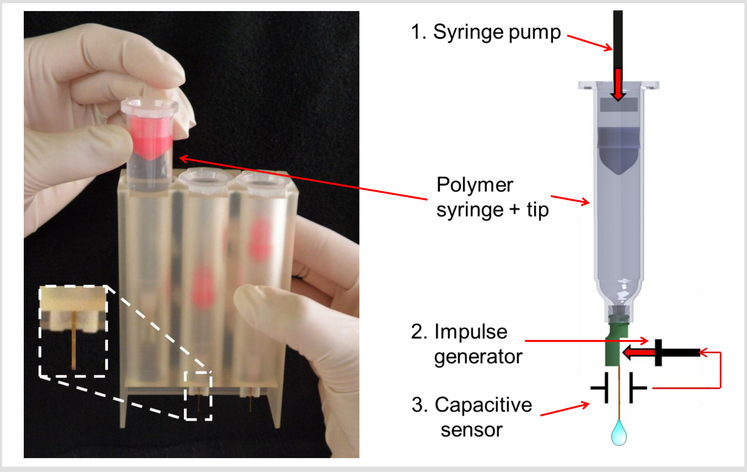

Figure 1: *Left: The disposable cartridge with three syringe reservoirs holding different reagents for e.g. an IVD assay. Right: Sketch of the polymer syringe with a polymer tip and the interfaces to the actuators (syringe pump (1) and impulse generator (2)) and the sensor (3).*

1. Syringe pump

Positive displacement to eject target volume in the form of a jet or free droplet.

2. Impulse generator

Detachment of pending droplet at the nozzle **by a mechanical impulse**: A piezo-actuated piston hits the polymer nozzle.

3. Capacitive sensor

Monitoring/controlling droplet detachment. A capacitive non-contact sensor above the nozzle detects the presence of a pending droplet and **retriggers the impulse generator** if necessary.

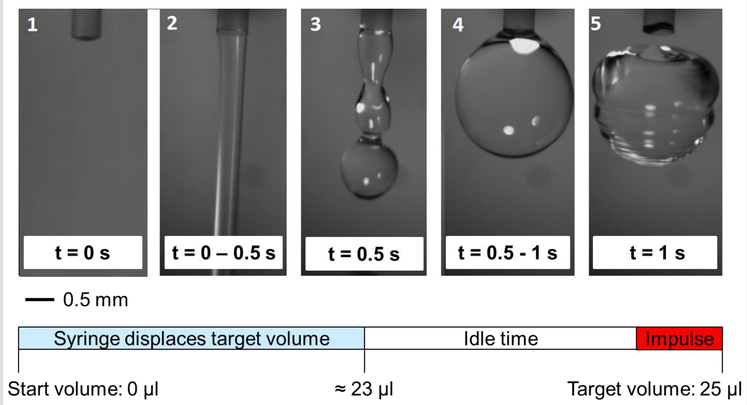

Figure 2: *Pictures of an exemplary dispense of 25 µl. The syringe pump positively displaces a jet of ca. 23 µl (1-3). Due to low dynamics, a pending droplet of ca. 2 µl forms at the nozzle (4), which is knocked off by a plunger mechanically hitting the nozzle with a stroke of 30 µm (5).*

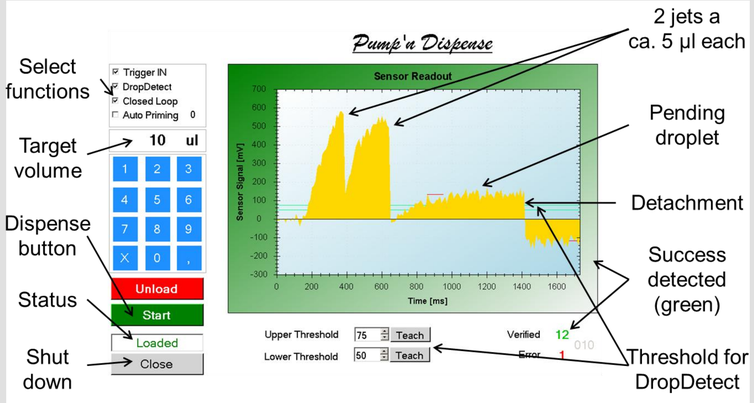

Figure 3: *Screenshot of the control software (touch panel at the backside of the prototype). Left: Selection of different functions and the target volume. Right: Life view of the detected sensor signal confirming a successful dispense of 10 µl.*

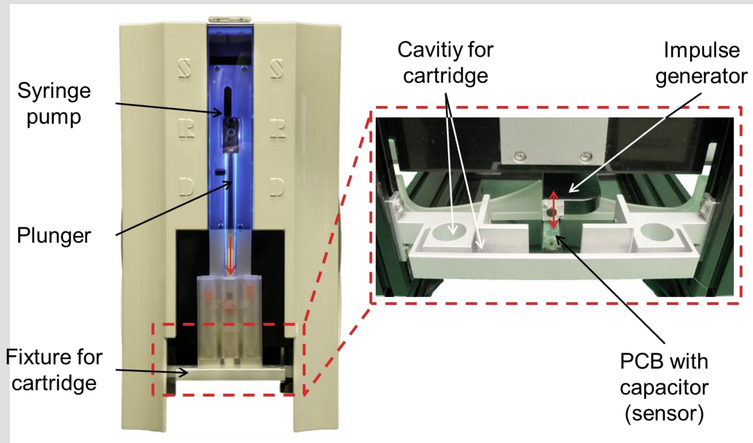

Figure 4: *Left: The prototype with the syringe pump and the disposable cartridge containing three syringes. Right: close up off the cartridge holder with the piezoelectric impulse generator and the capacitive sensor.*

Experimental Results

The prototype (see Fig. 3-4) was characterized for **five test liquids**, covering the complete range of rheological properties, **at one set of dispensing parameters** (see Fig. 5).

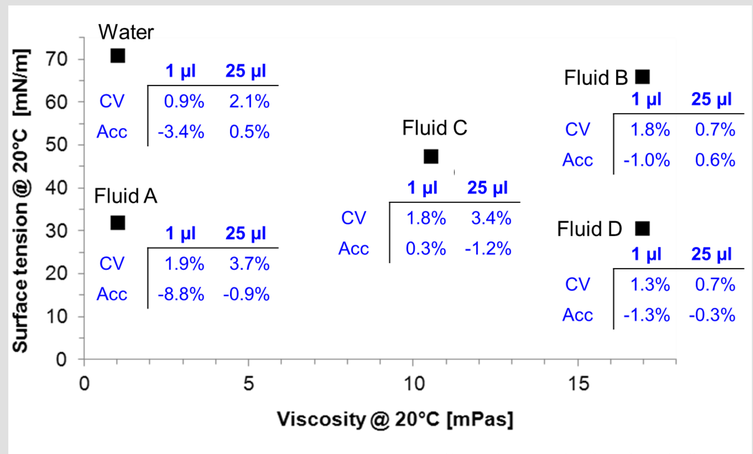

Figure 5: *The precision (CV) and accuracy (Acc) at a target volume of 1 and 25 µl for five test liquids having different rheological properties. The dispensing parameters were not changed or calibrated for any liquid.*

Conclusion

- **Calibration-free** liquid handling:
  No adjustment of dispensing parameters to different liquids or changing conditions (temperature etc.) necessary
- **Online process control** of the dispensing process
- **Non-contact** dispensing / sensing down to 0.25 µl
- **Low-cost**: Disposable use of contaminated components
- **Typical CV / accuracy**: CV < 2%; Acc < ±9% @ 1 µl

Acknowledgements

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