



- 1 *Sensor plus pump: integrated drug delivery module*
- 2 *Capacitive two-phase flow sensor with integrated micropumps as a controlled micro dosing system for lubrication of ball bearings in machine tool spindles*

## SMART MICRO DOSING SYSTEMS

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### Applications

Micro dosing technologies based on micro diaphragm pumps cover a wide range of applications – from medical technology to production to consumer electronics.

In medical technology, micro dosing systems can be used as implants, for example as artificial sphincters or for glaucoma therapy. Further applications lie in the micro liter accurate dosing of drugs by pump-based micro dosing systems. For the manufacturing industry, micro dosing systems offer completely new possibilities for the micro-lubrication of production machines.

In the field of consumer electronics, new features can be realized or optimized using miniaturized and cost-effective micro

dosing systems, for example gas sensors in mobile devices or scent dosing.

### Technical innovation

#### Micropumps:

The 5 x 5 x 0.6 mm<sup>3</sup> silicon micropump developed at the Fraunhofer EMFT is not only the world's smallest pump at present, but also has a low cost potential for micro dosing components for single use due to its small chip size. For higher flow rates the metal micropumps made of stainless steel (Ø20-30 mm x 2 mm) are favourable. Established and series-production-friendly manufacturing processes enable cost-effective production even for small volumes.

Fraunhofer EMFT is participant in the



All micropumps meet the highest reliability and safety requirements:

- High back pressure capability with liquids, but also with gases
- Self-locking „free flow“ protection to prevent mis-dosing
- Metering monitoring methods to monitor the dosing and detect malfunctions
- Integrated bubble detection and bubble separator
- Multiple autoclavability of the metal micro pump without loss of function

#### **Miniaturized high-voltage piezoelectric actuator driver:**

Fraunhofer EMFT has developed a dedicated actuator driver IC for its own micro dosing systems. It combines the advantages of power efficiency with miniaturization and smart driver control to compensate actuator degradation. The novel concept provides a number of unique features:

- Single-ended high-voltage driving enables the use of MEMS (micro-electromechanical systems) micropumps in close-to-body applications, the silicon channel structure requires ground connection
- Adjustable high voltage signal of positive and negative polarity to achieve fast and accurate pumping/mechanical displacement
- Programmable rising/ falling ramps allow accurate mechanical displacement control
- Miniaturized driver electronics in scale of 3 x 3 mm<sup>2</sup> allow entering of new application fields

#### **Systems with dosing monitoring**

In a joint project, Fraunhofer EMFT and Sensirion AG have developed a concept study for a smart and cost-efficient miniaturized module allowing a controlled and monitored drug delivery. It comprises a silicon micropump in combination with a single-use liquid flow sensor and measures a mere 35 x 15 x 5 mm<sup>3</sup>.

Together with GMN Paul Müller Industrie GmbH, Fraunhofer EMFT has developed a monitored dosing system of minute quantities of lubrication oil. The method is based on non-capacitive flow measurements by means of interfaces between gas and liquid, generated by two silicon micropumps in a microchannel.

The new dosing system saves up to 95% of the lubricant quantity previously required – thereby reducing production costs and negative environmental impact and increasing operational safety.

#### **Outlook**

Fraunhofer EMFT is working with industry partners on new, application-oriented micro dosing solutions to address current market requirements and to drive the industrialization of its silicon and stainless steel micropumps. Otherwise, an additional miniaturization is essential for many applications with future potential. In this context, a silicon pump with dimensions of only 3 x 3 x 0.6 mm<sup>3</sup> is currently being developed at Fraunhofer EMFT.

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3 *Micropump for use in smartphones*

4 *Micropump driver ICs realized with 0.35  $\mu$ m high voltage process*