

- 1 *Micropump for use in smartphones*
- 2 *Family of silicon micropumps*

## SILICON MICRO DIAPHRAGM PUMPS PORTFOLIO

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### Applications

The silicon micropump can handle various types of gases and liquids while demonstrating long time stability and accuracy. These properties are essential for diverse applications, thus making the micropump a valuable asset for a number of business fields.

**Consumer:** Due to the small size and low power consumption of around max. 8 mW, the micropump can facilitate integration of environmental sensors in smartphones, smartwatches and other wearable products. The reaction time of the sensor improves twentyfold, allowing real-time monitoring of the ambient air.

**Medical:** Due to its compatibility with many gases and liquids, the micropump has great potential in breath analysis for diagnosis of cancer, gastrointestinal tract and pulmonary diseases, diabetes etc. Another promising application lies in drug delivery systems for diabetes-, tumor-, hormone-, pain and ocular therapy in forms

of ultra-thin patches as well as targeted delivery within implantable systems.

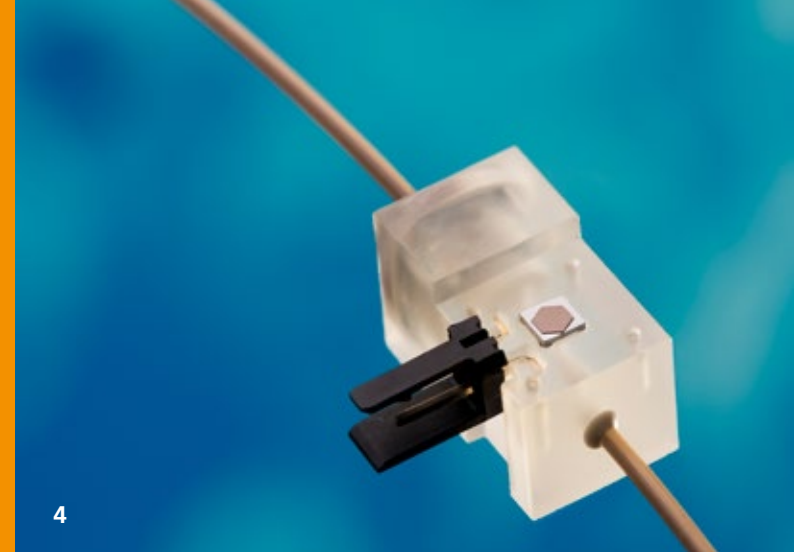
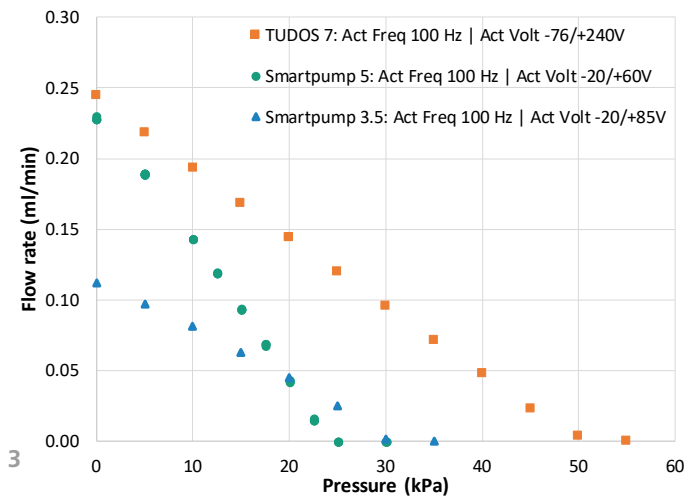
**Scent-Dosing:** Release of tiny amount of odor for individual experience within learning programs, psychotherapy, anosmia treatment, first responder and military training etc. to facilitate full immersion in the desired environment.

**Industry/Production:** Dosage systems for small quantity of lubricants, fuel dosing systems, micro pneumatics, micro hydraulic systems and dosage systems in production processes.

**Safety/Security Application:** Use in miniaturized detection systems for identification of smoke, explosives, drugs etc.

**Laboratory Technology:** Key component for ultralight air cushion pipette, filling of microliter plates to facilitate automation.

**Analysis Systems:** Use in environmental monitoring systems, production monitoring systems, lab-on-chip applications, HPLC systems etc.



3 Air characterization for silicon micropumps

4 Smartpump 3.5 in test housing

### Technical innovation

- Extreme miniaturization enables cost-efficient large scale manufacturing of silicon micropumps for disposable use in consumer application, point-of-care testing, lab-on-chip analysis etc.
- Tailored design for customer specific application with adjustable size, flow rate, backpressure and suction pressure etc.
- Cost efficient manufacturing and application
- Significantly reduced dead volume resulted in compression ratio  $\epsilon = \frac{\Delta V}{V_0}$  approaching 1, which implies high bubble tolerance and self-priming capability of the micropump

### Technical data

Overview of the performance of different silicon micro membrane pumps developed at Fraunhofer EMFT:

Pump type	Unit	TUDOS 7 ( $\mu$ P015/ $\mu$ P016)	HighFlow 5 ( $\mu$ P029)	Smartpump 5 ( $\mu$ P026v1)	Smartpump 3.5 ( $\mu$ P027)
<b>Weight</b>	mg	70	30	30	12
<b>Size</b>	mm <sup>3</sup>	7x7x0.8	5x5x0.6	5x5x0.6	3.5x3.5x0.6
<b>Operation voltage +</b>	V	240	100	60	70
<b>Operation voltage -</b>	V	-76	-20	-20	-20
<b>Stroke volume</b>	nI	80	65	50	20
<b>Back pressure air</b>	kPa	50	15	30	25
<b>Suction pressure air</b>	kPa	-38	-11	-20	-25
<b>Blocking pressure liquid</b>	kPa	380	55	80	100
<b>Flow rate (max. air)</b>	$\mu$ l/min	400	4500	300	500
<b>Flow rate (max. liquid)</b>	$\mu$ l/min	90	450	60	45

### Outlook

- The next step towards industrialization of the micropump in high volumes requires development of cost-efficient supply chain with front-end and back-end processes with wafer-level piezo mounting and pump testing.
- Development of the silicon micropump based on electrostatic actuation principle with further miniaturization down to 2x2 mm<sup>2</sup> according to the roadmap.