

1 *Fluidic Module (PEEK) of a Micro Volume Metering and Dosing System designed for Tumor Therapy. Left: (back side) channel system covered with PEEK foil using laser welding. Right: (front side) micro air pump, micro drug pump, bubble separator.*

MICRO DRUG DELIVERY SYSTEM FOR TUMOR THERAPY (TUDOS)

Description

The micro drug delivery system (TUDOS) is a new system for handling, metering and dosing of very small quantities of drugs, enabling very accurate dosing of volumes. As a demonstrator, a system to dose a very small quantity (14 μl) of drug (cytostatica) for tumor therapy has been realized, with a dosing accuracy of 4%.

The system comprises two micropumps (one for the dosing liquid, one for air), a metering meander (with the dosing volume) and a stop electrode which can distinguish between liquid and air by capacitive measurement. A bubble separator is installed directly behind the electrode.

Function principle of TUDOS

The air and liquid channels unite in a T-junction at the beginning of the metering

channel. First the metering channel is primed by liquid. Then the air pump (with a stroke volume of 80 nl) starts to operate, pushing an air-drug meniscus like a piston towards the metering channel and performing the dosing. At the arrival of the air-drug meniscus at the electrode at the end of the metering channel the air pump stops. Then the liquid pump starts and refills the channel with drug, at the same time the air disappears through the bubble separator. When the drug-air meniscus arrives at the electrode, the liquid micropump stops and the dosing cycle is completed.

Benefits of the metering system

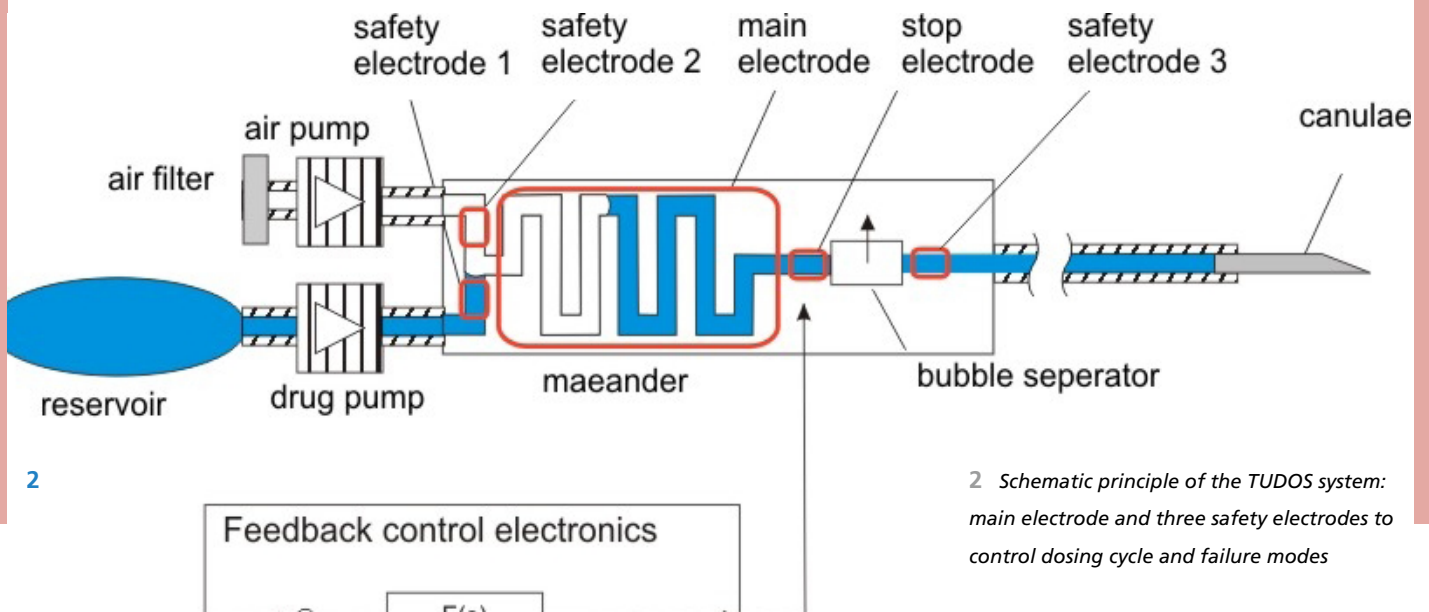
The metering and dosing accuracy is no longer dependent on micropumps, backpressure or temperature. The metering volume is only defined by the volume of the metering channel between T-junction and electrode.

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2 Schematic principle of the TUDOS system: main electrode and three safety electrodes to control dosing cycle and failure modes

High pressure micropumps

Both - air pump and drug pump - are silicon pump chips with the size of 7x7x1 mm³. The back pressure ability with drug is up to 6 bar, and the air pump can achieve a back pressure of 0,9 bar. That makes the pumps strong enough to purge a catheter in case of blockage.

Safety features

To detect other system failures, which are important in medical applications, this system has additional electrodes: before the T-junction two electrodes detect pump leakages and bubbles carrying from the reservoir, and after the bubble separator one electrode detects if a bubble is passing the bubble separator. Furthermore, a large electrode at the metering channel can measure every single pump stroke, enabling easy detection of pump failure or catheter blockage.

System control

Both micropumps and all sensor electrodes are controlled by a system control unit. The dosing of the metering volumes can be set using a special user interface. A simple and robust algorithm is implemented to realize the dosing step and to monitor and handle all possible failure modes.

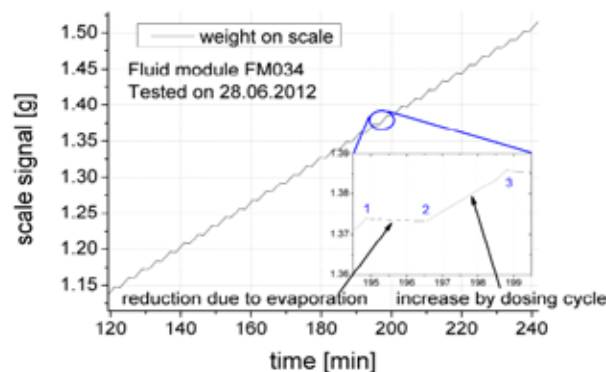
State of development

Currently, the animal testing (rat model) is starting. Prototypes of metering systems are available for evaluation within the framework of a feasibility study or an application project.

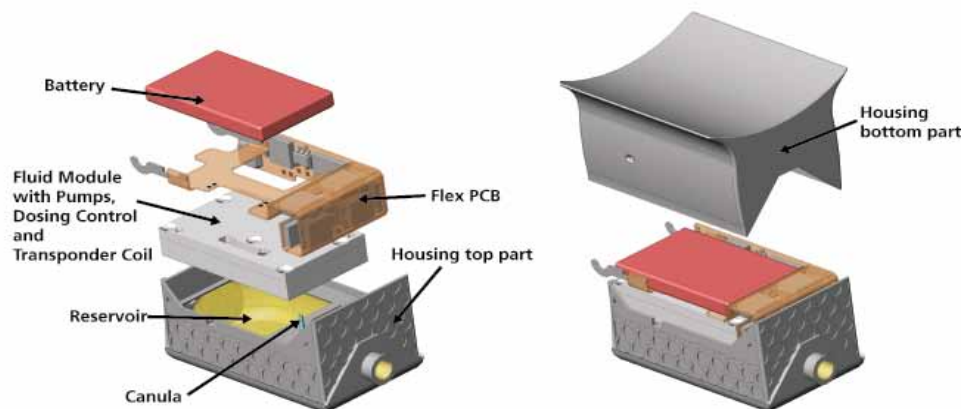
Project partner

The development was realized in a joint project of:

- Fraunhofer EMFT
- Fraunhofer IZM
- Fraunhofer ITEM
- Fraunhofer IBMT
- Fraunhofer LBF



Gravimetric fluidic test of the TUDOS drug dosing cycle. One dosing step delivers 14 µl of drug.



Assembly of the TUDOS drug dosing system. All accommodated components are arranged within the top-part of the housing (left). Finally, the arrangement is capped by the bottom-part of the housing (right). Weight: 5.47 g, Outer dimensions: Width 19.9 mm, Length 31.8 mm, Height 18.6 mm.