Ink Jet Printing of Organic Materials for Polymer Electronics

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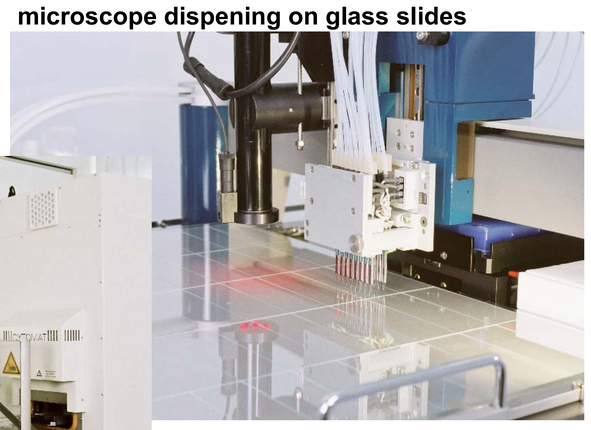
GeSiM Nano-Plotter

Pipetting device suitable for non contact pipetting and dispensing jobs in the sub micro liter range

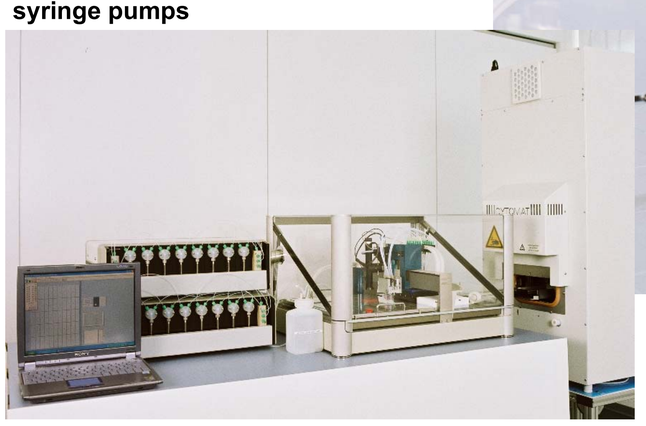
Key benefits:
- Excellent spot quality
- High reproducibility
- Low coefficient of variation from spot to spot
- Different spot sizes with one tip
- Arbitrary spot pattern with up to 16 tips
- Automatic function control of the pipettes
- Scalable workplate
- Head with 4 independend z-axis available

Accessories:
- Humidifier
- Optical droplet detection
- Optical target recognition
- Coolable plate holder
- Coolable and removable slide tray
- Chiller
- Target visualisation
- Micro plate handler
- Z-level sensor

16 channel Nano-Plotter with video microscope dispening on glass slides

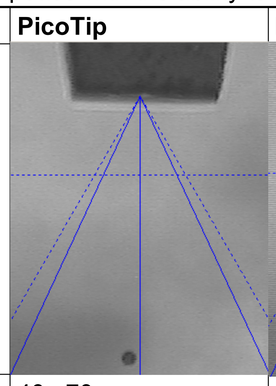
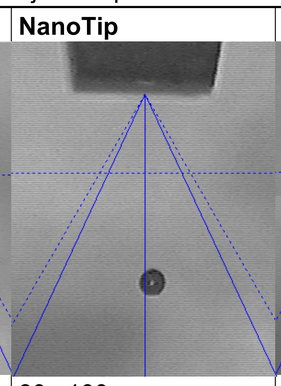
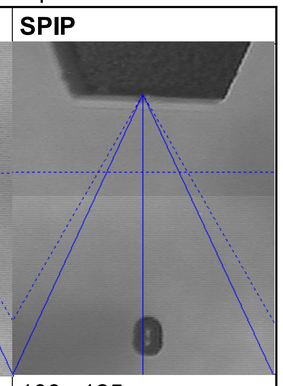


16 channel Nano-Plotter with syringe pumps



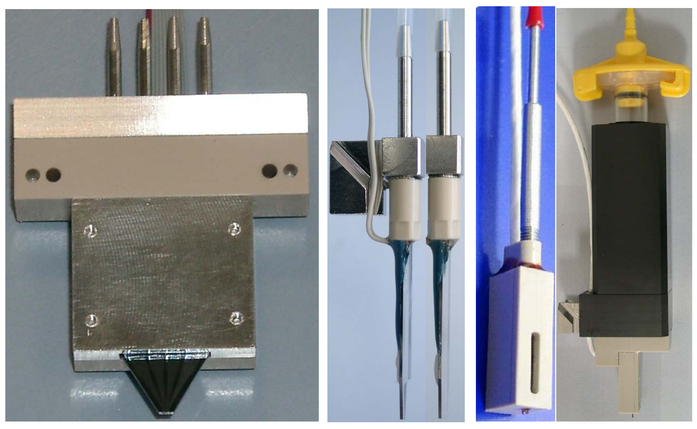
GeSiM micropipettes

Piezoelectric micro dispensers and pipettes with the ability to eject droplets down to 50 pico liters

Type	PicoTip	NanoTip	SPIP
			
Droplet diameter [µm]	40...70	80...100	100...125
Dispensing volume [pl]	33...180	250...520	600...1000

Options:
- Different inlet configurations
- Integrated heater
- Layout adaption to specific dispensing tasks
- Multi nozzle print heads

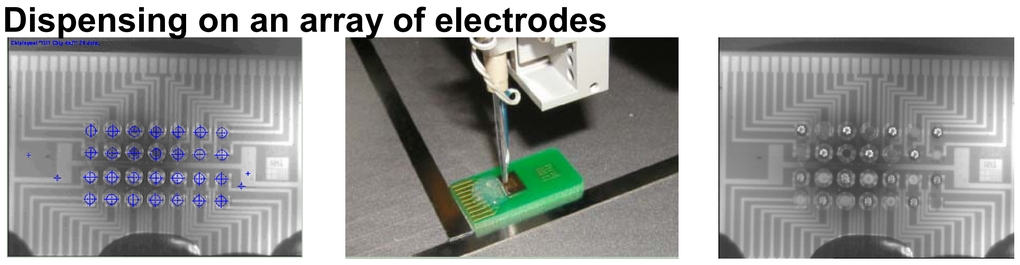
Successfully dispensed media:
- Organic solvents like toluene, DMF, dichlorobenzene, xylene, DMSO, ...
- Proteins (< 1 mg/ml), DNA
- Glycerol (50 % at rt, 100 % with heater)
- Ethylene glycol
- Up to 50 % PDMS
- Different adhesives
- Different liquid crystals



Applications

Targets and pattern recognition

Dispensing on an array of electrodes



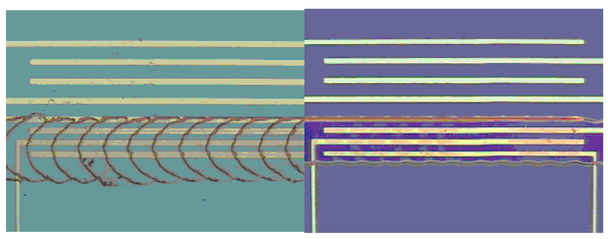
The pictures show the finding of the spotting positions (left), the dispensing of the sample and the array with sample on the desired positions after spotting

The image recognition module of the NPC8/16 software contains a set of algorithms to detect spotting positions on several types of targets. For the electrode chip an algorithm which uses two rectangular alignment marks on the chip was chosen. These markers define a coordinate system and the user is free to set the spot positions anywhere by entering its coordinates with the help of our ChipDesigner program.
The pattern recognition algorithm finds the alignment marks and and calculates the spot Now the Nano Plotter™ is ready to spot exactly into the wells of the chip. After the camera returned to the chip we can observe the spotting result in a live video image. It is also possible to store images for documentation purposes. For better visibility just every second position is spotted in this example.

Polymer Electronics

P3OT

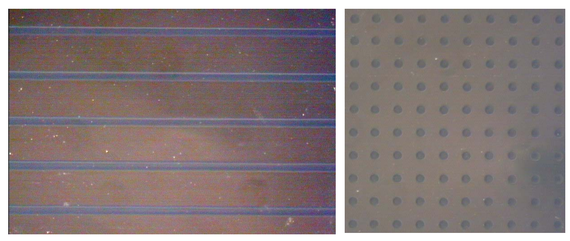
- Line printing via overlapping of single dots
- Problems (flake like overlap) with trichloroethylene based solution due to too fast evaporation
- Well from chlorobenzene and xylene
- 150 .. 180 µm in width depending on concentration and jetting parameters with the given tip



oFET test devices with ink-jet printed line of dissolved P3OT: left: 1 mg/ml in trichloroethylen, right: 1 mg/ml in chlorobenzene

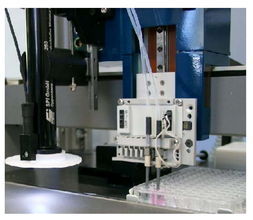
PEDOT:PSS

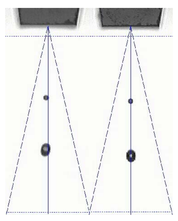
- test liquid: poly(styrenesulfonate)/poly(2,3-dihydrothieno[3,4-b]-1,4-dioxin), 2,8 wt% disp in water, elec. grade from Aldrich has been used
- the content of PEDOT and PSS in this solution is about 0,14% and 2,6 % respectively
- the viscosity is about 20 mPas.



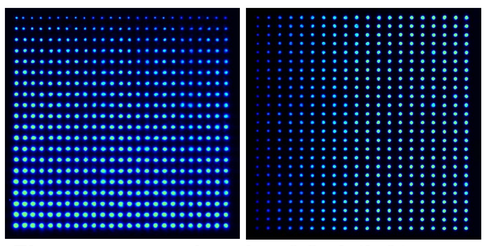
Ink-jet printed lines and spots of PEDOT:PSS: left: lines dispensed at 1 kHz, width about 170 µm right: 10 x 10 array, spot size 145 µm

Combinatorial Experimentation





Aspiration from a 96 micro well plate (left) and the stroboscopic images of tip 1 (Cy3, middle) and tip 2 (Cy5, right)



Fluorescence signals of Cy3 (left) and Cy5 (right)

One opportunity is to generate spots on a target consisting of defined amounts of different materials. To show this only two different materials are used here. The first material is deposited in horizontal lines with a constant number of droplets/spot within one line and an increasing number of droplets/spot from line to line. For the second material the number of droplets/spots is constant in the vertical lines. While travelling from one column to the other the number of droplets/spots has been increased by one. Following this procedure 400 spots with different composition have been fabricated.

The experiment has been performed using a two channel Nano-Plotter equipped with two Nano-Tips. The spotting position of the two tips has been adjusted using a video microscope and an image processing system.

The aspirated volume for both channels was 3 µl. A droplet volume of 320 pl has been used for both tips. The pitch of the resulting micro array was 600 µm. For the evaluation of the spots a fluorescence reader was used.

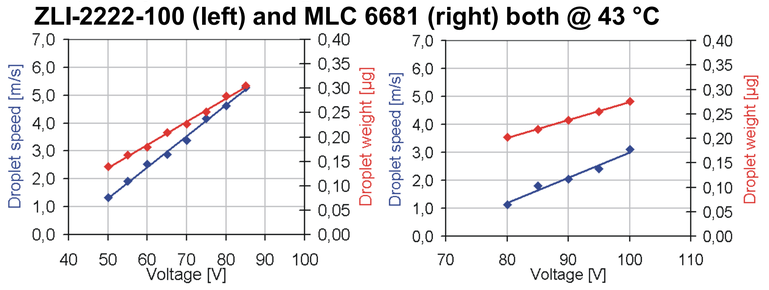
High viscous liquids

Liquid crystals

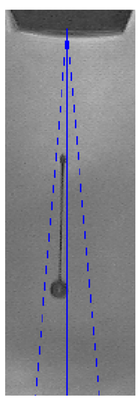
Tested solutions:
- Merck Licristal ZLI-2222-100 (viscosity=12 mm²/s @ 23 °C)
- Merck Licristal MLC-6681 (viscosity=96 mm²/s @ 23 °C)

- Test solutions cover a wide viscosity range
- Although heating is recommanded both liquids can be dispensed even at room temperature
- Droplet weight adjustable between 150 and 600 ng
- The maximum dispensing frequency is about 2 kHz depending on the temperature and the viscosity of the liquid

Droplet speed and weight of Merck Licristal ZLI-2222-100 (left) and MLC 6681 (right) both @ 43 °C



Ejected droplet of ZLI-2222-100



ZLI-2222-100 on glass pitch 350 µm