Dispensing of PEDOT:PSS using GeSiM micro pipettes

Goal
The conductive polymer PEDOT:PSS is widely used for hole injection and transportation layers in OLED devices. The mixture of PEDOT and PSS is suspended in water.
The goal of the paper is to show that such a suspension can then be dispensed using GeSiM micro dispensing tools.
Furthermore some tests have been carried out to determine spot sizes and line widthes on glass slides coated with aluminium.

Test liquids
For the dispensing test poly(styrenesulfonate)/poly(2,3-dihydrothieno[3,4-b]-1,4-dioxine), 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.

Experiment
The tests have been performed using three different dispensers including the GeSiM standard NanoTip and two modified NanoTips including one especially designed for liquids with higher viscosities. For each tip a parameter optimization has been run to find a set of suitable settings for the micro dispensers.
Glass slides with an aluminium coating has been used as targets for the dispensing. This coating has been choosen just to increase the visuability of the spots.
The spot diameter as a function of the settings has been measured as one of the parameters of interest.
A rectangular excitation voltage has been used for the dispensing tests.
A one channel Nano-Plotter has been used for the tests.
The PEDOT/PSS has been aspirated from a 384 micro well plate. After that the tips have been check in the stoboscope and the arrays have been dispensed.
The pitch of the arrays is 400 µm.

Results
NanoTip
The first tests have been performed using the standard version of the GeSiM NanoTip. The results are shown in Fig. 1.

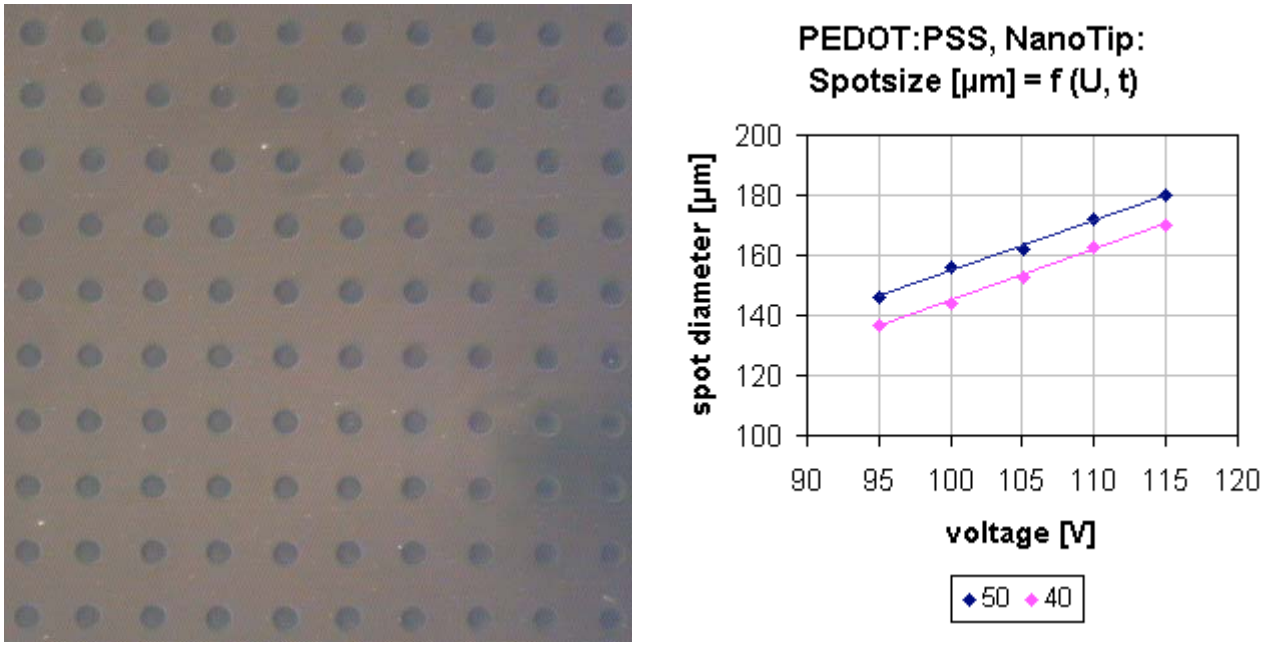


Fig. 1: NanoTip: Spotpattern of PEDOT:PSS, spot size about 145 µm (left) and the spot diameter as a function of the setting (right, blue line: pulse width 50 µs, pink line: pulse width 40 µs)

The small spot diameter is about 135 µm for 95 V and 40 µs. The spot diameter increases as expected with the exitation voltage of the piezo dispenser.

NanoTip-A
Next a NanoTip-A has been used to see whether it is possible to decrease the minimum spot diameter on the aluminium coated glass slides. The NanoTip-A has a different layout of the fluidic structure. The results can be seen from Fig. 2.

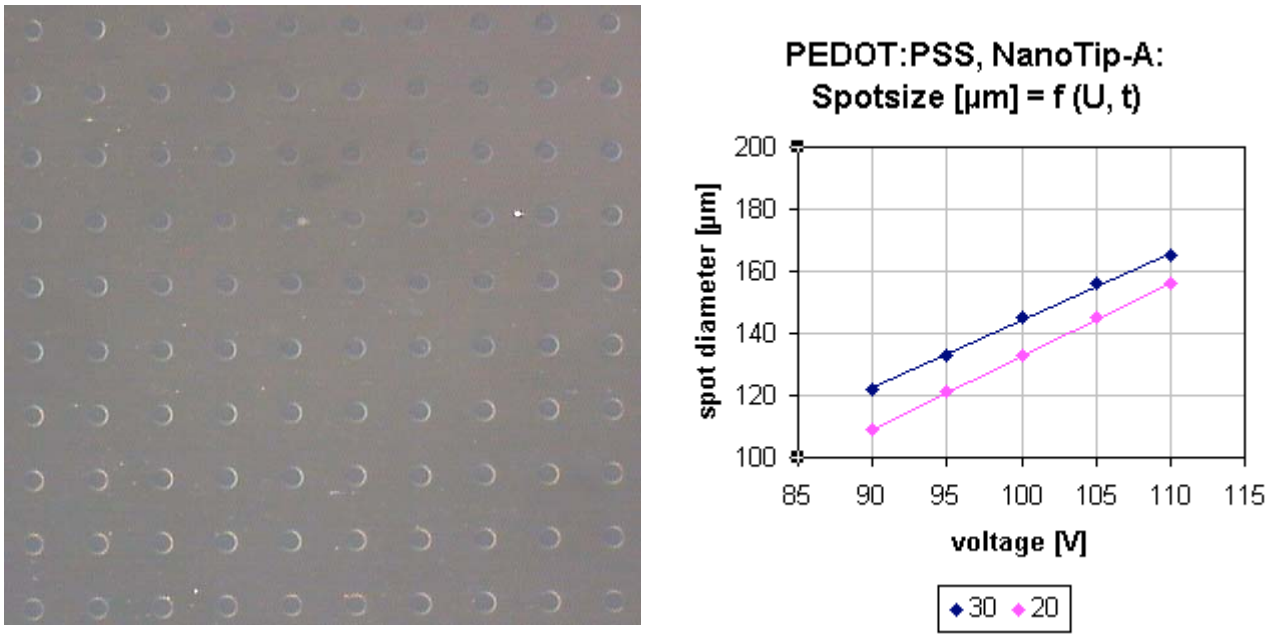


Fig. 2: NanoTip-A: Spotpattern of PEDOT:PSS, spot size about 135 µm (left) and the spot diameter as a function of the setting (right, blue line: pulse width 30 µs, pink line: pulse width 20 µs)

As can be seen from the graph in Fig. 2 the minimum spot diameter starts at about 110 µm.

NanoTip-HV
For the standard piezo dispensing tools 20 mPas are a relative high viscosity. The NanoTip-HV is a piezo dispenser especially designed for liquids with higher viscosities. We have used this dispenser to dispense lines of PEDOT:PSS on the aluminium coated glass slides. The result of this test at low frequencies is shown in Fig. 3

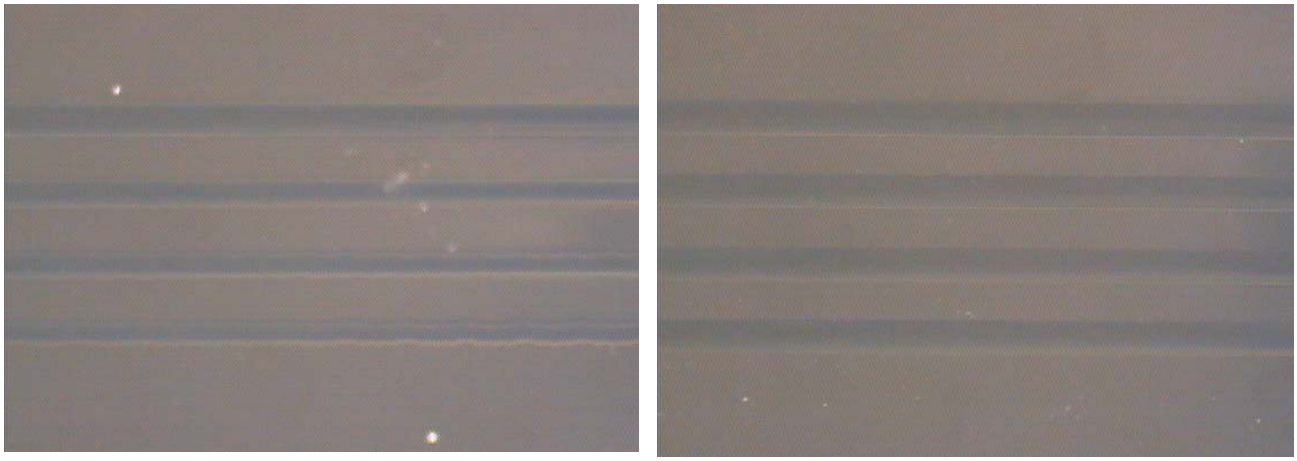
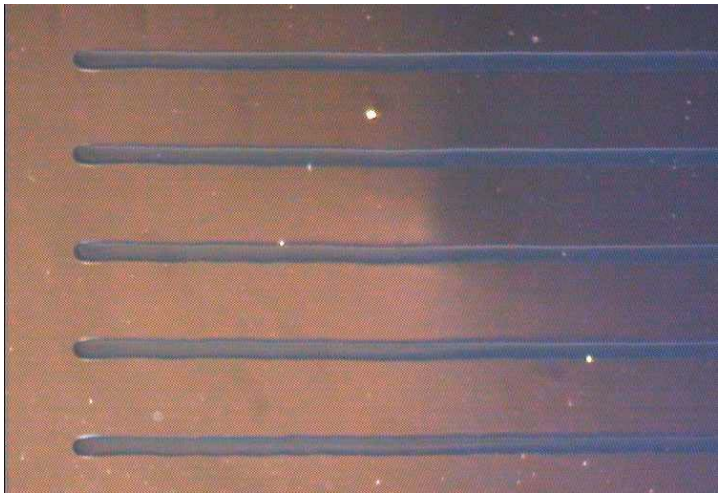


Fig. 3: NanoTip-HV, variation of the x-speed of the dispenser during dispensing from 2,5 mm/s (top) to 10,0 mm/s (bottom), step width 2,5 mm/s at a dispensing frequency of about 100 Hz. The right picture shows lines dispensed at a frequency of 200 Hz and 5 m/s x-speed.

To investigate the dispensing performance at higher frequencies tests have been carried out at 600 Hz and 1000 Hz. Using higher dispensing frequencies the speed of the axes of the Nano-Plotter during dispensing can also be increased. Fig. 4 shows the resulting line widths on the aluminium coated glass slides at 600 Hz and 1000 Hz as a function of the speed of the x-axes.



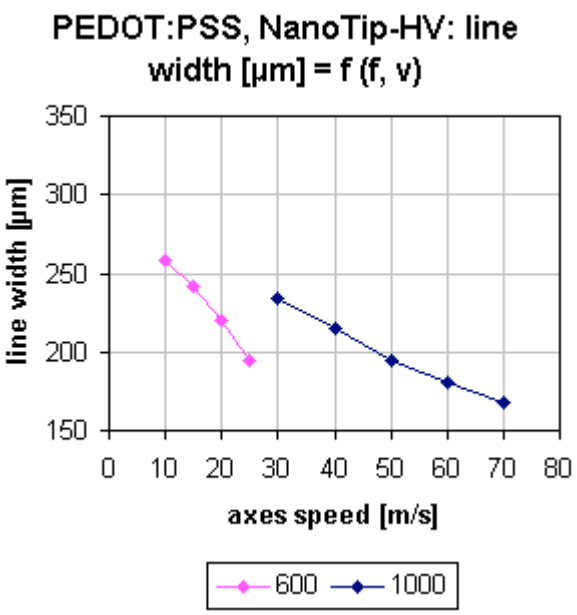


Fig. 4: Dispensed lines at a speed of the x-axes of 70 mm/s and a dispensing frequency of 1000 Hz (left). The line pitch is 700 µm. The right graph shows the line width for different speeds of the x-axes (blue line: 1000 Hz, pink line: 600 Hz).