INKJET-PRINTED CONDUCTIVE POLYMER ELECTRODES FOR AC ELECTRO-OSMOSIS

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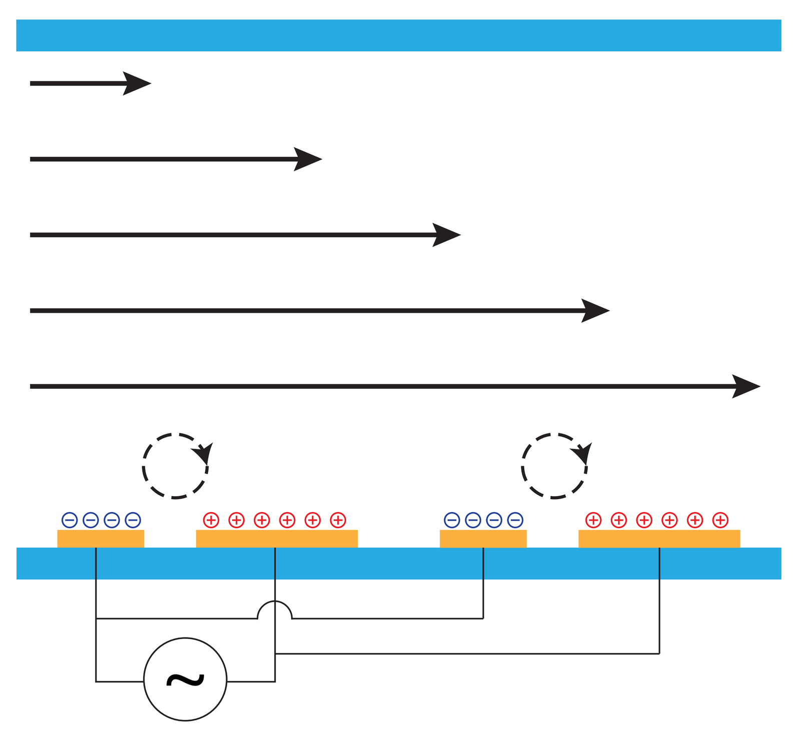
AC Electro-osmosis

Standalone integrated microfluidic systems require pumping elements. Electro-osmosis (EO) is an effective method of actuating liquids [1,2]. ACEO exploits much lower potentials and, by using alternating fields, overcomes the issues of electrolysis and gas generation [3].



Low-voltage

No gas generation

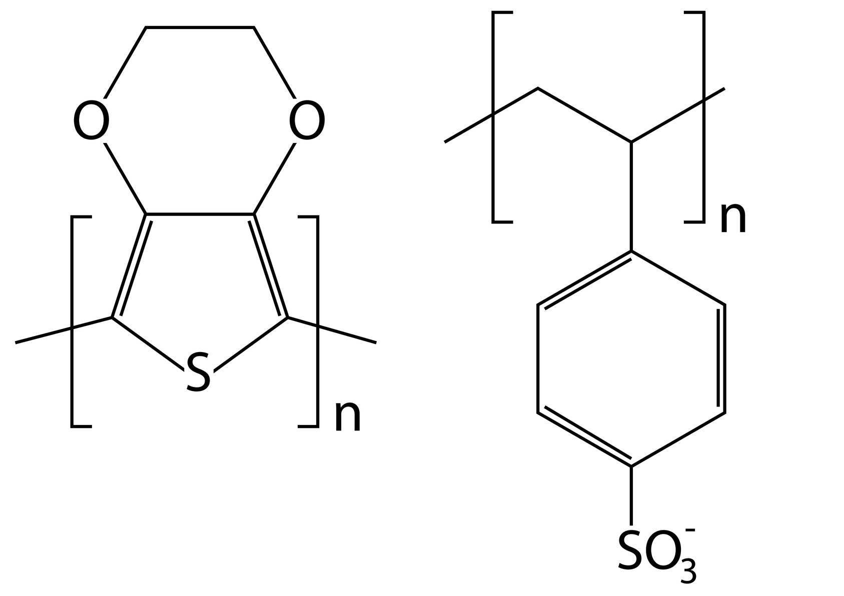
Good velocity

$$v_{aceo} \sim \int V^2 \frac{(\omega/\omega_0)^2}{(1+(\omega/\omega_0)^2)^2}$$

PROBLEM: electrolysis at very low frequencies and/or high voltages [4]

Why using PEDOT electrodes?

Poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate) (PEDOT:PSS) can withstand DC voltages as high as 100 V without electrolysis [5]. ACEO works fine with micromachined arrays of PEDOT electrodes [6].



Resists high voltages

Avoids electrolysis

Can be used for ACEO

Printable on plastics

LOW-COST

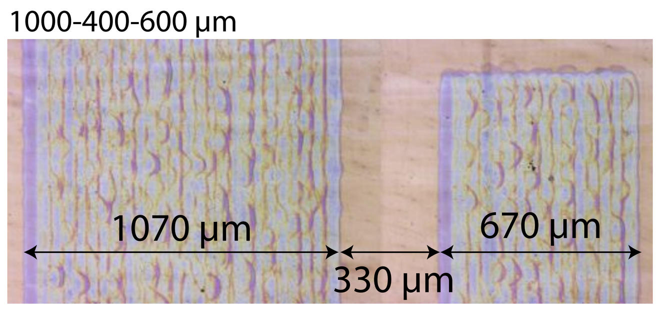
GOOD POTENTIAL FOR ACEO

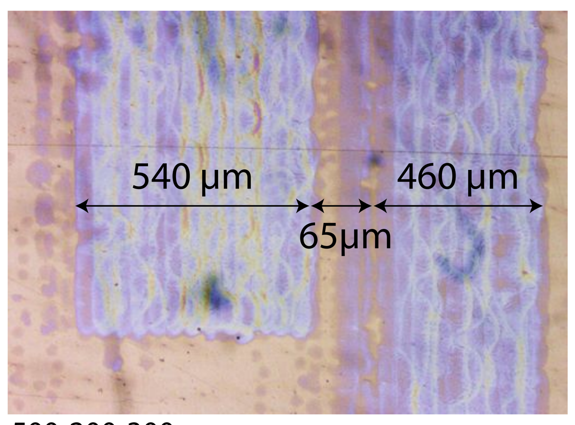
Inkjet-printing of PEDOT electrodes

Parallel to print direction

(8 layers)

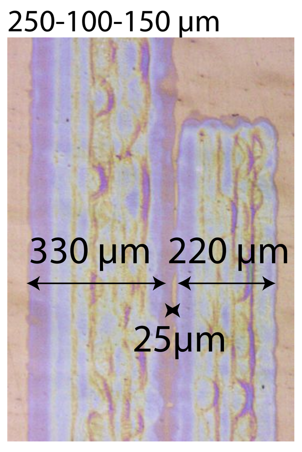
1000-400-600 µm

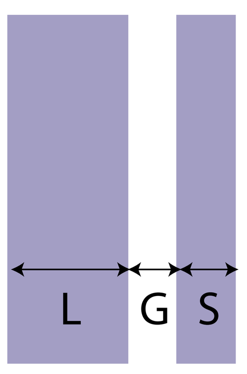




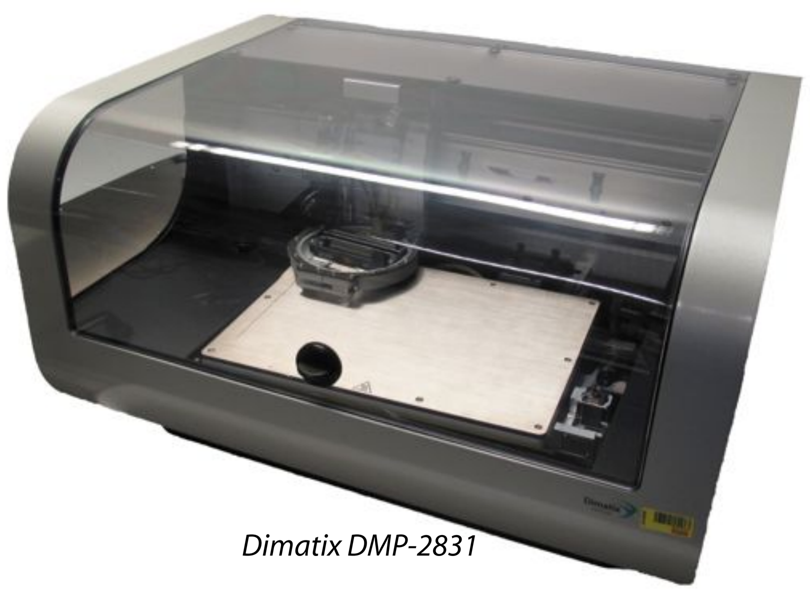
500-200-300 µm

250-100-150 µm





design of printed L-G-S electrodes



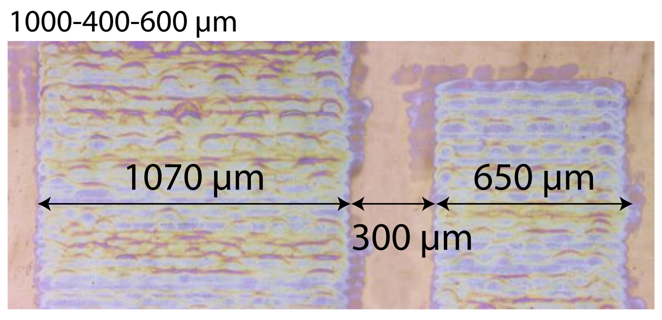
Dimatix DMP-2831

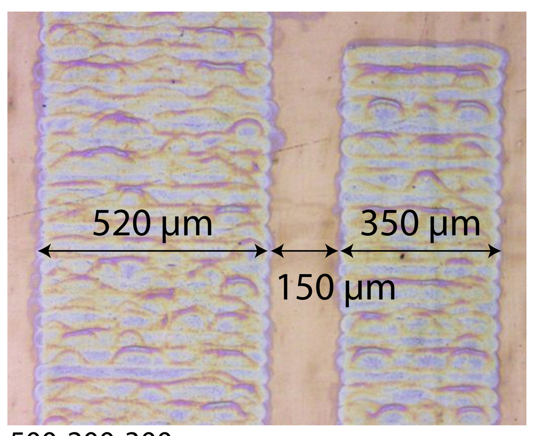
Substrate temperature	*Ink Temperature*
40 °C	30 °C
Jetting voltage	***Jetting frequency***
19.5 V	5 kHz

Perpendicular to print direction

(8 layers)

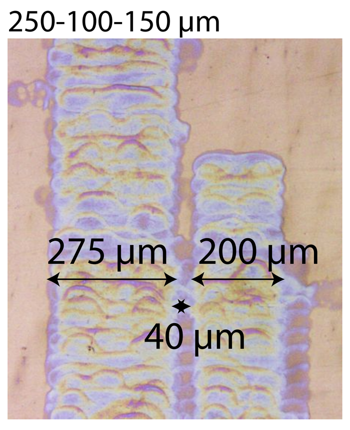
1000-400-600 µm



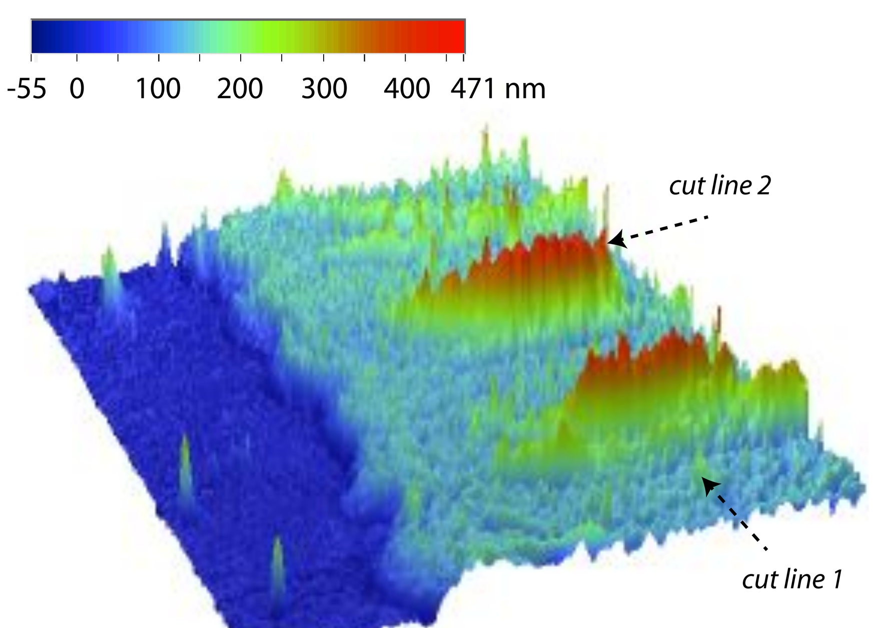


500-200-300 µm

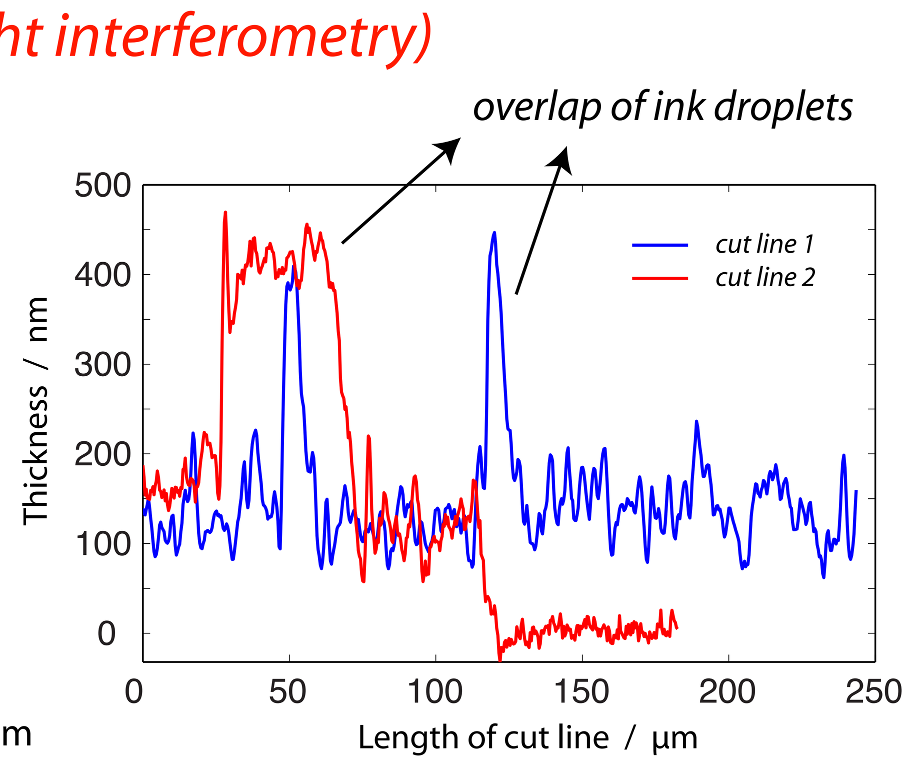
250-100-150 µm



Profile of 8 printed layers *(white light interferometry)*

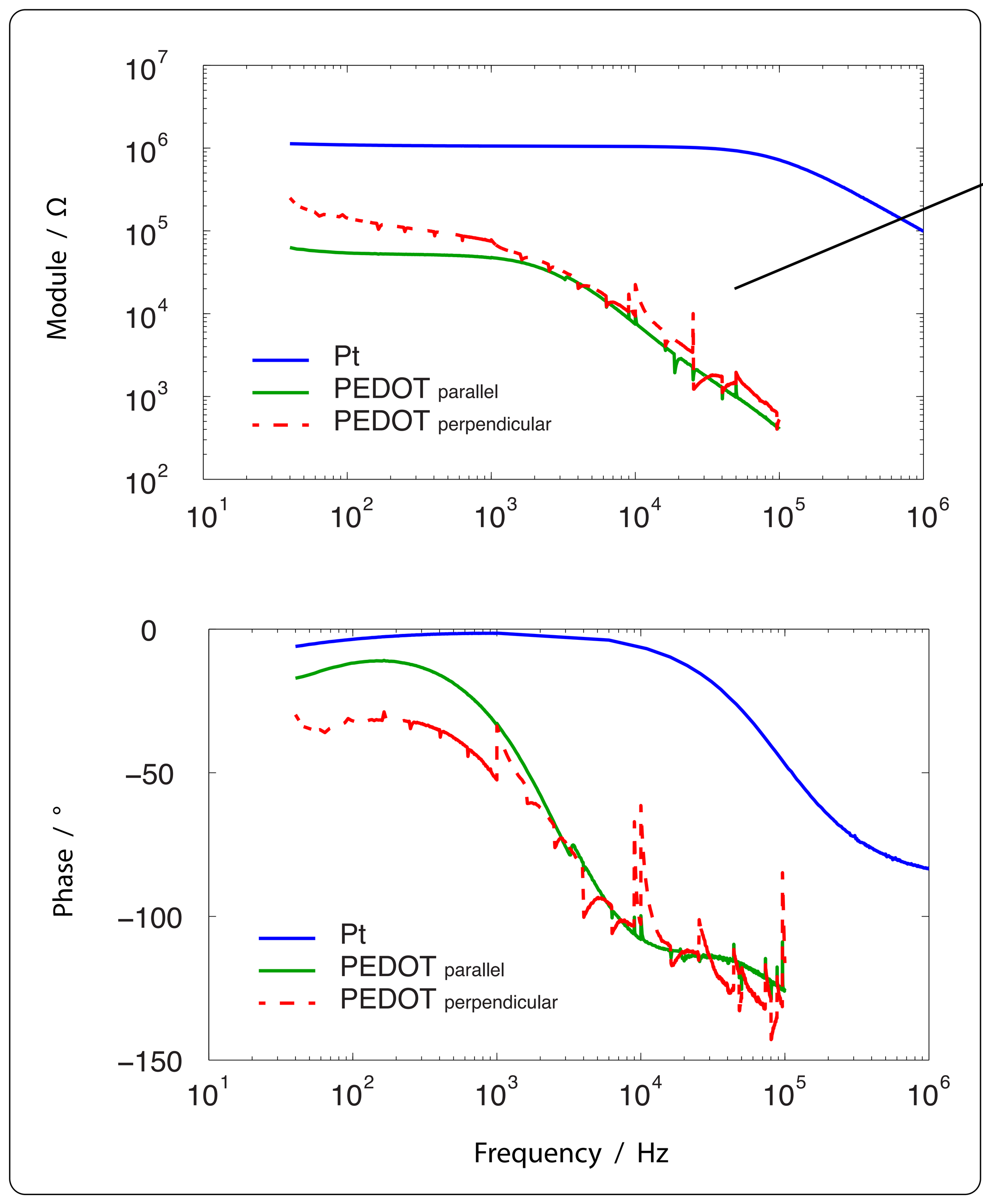


Average thickness 128 ± 10 nm



A qualitatively good impedance

Comparison of printed polymer with evaporated Pt

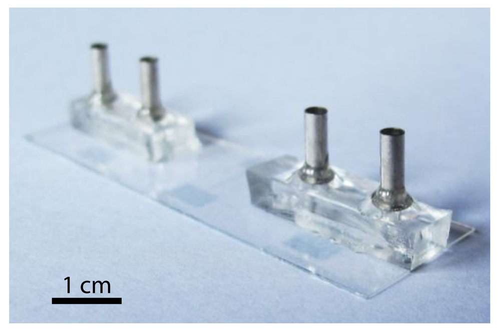


PEDOT:PSS has lower impedance, due to a printed electrode gap smaller than designed

Sheet resistance

PEDOT:PSS on PET
1.88 ± 0.33 kΩ/sq.

Pt lift-off on PET (120nm)
3.20 ± 0.58 Ω/sq.



500-200-300 µm electrode patterns

measured with KCl 0.01mM

Conclusion

PEDOT:PSS impedance has a comparable shape to that of Pt electrodes and both correspond well to theoretical predictions [8]. Inkjet-printed electrodes can be used for ACEO.

Impedance OK, but need smaller sizes for effective velocity generation

CHALLENGE for the future → Improve definition (need structures < 100µm)

Acknowledgements

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