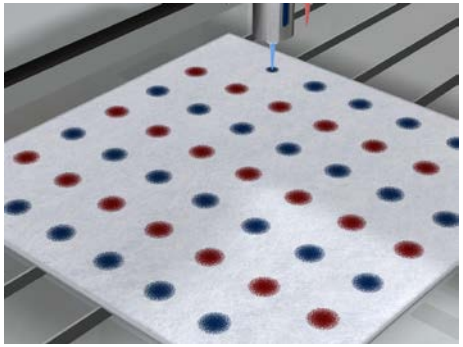
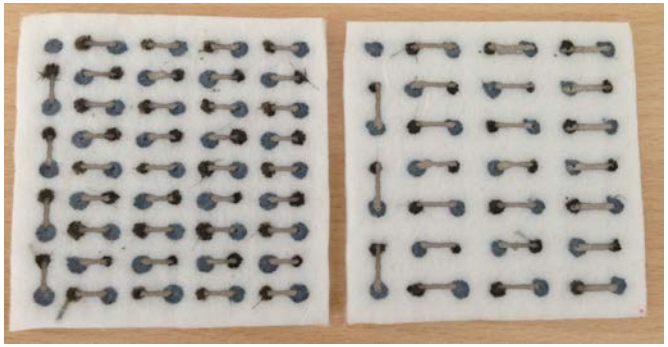
Dispenser printed flexible and full organic thermoelectric generators

Judith Leisten, Lukas Stepien, Roman Tkachov, Liana Sinowzik, Aljoscha Roch, Christoph Leyens

Overview

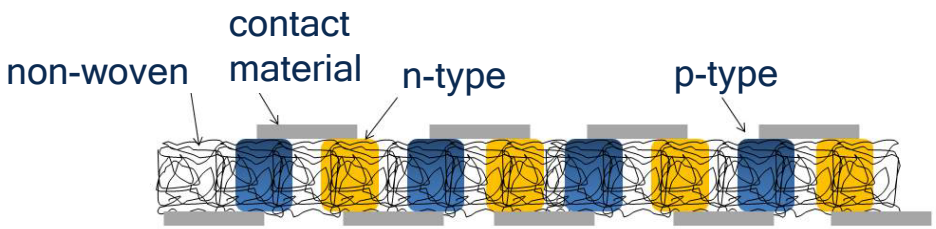
- Motivation
- Dispenser Printing
- Organic materials
- Substrates
- TEGs
- Summary/Outlook





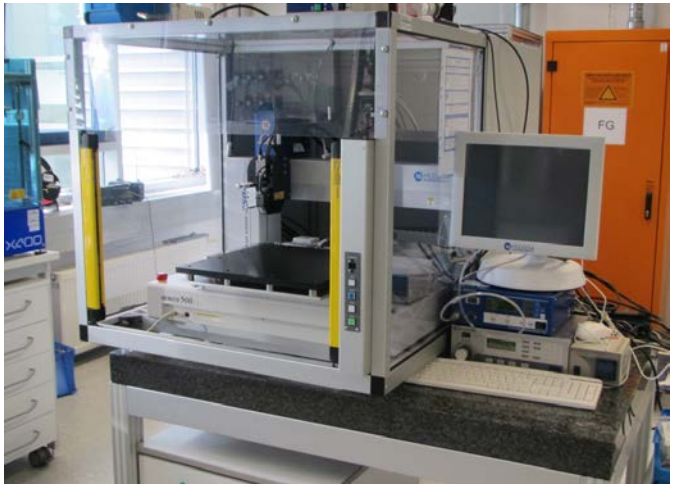
Motivation

- AIF-project „FlexTEG“ – development of a flexible TEG based on special printable non-wovens (co-workers: Saxonia Textile Research Institute)

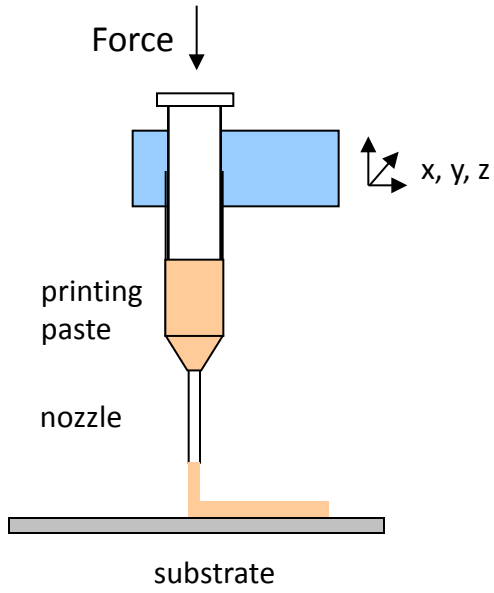


- applications: pipes, smart textiles
- dispenser printing: barely no loss of material, free geometry
- materials: ICP (p- and n-type)
  → easy to handle, available

Dispenser Printing



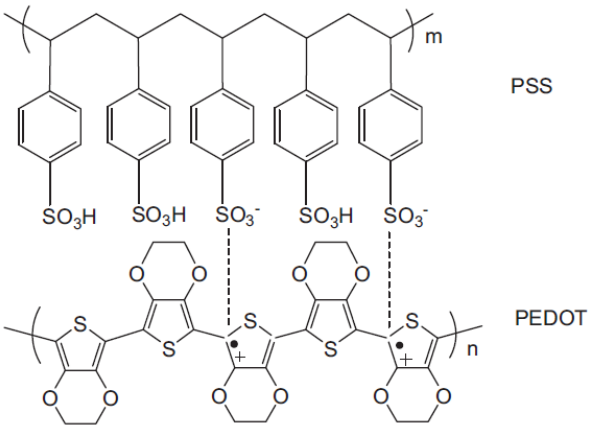
- Musashi Shotmaster 500 (2D and 3D)



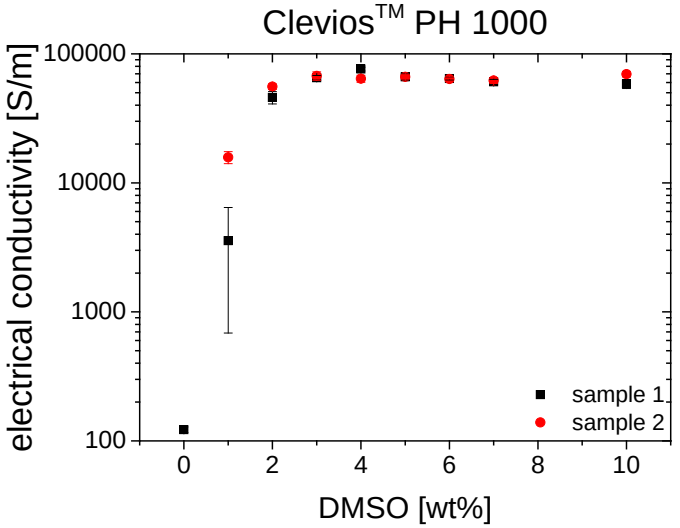
Features	
Line width	> 100 µm
Line height	< 500 µm
Print speed	~ 500 mm/s
Accuracy	± 25 µm
Viscosity	< 1000 Pa·s

Organic materials

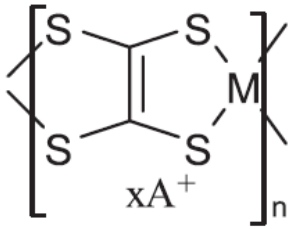
- PEDOT:PSS (poly(3,4-ethylenedioxythiophene):polystyrene sulfonate)
  - Clevios™ PH 1000 (ink) and Clevios™ S V3 (printing paste)
  - treatment with co-solvent DMSO (dimethylsulfoxide)
    → increases electrical conductivity



R. Yue, J. Xu / Synthetic Metals *162 (2012) 912– 917*



Organic materials



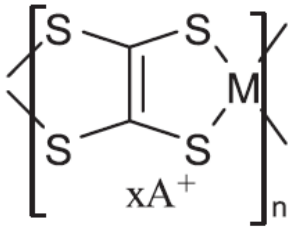
Poly(A_x[M-ett])

- Poly[K_x(Ni-ett)] (poly(nickel-ethylenetetrathiolate)

		σ [S/cm]	α [µV/K]	PF [µW/mK²]
bulk	Sun et al., Adv. Mater., 2012, 24, 932	44	-122	65,5
	Yu et al., Chem. Lett., 2015, 44, 1185	1,6	-50	0,4
	our method	26,9	-33,5	3,0

- problem: polymer is insoluble

Organic materials



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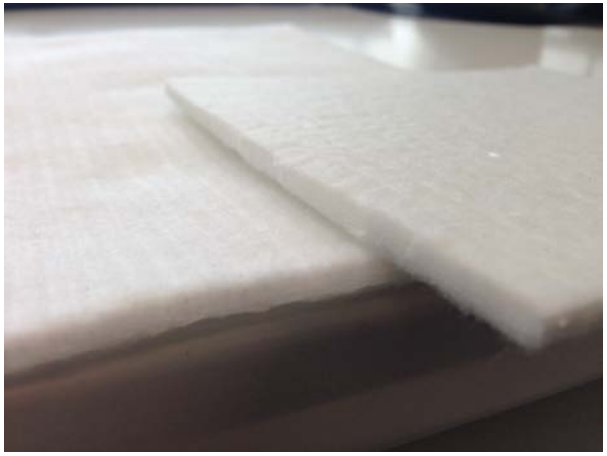
bulk	Sun et al., Adv. Mater., 2012, 24, 932	44	-122	65,5
	Yu et al., Chem. Lett., 2015, 44, 1185	1,6	-50	0,4
	our method	26,9	-33,5	3,0
film	our method	4,5	-86,6	3,4

- problem: polymer is insoluble
- processable as a paste

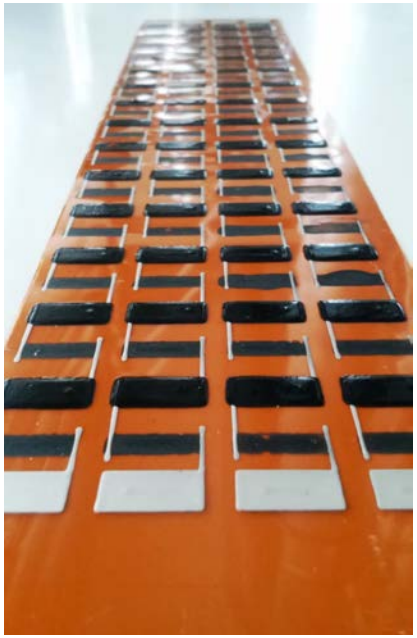
Substrates

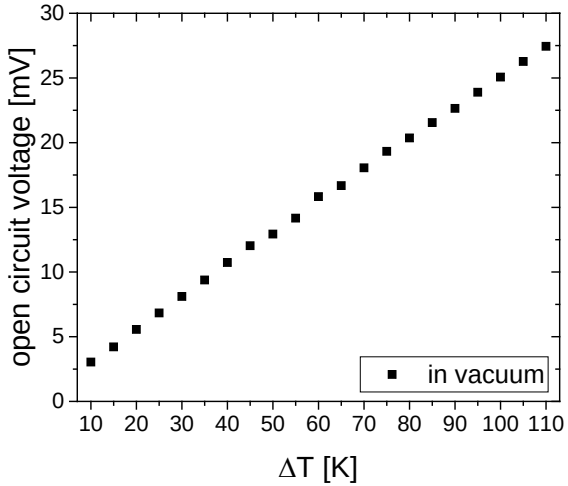
- Kapton-foil
  - PI (polyimide)
  - flexible
  - wide temperature range (-269 – 400 ° C)
- non-wovens
  - also flexible
  - light-weight
  - opportunity of functionalization
  - serves as support structure



TEGs

- Kapton
  - 14 thermocouples
    - PEDOT:PSS (Clevios™ S V3) and poly[K_x(Ni-ett)]
    - contact material: PEDOT:PSS (Clevios™ S V3)
  - internal resistance ~ 12-20 kOhm





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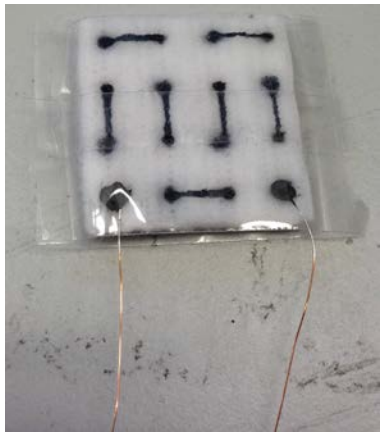
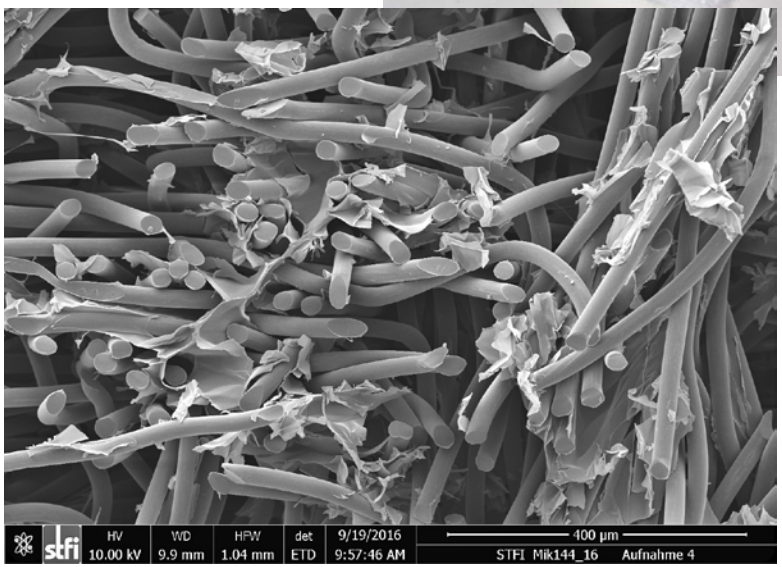


- non-wovens
  - 8 thermocouples
    - PEDOT:PSS (Clevios™ PH1000) and Poly[K_x(Ni-ett)]
    - contact material: PEDOT:PSS (Clevios™ S V3)
  - internal resistance 5 – 12 Mohm
    → too high for measurement of open circuit voltage

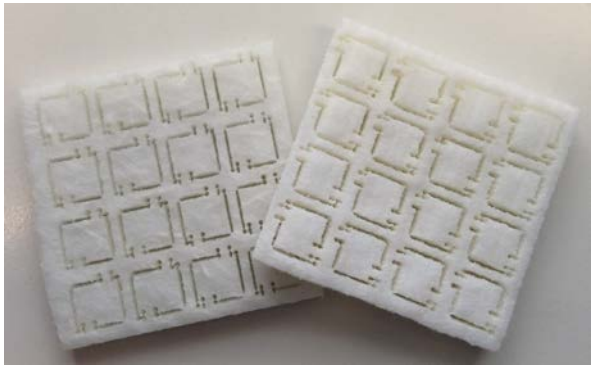
TEGs

- non-wovens
  - problems
    - wetting of legs
    - barely no material between fibers
      → problems with percolation
    - volume fill factor vs. area



Summary/Outlook

- printing on Kapton or non-wovens offers a high flexibility regarding the application on curved surfaces
- improvement of charge transport and thus efficiency
- structuring of non-wovens



Thank you for your attention!

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