



Flexible Polymer Solar Cells and Development of Reel-to-Reel (R2R) Coating Processes

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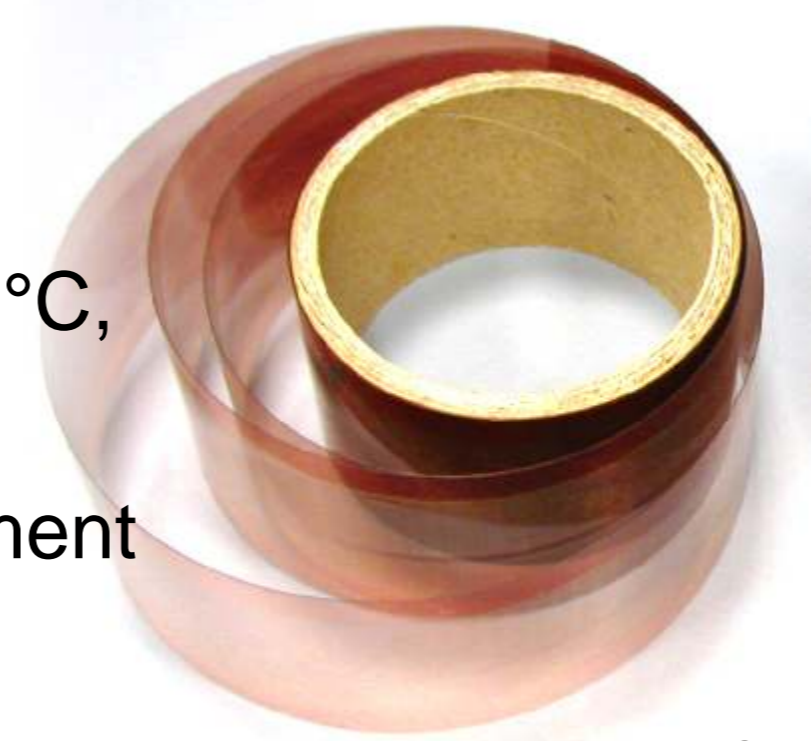
Main working fields

- **Polymer solar cells** (preferably on flexible substrates, large area, module development, reel-to-reel coating, testing of new donor and acceptor materials – close cooperation with TU Ilmenau)
- polymer field effect transistors for polymer electronics
- **laser patterning** (conducting polymers, isolating polymers, metal films, ITO, reel-to-reel patterning)
- **gel electrolytes** (for instance for dye-sensitized solar cells, electrochromic devices or other applications)

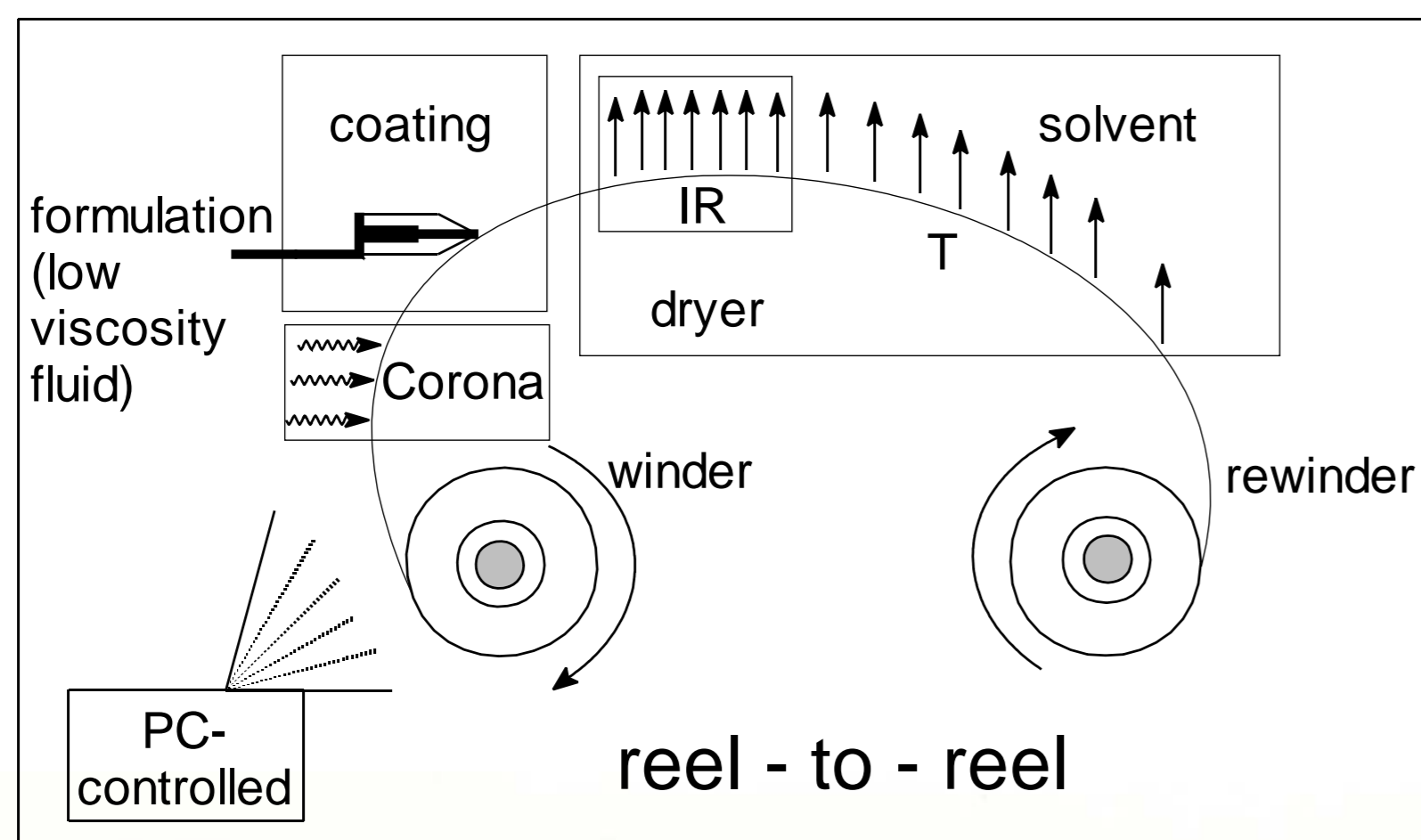


Reel-to-reel coating machine

- slot die coating (curtain coating/ blade coating) for low-viscosity fluids
- variable slot distance, caster geometry and caster arrangement/ ~ angle
- thickness control via dosage and web speed
- laminar flow box housing the starting area (clean room class 100)
- corona treatment suitable for conducting films
- coating width 1-17 cm/ web width up to 20 cm
- coating speed 1-10 m/min
- IR drying field
- air drying unit (adjustable up to 120 °C, length 13 m)
- modular construction – extra equipment implementable (UV curing)



P3HT:PCBM

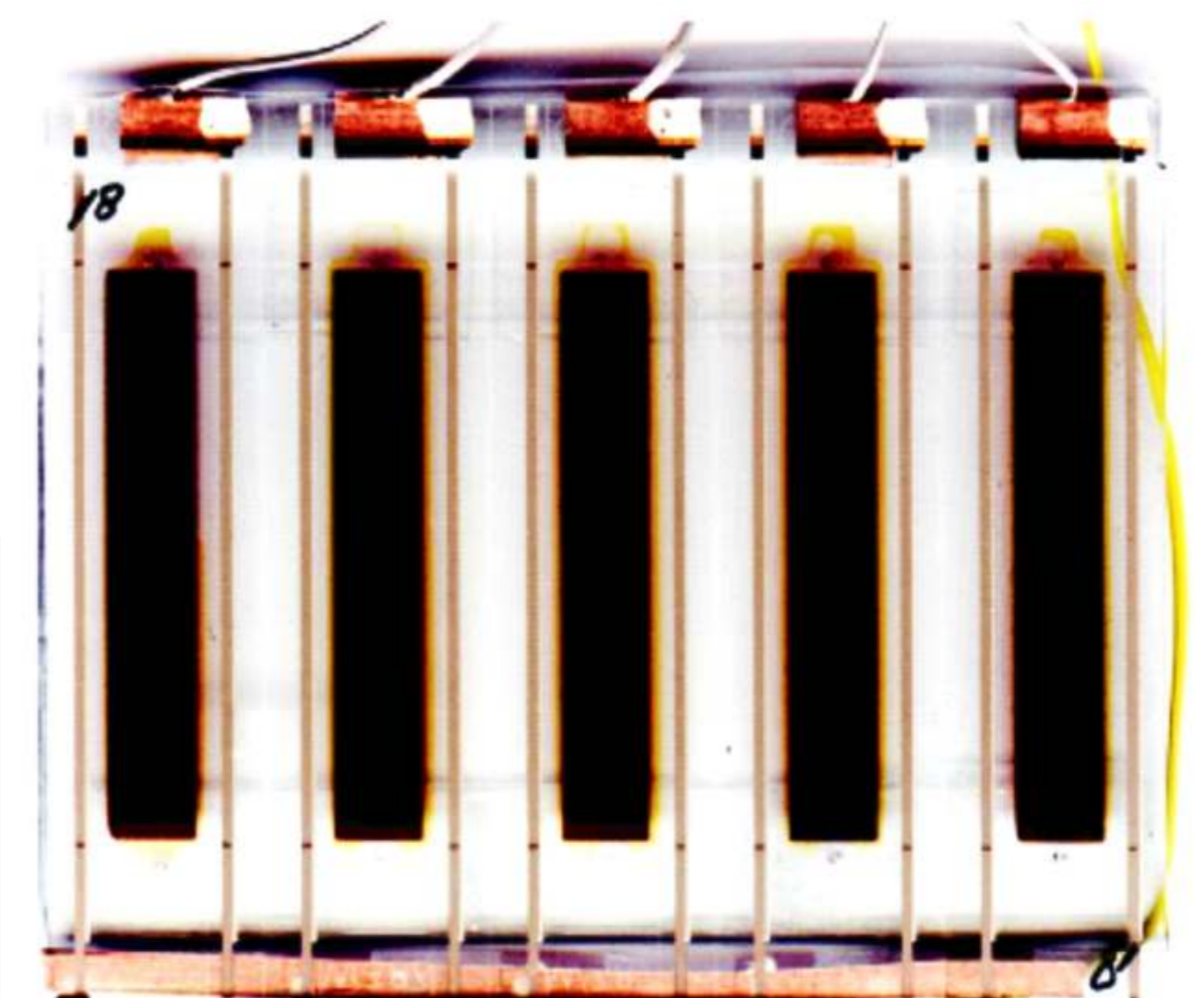


BMW project IW 061016

PEDOT on ITO-PET (coating width: 4 cm)



Gel electrolytes for DSC



cooperation with ISE Freiburg

BMBF network 01SF0304

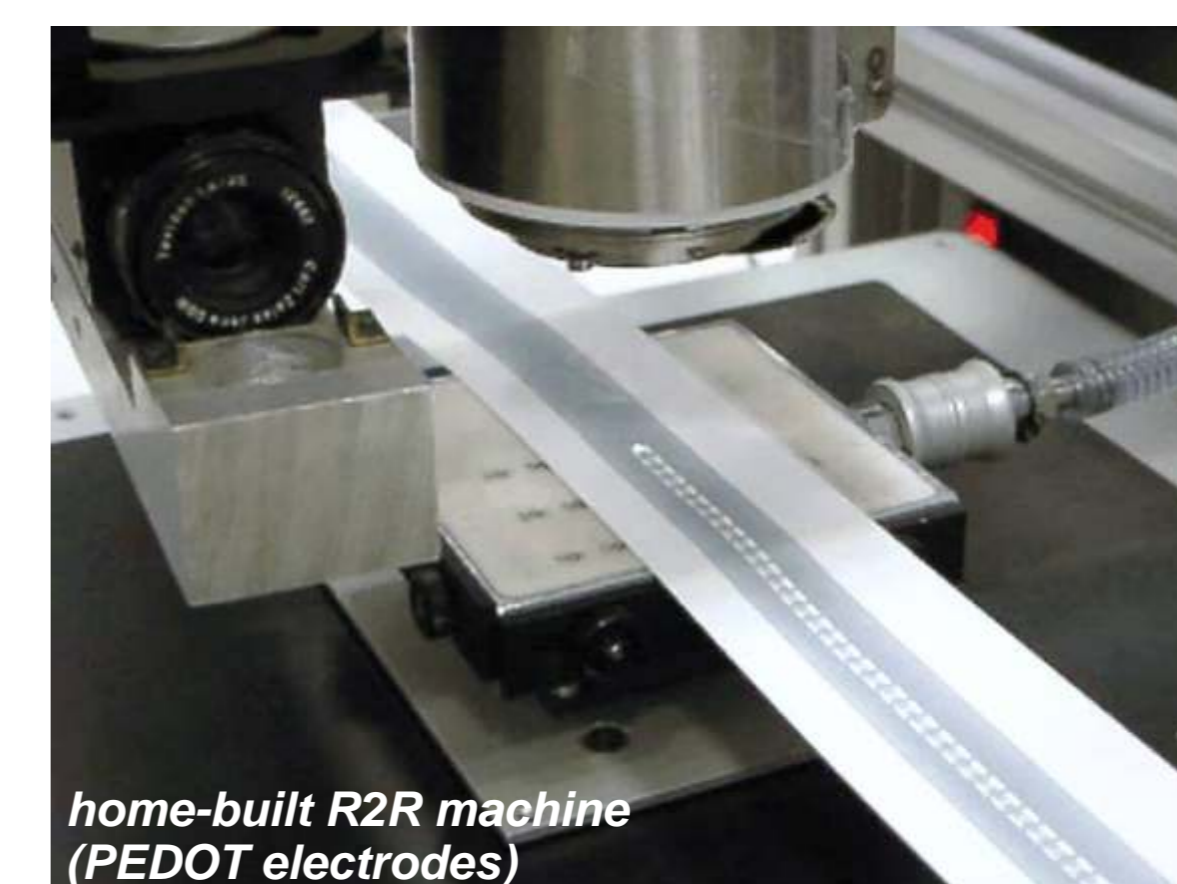
- gelation with PVDF-HFP, PAN or nanoparticles
- application of ionic liquids for the iodide and as solvent
- no deterioration of the ion mobility by the gelator
- conductivity >5 mS/cm at 25°C
- $D(J^{-3})$ up to $9 \times 10^{-7} \text{ cm}^2/\text{s}$, R_{CT} : 0.5–7 cm^2
- best cell efficiency 4.75% vs. 5.8% with liquid reference electrolyte

Staff and Equipment

- staff ~ 8 scientists, 2 engineers, 3 laboratory assistants
- reel-to-reel (R2R) slot die laboratory coating machine (nanolayers)
- R2R laser patterning
- laser technique (Ar^+ , excimer, dye, Nd:YAG) with X-Y position table
- clean room, glove box
- spin coater, doctor-blade coater
- vacuum deposition, sputter coater
- AM1.5 solar simulator, wafer prober
- stationary and time-resolved ESR/LESR (X-band, K-band, tuned temperature)
- impedance spectroscopy, potentiostat, impedance analyser (20 Hz - 1 MHz)
- contact angle/ surface tension measuring instrument DSA100/ DSA100 Micro
- plasma treatment equipment
- ellipsometer (600-1200 nm)
- 3D confocal white light microscope μSurf
- AFM, SEM/ EDX
- light and phase change microscopy, UV-VIS, FTIR with IR-microscope

Reel-to-reel laser patterning

- comb-like electrodes applying PEDOT, PANI or metal films for polymer electronics with resolutions of 10 μm (standard)/ 1 μm (optimized conditions)
- vias for electrical circuits
- ITO patterning possible for module preparation (excimer, Nd:YAG laser)

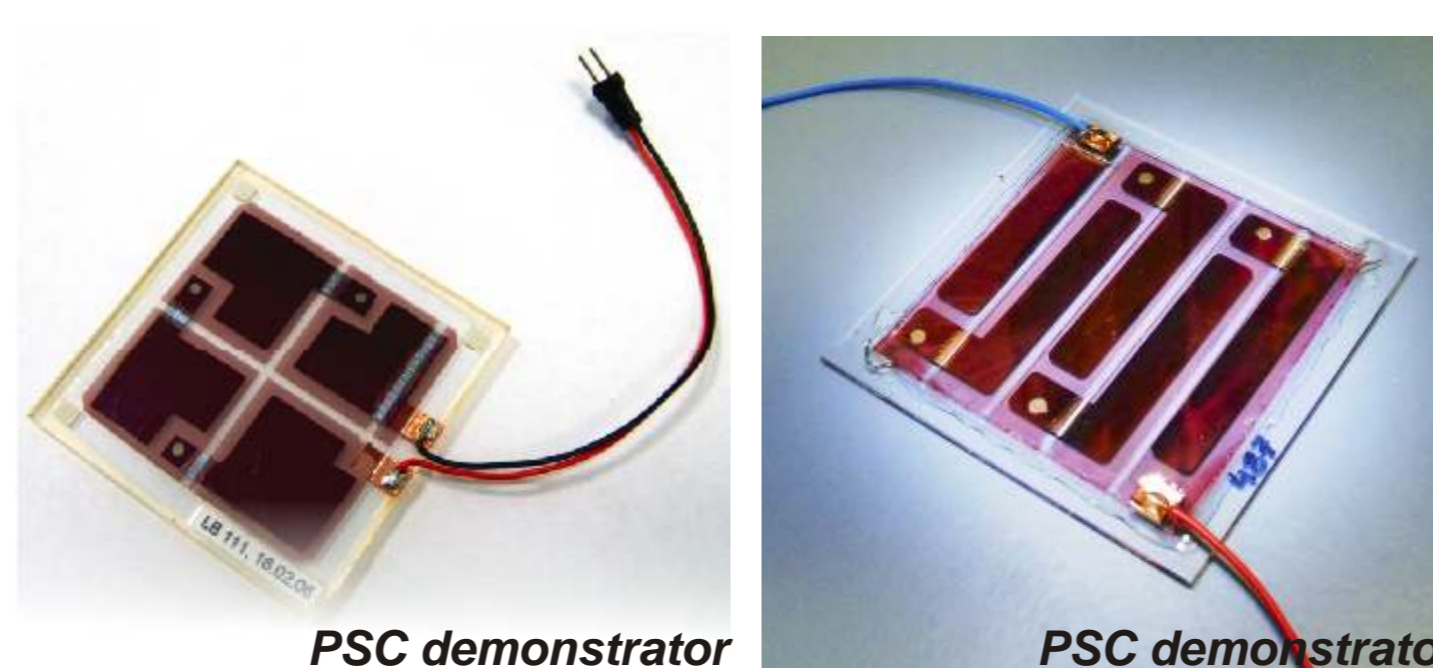


home-built R2R machine (PEDOT electrodes)

Technical details:
 UV objective: 5x/18, NA=0,13
 illumination field: up to 10x10 mm²
 excimer laser: Compex 205
 wave length: 248 nm
 pulse duration: 15 ns
 repetition rate: up to 50 Hz
 web speed: up to 0.15 m/s

Upgrade planned in 2008:
 illumination field: 28x10 mm²,
 camera system for image identification

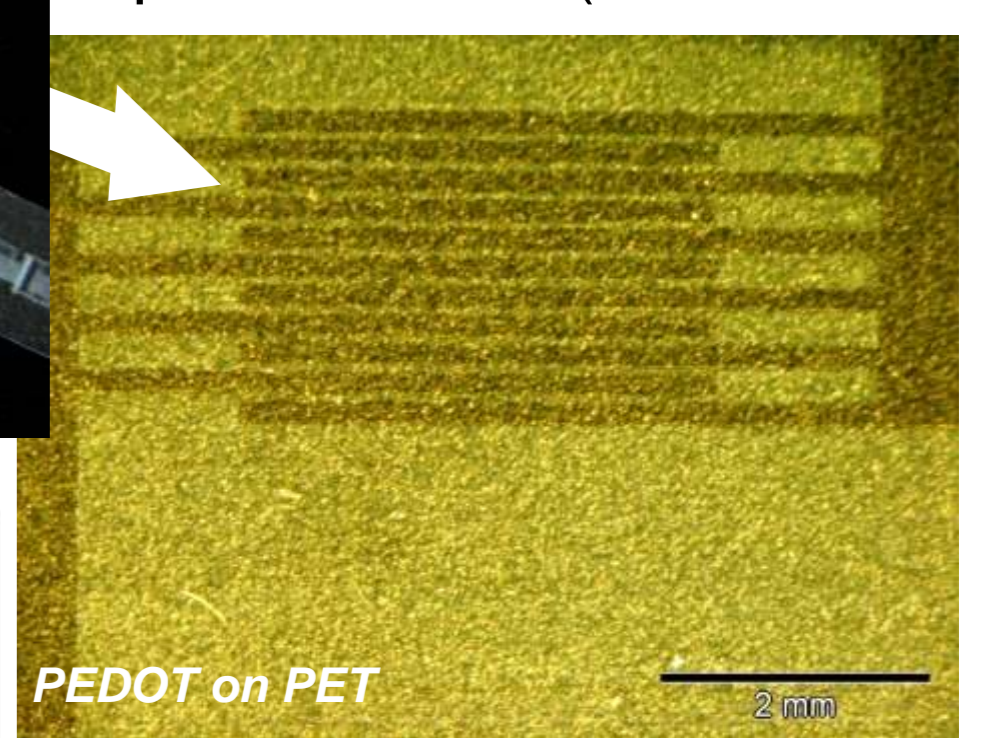
Further upgrade is possible:
 300 Hz excimer laser and 3 m/s web speed enabling through-put up to 300 m²/h (mask technique)



PSC demonstrator

PSC demonstrator

BMW project 1136/03
 BMW project IW 060047



PEDOT on PET

Flexible polymer solar cells testing new materials

Donors

$E_g^{opt.}: 1.68 \text{ eV}$, $AM_{1.5}: 1.76\%*$
 (* cells with PCBM)

$E_g^{opt.}: 1.57 \text{ eV}$, $AM_{1.5}: 1.36\%*$
 (* cells with PCBM)

$E_g^{opt.}: 2.13 \text{ eV}$, $AM_{1.5}: 1.85\%*$
 (* cells with PCBM)

$E_g^{opt.}: 2.5 - 3.0 \text{ eV}$

new C₆₀-fullerene acceptor
 $AM_{1.5}: 2.4\%$ with P3HT

fibillar self-organisation detected by AFM (from CB)

0.4 μm

AFM: self-assembling from CHCl₃

0.5 μm

cooperation with Uni Jena

TAB project 2006 WF 0068
 TKM project B 507-04010