



A new “Smart” Web Coater for Flexible Display and Electronic Products

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Outline

- New Products / New Requirements for Production Equipment
- State of the Art Sputter Roll Coaters
- New Modular PVD Roll Coater SMARTWEB
- Deposition Sources and First Coating Results
- Pre / Post-Treatment Sources
- Inline Measuring Tools
- Conclusion



New Products / New Requirements For Production Equipment

- FPCB - with increased line density
- Flexible Displays
 - ITO as transparent top electrode
 - Metallic electrode layers for flexible OLED
 - Organic LED layers
 - Barrier layers
- Flexible ICs e.g. for Flexible Displays, Smart Cards, RFID-tags
- Flexible Solar Cells



New Products / New Requirements **For Production Equipment**

- Low particle generation
- Clean room compatibility
- In-line pretreatment
- High process flexibility & multiprocess capability
 - Sputtering
 - Evaporation
 - PECVD
 - New deposition technologies
- In-line process control

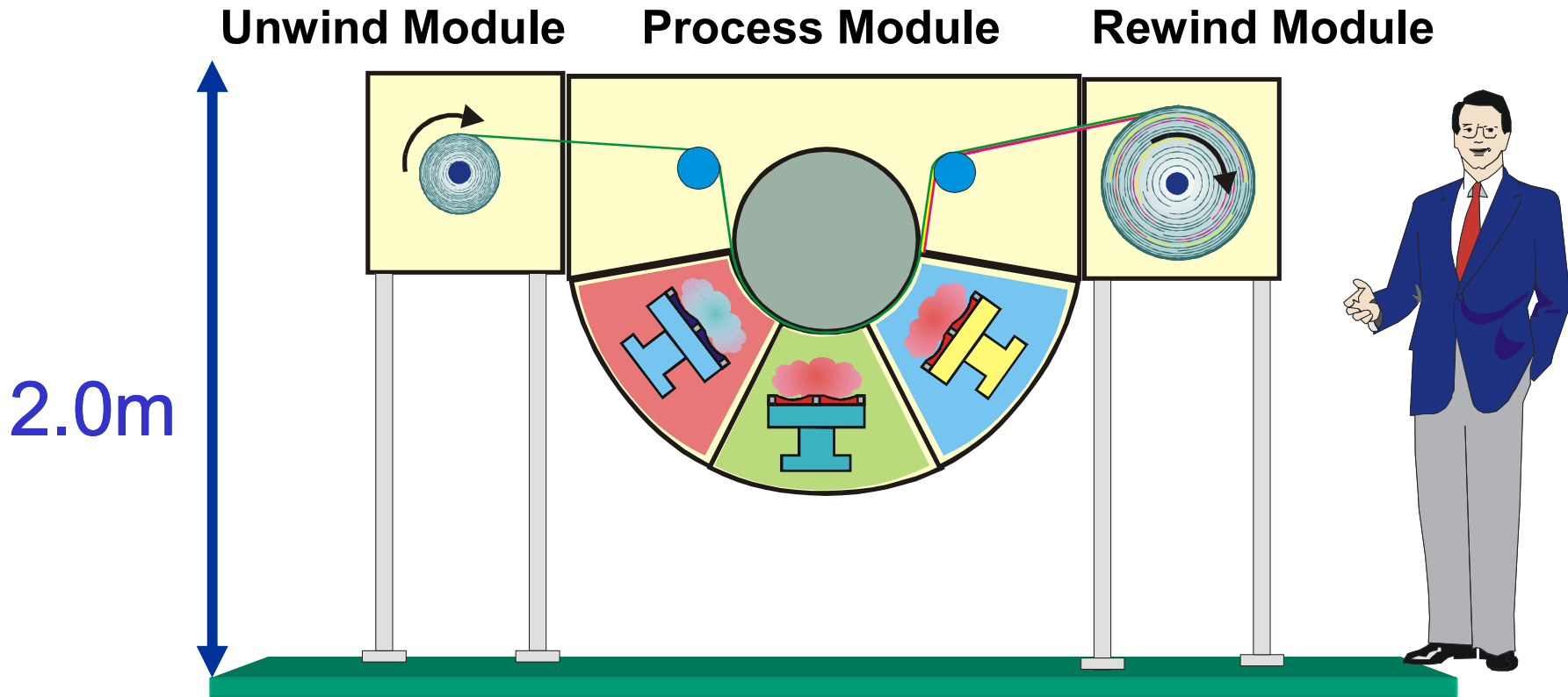
State of the Art Sputter Web Coaters

One vacuum vessel.
Huge (5m high).
Heavy (80t).
Limited No of Cathodes
Winding system on top
of coating drum
(-> particle generation)



Modular PVD Roll Coater SMARTWEB

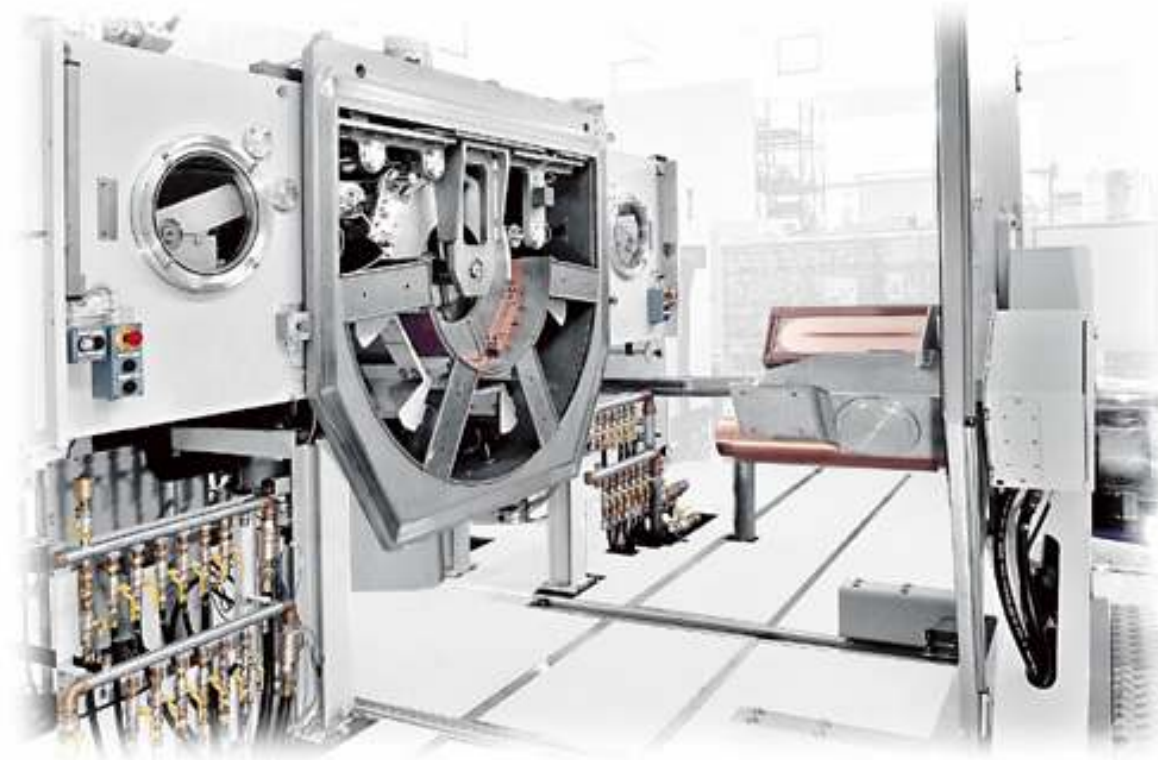
1 Process Module with 3 Sources





Modular PVD Roll Coater SMARTWEB

1 Process Module, 3 Sputter Sources, Front Side opened





Modular PVD Roll Coater SMARTWEB

1 Process Module, 3 Sputter Sources, Front Side closed





Modular PVD Roll Coater SMARTWEB

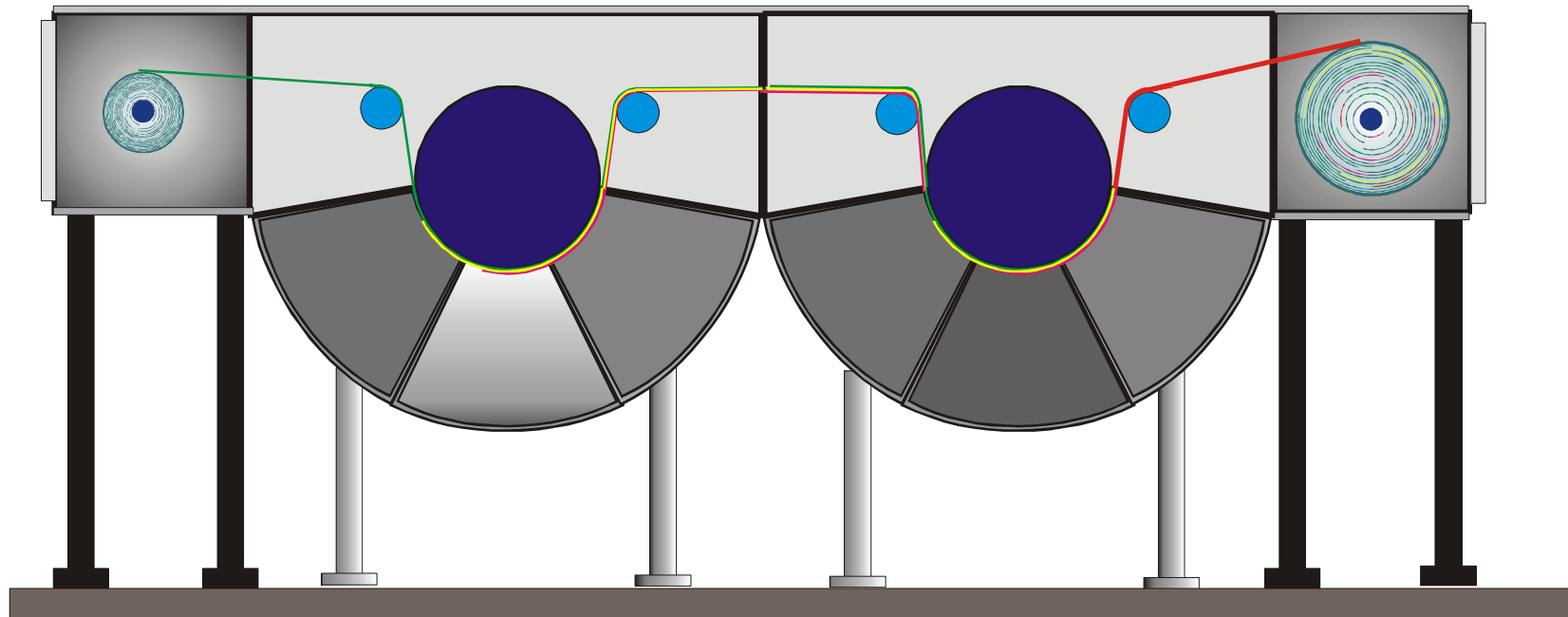
1 Process Module, 3 Sputter Sources, Back Side





SMARTWEB 6

2 Process Modules, 6 Deposition Compartments





Deposition Sources

- Planar DC-Magnetron
- Planar AC-Magnetron
- Rotatable Magnetron
- Evaporator for Metals
- Evaporator for Small Molecule OLEDs
- PECVD Systems



Deposition Sources:

Planar DC-Magnetron with wide race track





Deposition Sources:

Planar DC-Magnetron with wide race track

Used target

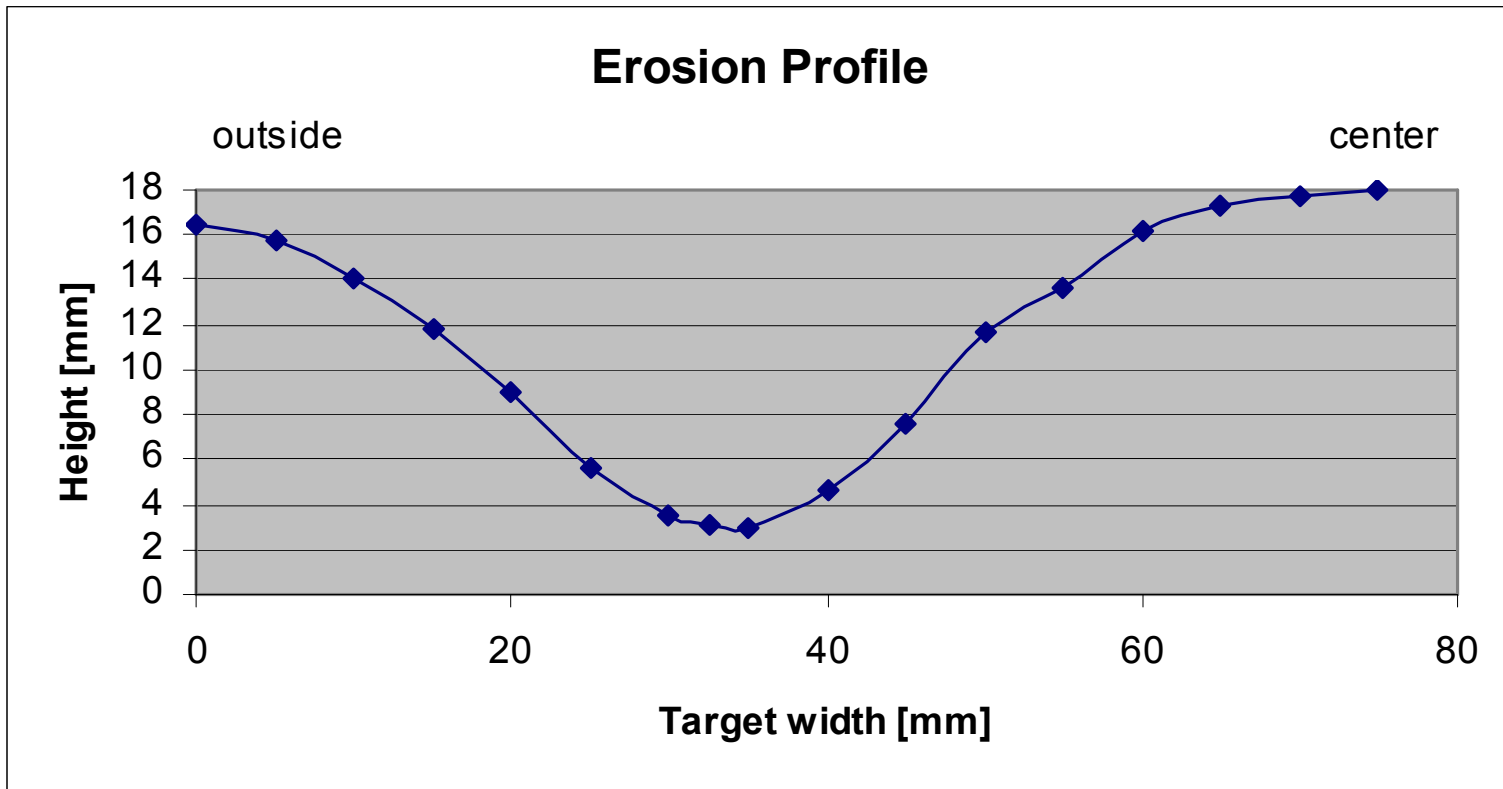


New target



Deposition Sources:

Planar DC-Magnetron with wide race track



Target utilization: 41 %

Deposition Sources:

Planar AC-Magnetron TWINMAG™

- High process stability
- Dielectric coatings: Silicon-oxide, titanium-oxide,...
- Long target lifetime
- Uniformity and reproducibility
- Up to 10 x faster in transition mode compared to compound sputtering mode.



Deposition Sources:
Rotatable Magnetron with Copper Target





Deposition Sources:

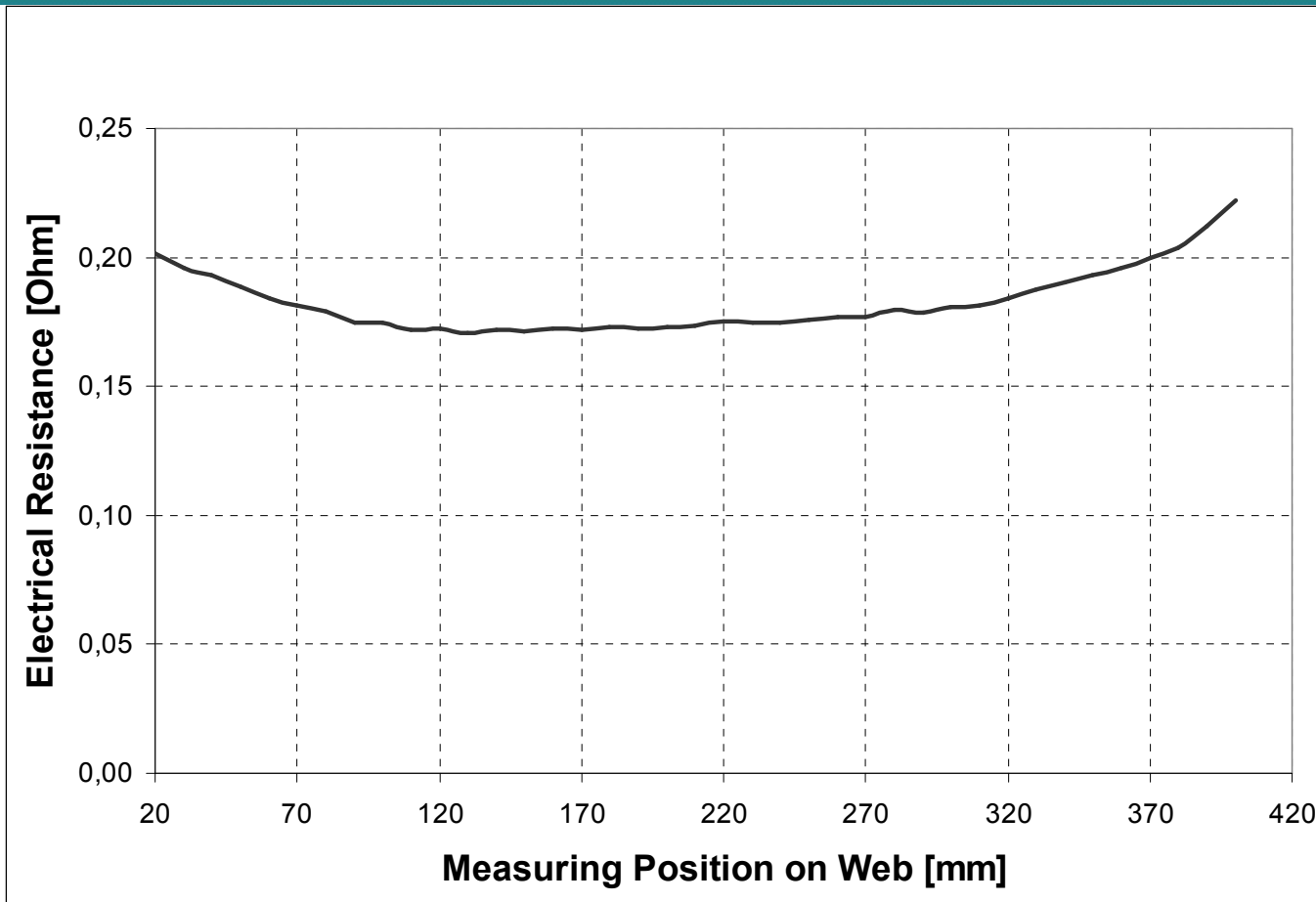
Rotatable Magnetron with Copper Target

First Deposition Results: High Rate Deposition of Copper

- Substrate material: PET
- Substrate thickness: 25 μm - 175 μm
- Web width: 420 mm
- Coating width: 400 mm
- Deposition rate/magnetron: 240 nm m/min*

*at 20 kW. Test with increased power will follow.

Resistance distribution of a 135 nm thick copper layer on standard PET film deposited from a rotatable copper target with 10 kW power and 1 m/min film speed without masking.





Deposition Sources:

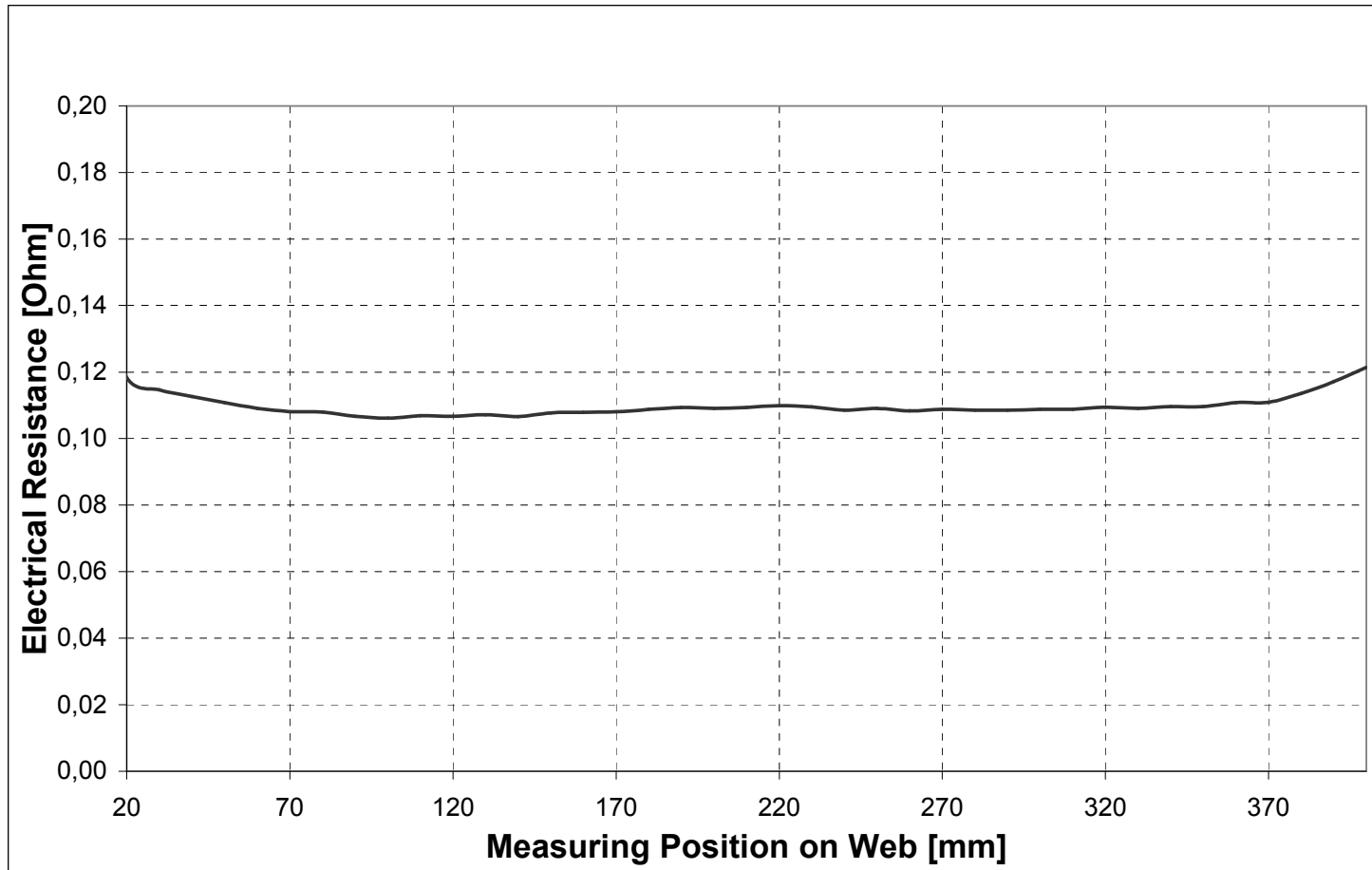
Planar Magnetron with Copper Target

First Deposition Results: High Rate Deposition of Copper

- Substrate material: PET
- Substrate thickness: 25 μm - 175 μm
- Web width: 420 mm
- Coating width: 400 mm
- Deposition rate/magnetron: 260 nm m/min*

*at 20 kW. Test with increased power will follow.

Resistance distribution of a 260 nm thick copper layer on standard PET film (175 μm) deposited from a planar copper target with 20 kW power and 1 m / min film speed without masking.



Deposition Sources:
Planar and Rotatable Magnetron with ITO-Targets





Deposition Sources:

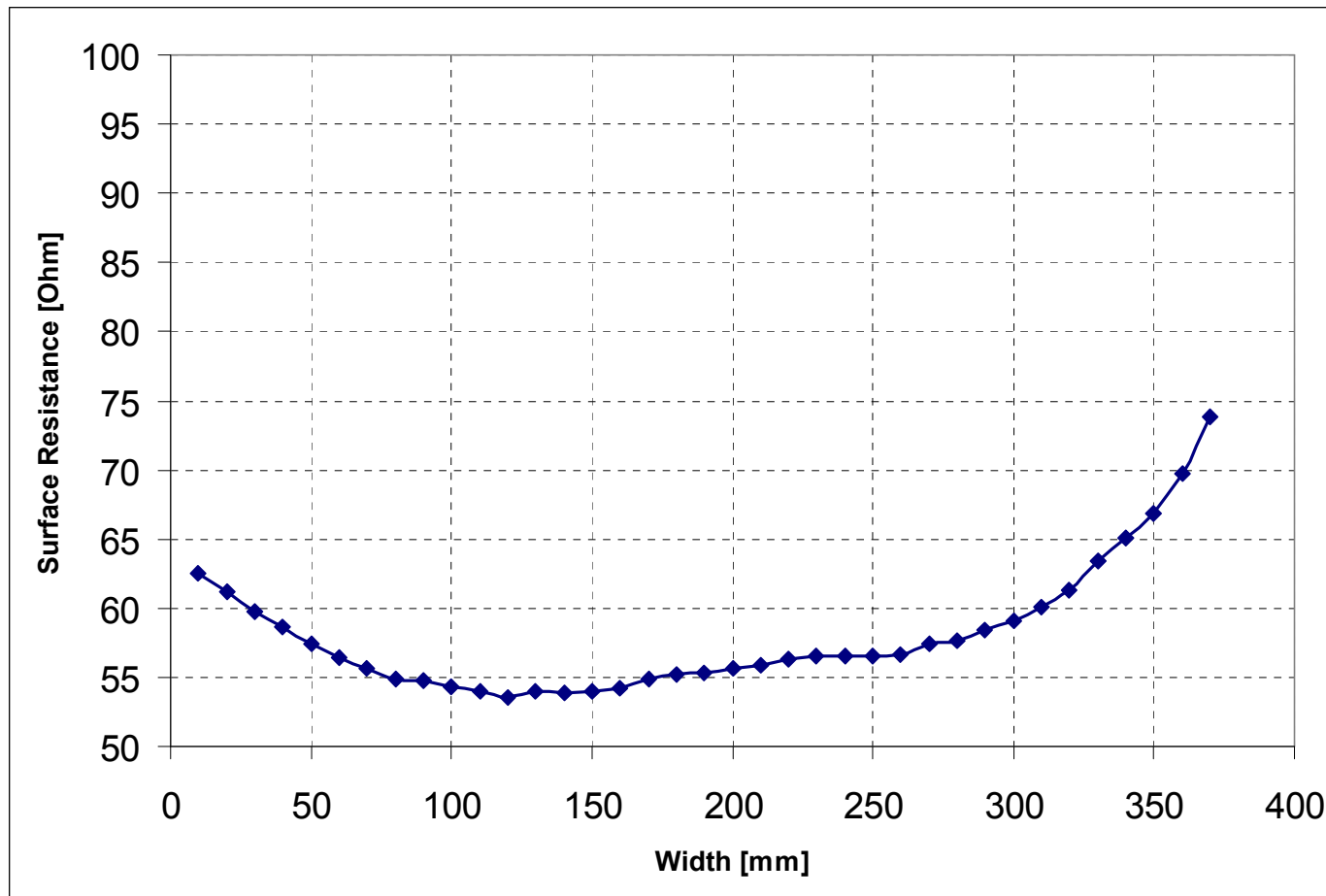
Rotatable Magnetron with ITO-Target

First Deposition Results: High Rate Deposition of ITO

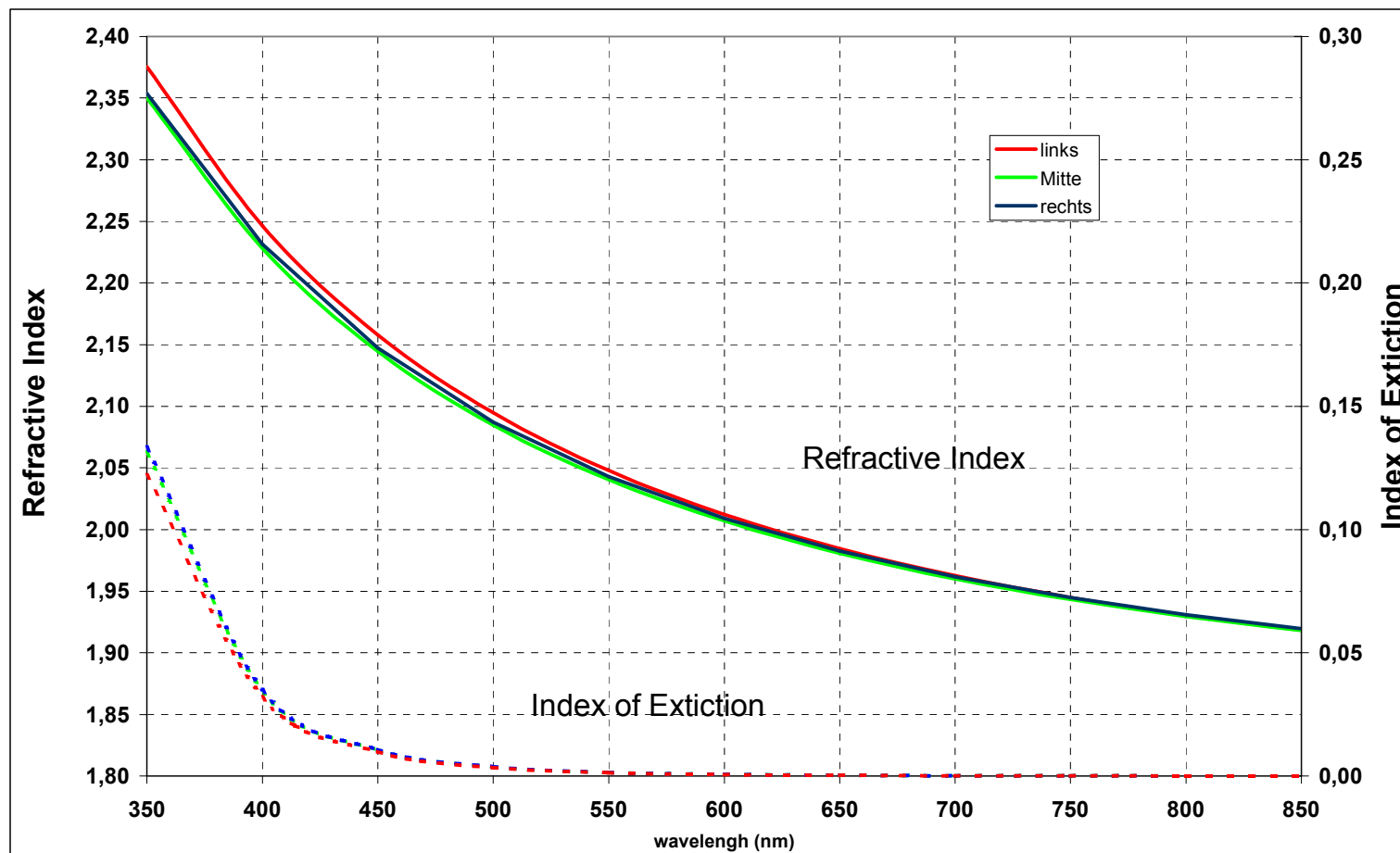
- Substrate material: PET
- Substrate thickness: 175 μm
- Backing tube diameter: 155 mm
- Web width: 420 mm
- Coating width: 400 mm
- Deposition rate/magnetron: 42 nm m/min at 4 kW*
- Specific Resistivity 500 $\mu\text{Ohm cm}$

* Longtime test regarding nodule growth not yet performed

Resistance distribution of a 90 nm thick ITO layer on standard PET film deposited from a rotatable ITO target with 2 kW power and 0,25 m/min film speed without masking.



Optical Properties of a 90 nm thick ITO layer on standard PET film deposited from a rotatable ITO target with 2 kW power and 0,25 m/min film speed without masking.





Deposition Sources:

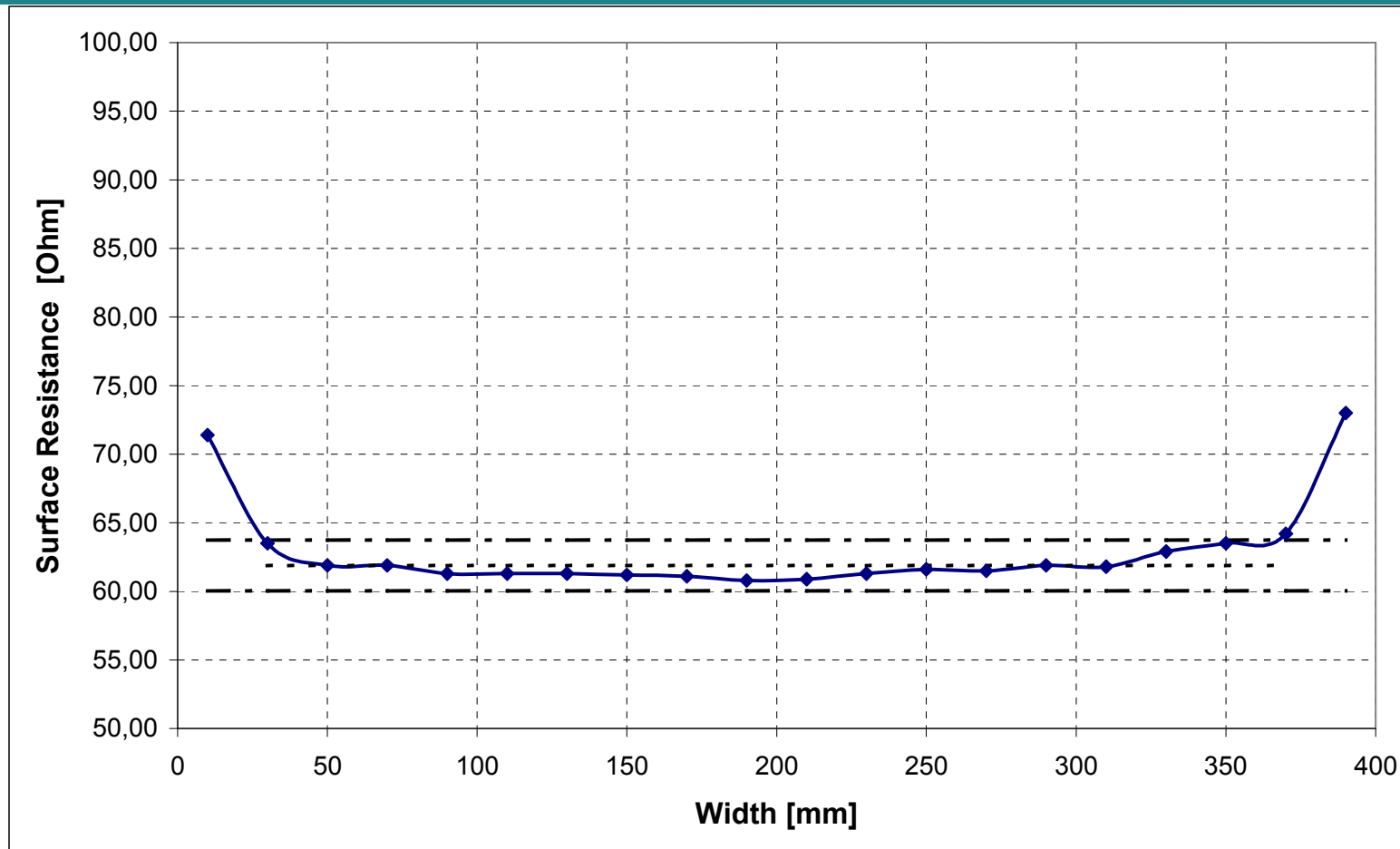
Planar Magnetron with ITO-Target

First Deposition Results: Deposition of ITO

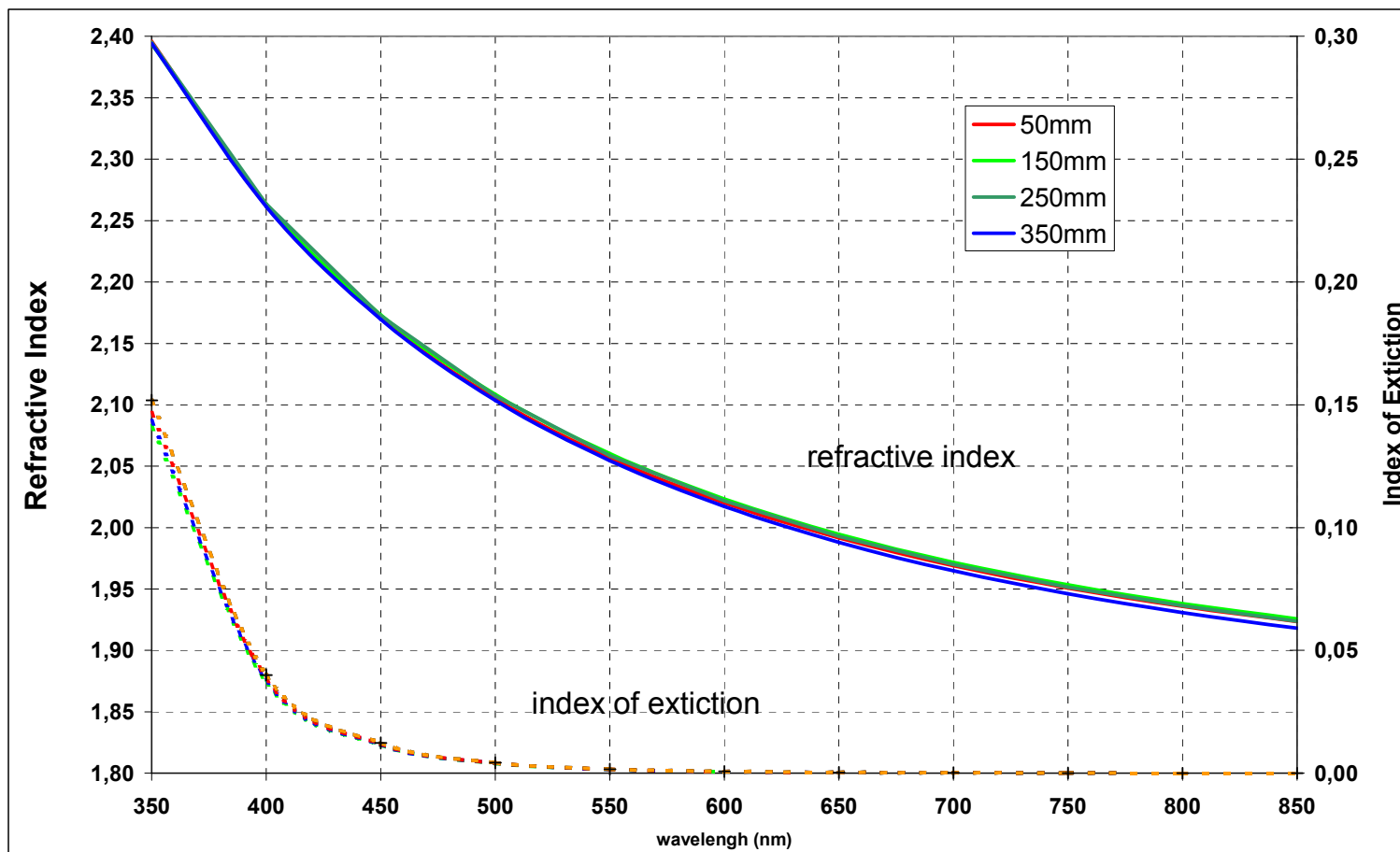
- Substrate material: PET
- Substrate thickness: 175 μm
- Target width: 160 mm
- Web width: 420 mm
- Coating width: 400 mm
- Deposition rate/magnetron: 20 nm m/min at 1,9 kW*
- Specific Resistivity 495 $\mu\text{Ohm cm}$

* Longtime test regarding nodule growth not yet performed

Resistance distribution of a 82 nm thick ITO layer on standard PET film deposited from a planar ITO target with 1,9 kW power and 0,25 m/min film speed without masking.

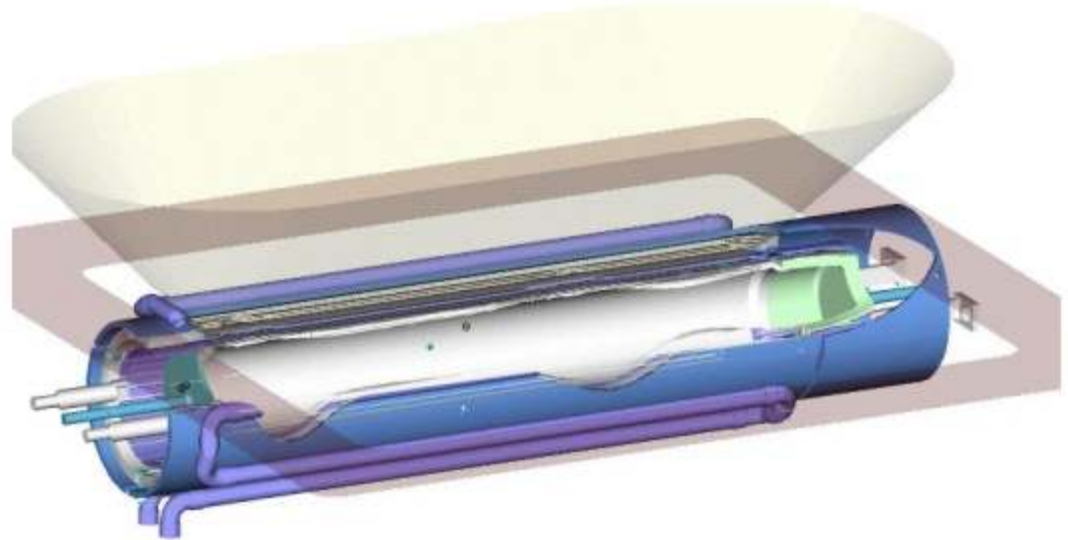


Optical Properties of a 82 nm thick ITO layer on standard PET film deposited from a planar ITO target with 1,9 kW power and 0,25 m/min film speed without masking.



Deposition Sources: Linear Metal Source

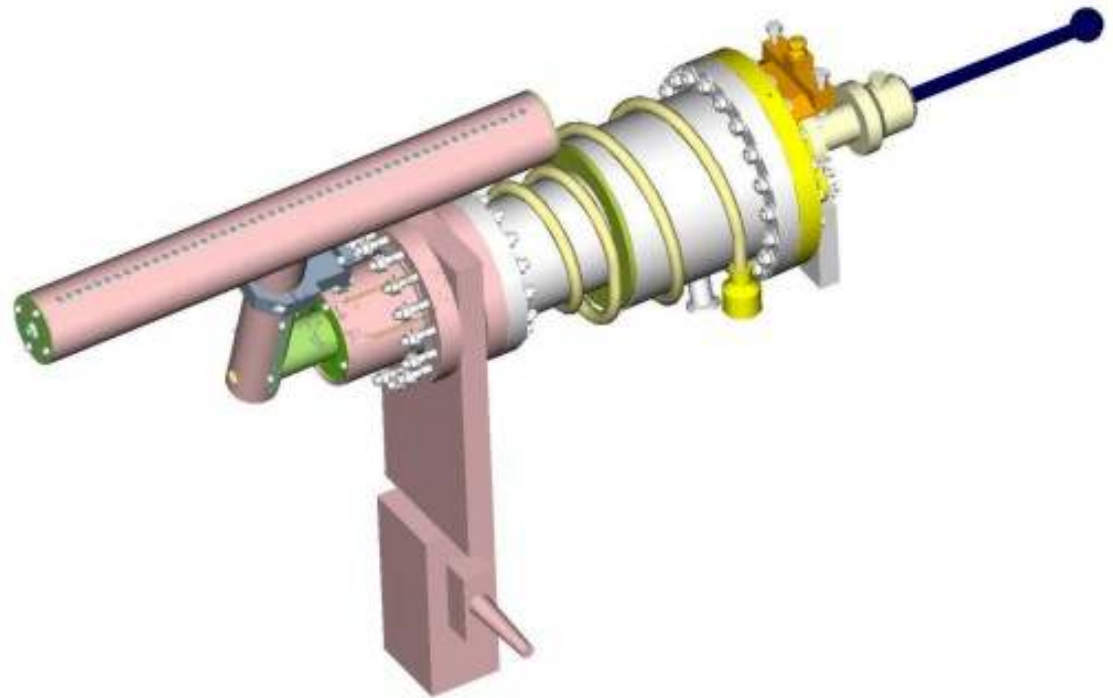
Vertical and horizontal evaporation.
Temperature of column and crucible independently controllable.
Material for crucible and distributor exchangeable (for Ag, Mg: Graphite).
Water cooled surrounding and shielding



PVD Sources:

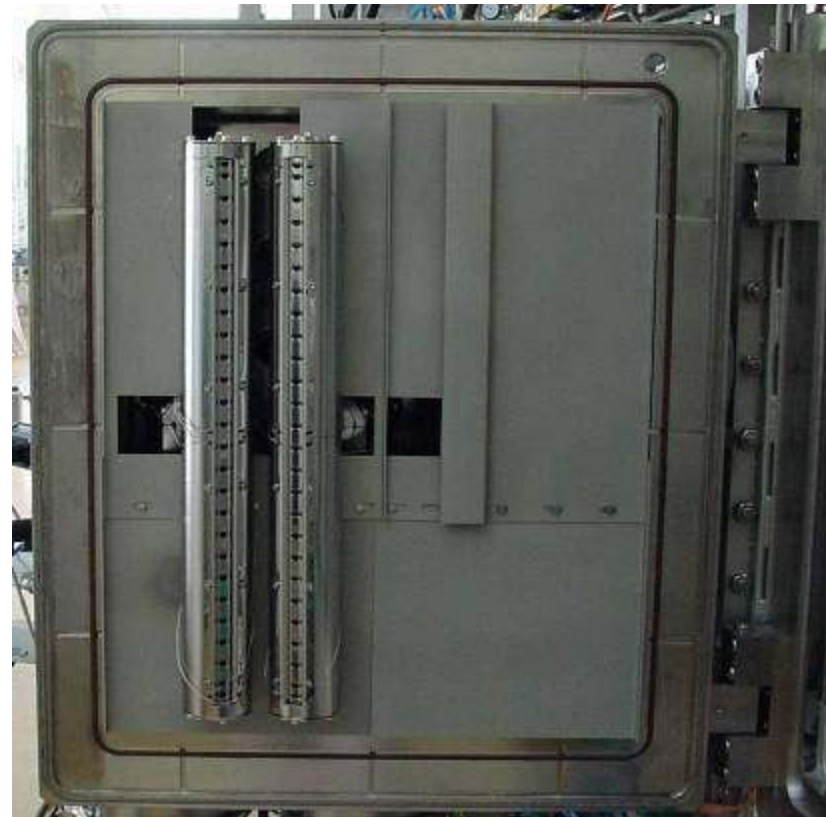
Linear Organic Material Evaporator

- High material usage
- Easy scalable
- Refill without venting the chamber
- Organic material only in contact with inert material (quartz)
- Temperature of column and crucible independently controllable





Deposition Sources: Organic Material Evaporator in Vertical OLED Coater





Pretreatment Sources

- Magnetically enhanced glow discharge, μbar range:
Magnetron
Ion energies low, <70 eV
- Linear Ion Source
Ion energies >70 eV
- Hollow Anode
Ion energies 100 - 2000 eV



Inline Measuring Tools

- Optical : Density
- Optical : Spectral Transmission / Spectral Reflection
- Resistivity : Roll to Roll
- Resistivity : Contactless (eddy current)
- Optical : Ellipsometry



A new “Smart” Web Coater for Flexible Display and Electronic Products

Conclusion

- New products like FPCBs, flexible displays, flexible ICs and flexible solar cells put increasing demands on PVD roll coaters.
- SMARTWEB provides highest flexibility, clean room compatibility and multiprocess capability, making it an ideal tool for development labs and for production of flexible display and electronic devices.
- We have realized outstanding high deposition rates for copper and ITO together with promising layer quality.

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