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SPUTTERING OF ROTARY SINTERED CERAMIC ITO-TARGETS IN HIGH POWER APPLICATIONS

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Outline

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- Why rotary magnetrons for ITO ?
- Long term sputter stability of rotary ITO
- Influence of several sputter parameters on the ITO thin film properties of DC deposited films
  - Reactive gas mixture
  - Planar compared with rotary magnetrons
  - Substrate temperature
  - Sputter power load
- Other compositions than ITO-90/10
- Cost comparison rotary vs. planar technology: two examples
- Conclusions

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WHY ROTARY TECHNOLOGY FOR ITO ?

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State-of-the art rotary ITO targets

- Physico-chemical properties of ITO cylinders are identical to ITO-plates:
  - Density: ≥ 7.10 g/cc
  - Chemical purity 4N
- Multiple cylinders are bonded onto Ti-backing tube.Typical backing tube OD = 133 mm.
- ITO-cylinders:
  - ITO-ID: standard = 135 mm
  - ITO-wall thickness, standards today: 6 - 10 mm
  - 12 mm wall thickness in development
  - Segment length: appr. 200 mm

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SPUTTER STABILITY OVER TARGET LIFETIME

Target performance testing ('BUTTU')

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'BUTTU' characteristics

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- Horizontal, cantilever magnetron (SCI), length 1 m (960 mm target length).
- Sputter down against Cu-shields (no coating collection)
- DC power supply: AE Ascent, 60 kW (yielding max. power load > 60 kW/m)
- Electrically isolated anode (gas manifold serving as anode)
- Cathode cooling: water in 21℃, appr. 5 bar, typical flow 31.7 litres/min.

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THIN FILM PROPERTIES OBTAINED WITH ROTARY AT HIGH POWER

Deposition experiments : sputter system

Leybold Optics A600/V7: dynamic sputter coating line with twin rotary cathode and with twin planar cathode

Substrate pre-heating in load-lock possible (RT – 430℃)

Rotary cathodes: SCI end blocks, LO magnet arrays, target length 0.6 m

Sputter power supplies: Advanced Energy Pinnacle+ (2 x 10 kW in M/M)

- Tuning of the reactive process

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- Difference rotary vs. planar

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- Influence of substrate temperature

- Sputter power load: T_{sub} appr. 200℃

OTHER COMPOSITIONS THAN ITO-90/10

TCO trends in Hetero-Junction crystalline Si solar cells

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- Cell production cost reduction: requires usage of rotary technology for all sputter depositions (metal and TCO).
- HJ c-Si cells convert sunlight up to appr. 1200 nm: TCO with increased transmittance in the NIR required :
  - A lot of R&D on pure H-doped In_2O_3 (IO:H), but:
    - brittle material, low sputtering target production yield
    - difficult to make rotary In_2O_3 targets
    - high In content
  - Hence: expensive targets and high coating cost with In_2O_3
- ITO-97/3 (3 wt % SnO_2) targets can still be produced in rotary format with high yield. Could be a nice trade-off for the industry.

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COATING COSTS: TWO EXAMPLES

EXAMPLE 1: ITO coating for CF-plane

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Coating on a dynamic in-line tool :

- Vertical system with load locks
- Substrate heating capabilities
- Example: Applied Materials' AKT® NEW ARISTO 2200

Photogr.: Courtesy of Applied Materials

Example 2. ITO-coated film for projected capacitive touch panels

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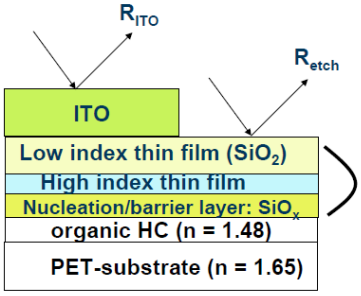

Optical coating stack, increases refractive index of PET/HC to appr. 1.95, equal to ITO

$R_{ITO} = R_{etch}$ – 'invisible' ITO

High index film: e.g. Nb_2O_5, SiN_x, TiO_2, ZrO_2, …
(selected a.o. to guarantee colour neutrality)

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CONCLUSIONS