PRECISION OPTICAL FILTERS BY EOSS® - ENHANCED OPTICAL SPUTTERING SYSTEM

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EOSS®
ENHANCED OPTICAL SPUTTERING SYSTEM

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EOSS® Coating System for Precision Optical Filters

Motivation

- A coating system that ...
  - ... offers stable and easy to use processes without complex process control
  - ... combines the advantage of IBS processes (stability & quality) and evaporation (deposition rate & substrate size)
  - ... is build for continued changes of designs to meet customer demands
  - ... offers inherent long term stability
  - ... produces clean and reproducible coatings
EOSS® Coating System

Setup

- Dual cylindrical magnetron
- Evacuated magazine holding 1-12 substrates
- Optical monitor
- Atmospheric handling system
- Plasma source
- Rotating turntable
- Automated handling system
EOSS® Sputter Coating System

Key performance

- **Processes**
  - MF, RF sputtering, RF-plasma source
  - CARS, Metamode, reactive

- **Coating materials:**
  - SiO₂, Al₂O₃, Ta₂O₅, Nb₂O₅, TiO₂, ZrO₂, HfO₂, easy to mix materials, metals

- **Large area, fast rate:**
  - 12x200mm substrates
  - Uniformity within ±0.15%
  - Deposition rate: ≤ 0.6 nm/s

- Fully automatized production control:
  - MOCCA+®, BBM 360-1650nm
EOSS® Coating System
High volume coating system

- 12 carriers on turntable
- Substrate cabinet with 60 carriers (200mm diameter)
- Base pressure < 2x10^{-7} mbar
- Process temperature \( \leq 300^\circ\text{C} \)
- Handling and coating fully automatized
EOSS® Coating System
Improved coatings by applying cylindrical magnetrons

- No redeposition zone
- No racetrack!
- Continuous and uniform erosion of the surface

transition area: source of particles

redeposition zone

racetrack

No redeposition zone and no racetrack! Continuous and uniform erosion of the surface
EOSS® Coating System

Very clean process

Processes
- #1-#5: Sputter down
- #3-#7: Rotatable
- #6: EOSS®, SiO₂
- #7: EOSS®, 14 layer filter

Particle contamination < 10 ppm
EOSS® Coating System
Extremely high uniformity

- Distribution of material within the direction of rotational motion
- Uniformity better than ±0.10 %
EOSS® Coating System
Extremely high uniformity

- Distribution of material perpend. to the direction of rotational motion
- Uniformity better than ±0.15 %
EOSS® Coating Examples

Longpass filter

- 40 layer longpass filter with defined spectral edge
- Partial substrate coatings by handmade masks

Graph showing transmission [%] vs. wavelength [nm] for different samples:
- 50% @ 436.5 nm ± 0.3 nm substrates masked and positioned by hand
EOSS® Coating System

Notch filter

- OD6 notch filter (80 layers)
- Broad band transmission
- Excellent layer quality
- On 200 mm wafer

![Image of notch filter](image)

![Graph showing transmission vs. wavelength](graph)
EOSS® Coating Examples
Filter for Laser 3D-projection, 60-80 layers

- 60-80 layer filter
- MOCCA+® monitor
- 20 measurements on a 200mm wafer
EOSS® Coating Examples
AR Coating (time-controlled)

- Double side coating, 12 layers/side
- Spec: $R < 0.5\%$ @ 400-700 nm
- 10 runs, 5 substrates
- Time control only
- **Extremely reproducible**
  - Thinnest layer $< 6$ nm
  - r.m.s. thickness error $< 0.1$ nm
- Very low particular contamination
EOSS® Coating Examples
Laser clean-up filter 375 nm

- Specs:
  - $T_{\text{avg}} > 90\%$ 372 – 378 nm
  - $OD_{\text{avg}} > 5$ bei 337-359 nm und 393-415 nm
  - $OD_{\text{avg}} > 3$ bei 212-265 nm und 385-554 nm
- Fabricated without test run
- No AR on back side
EOSS® Coating Examples
Bandpass filter, wide blocking range

- 9 substrates with 200 mm diameter each
- Double side coating
- Spectra shown for
  - 3 different batches
  - 3 different carriers
- Wavelength position within 0.25% (± 0.125%)
**EOSS® Coating System**

**Blended layers by co-Sputtering**

- Due to the layout of the coating system, co-sputtering in every sputtering mode is possible
- Virtually free tunable index of refraction between the materials
- Production of Rugate layers
- Stabilization of critical materials such as TiO$_2$, HfO$_2$ by doping with SiO$_2$

Filters created by mixed oxides presented at the Optatec 2012 in Frankfurt
EOSS® Coating System
Products & Application

- Optical filters ranging from single layers up to several hundred layers
  - Steep edge
  - Notch, Multinotch
  - Bandpass
  - Beam splitters
  - High/Low reflection
  - Polarizers
  - Dielectric-metal-hybrid
  - Chirped mirrors
  - Rugate, Material mixtures

- Applications
  - Analytics: e.g. fluorescence microscopy, raman spectroscopy, biomedicine, solar simulators, ...
  - Laser based systems: e.g. reflectors, chirped mirrors, ...
  - Coatings on sensitive substrates
  - The system is build for continued changes of designs to meet customer demands
EOSS® Coating System
Full production automation by MOCCA+®

- The MOCCA+® kit includes
  - 19” system rack
  - Spectral range 360 – 1650 nm
  - Accuracy < 0.3 nm (< 0.6 nm IR)
  - Light source: 50W halogen
  - Optical fiber system
- Fast measurement interval: 1.6 ms
- Optilayer adapter
EOSS® Summary

- High precision optical coating system based on magnetron sputtering and cylindrical magnetrons
- Fully automized
- Excellent layer quality
  - Low absorption and scatter losses
  - Dense and defect-free layers
- Rotatable magnetrons
  - Excellent long-term stability with rotatable magnetrons
  - Target lifetime up to 3 months - 24/7!
  - Extremely high uniformity, virtually no drift (no racetrack)