LASEROPTIK
Home of high power optics and coatings

Stable, precise and durable sputtered, dielectric coatings for LISA and other space missions

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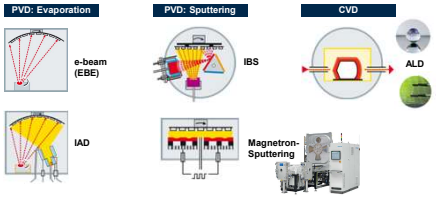
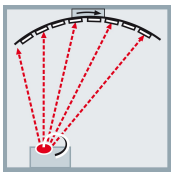
Coating Technologies: All Demands Covered



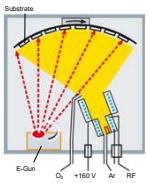
EBE Electron Beam Evaporation



+ density near to bulk
+ internal stress can be optimised
+ DUV to IR
– thermal drift
– internal stress (tensile)

EBE machines called Paula, Sara, Wilma, Betty, Hanna, Frieda, Luzy, Xena, Rosi, Aida, Klara, Maria, Cohra

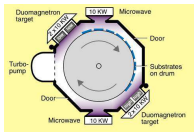
IAD Ion Assisted Deposition



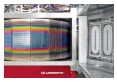
+ density near to bulk
+ internal stress can be optimised
+ high evaporation rate
± VIS/NIR: LIDT close to e-beam

IAD machines called Sally, Jenny and Elli

MS Magnetron Sputtering machine with twin magnetron and plasma source

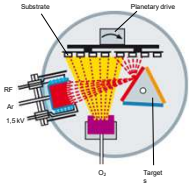


+ very dense and hard coatings, space certified by ESA
+ high precision
+ high LIDT for UV-coatings and cw-applications
– compressive stress

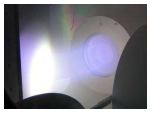


MS machines called Gabrielle and Lila

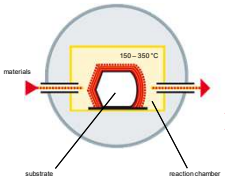
IBS Ion Beam Sputtering with two ion guns and neutralisers



+ excellent microstructure
+ high density
+ space certified by ESA
+ highest precision
+ lowest losses
– internal stress
– small rate and coating area



ALD Atomic Layer Deposition



+ coatings on 3D optics
+ amorphous films
+ no pinholes
+ small stress
– small rate
– all areas coated

ALD machine called EsmerALDa

Layer structure (schematic images)

without assist
Columnar structure
– thermal drift
– tensile stress

EBE

medium assist
Nano-Cavities
+ thermal stability
± variable coating stress

IAD

high assist
Dense structure
± low thermal drift
– compressive stress

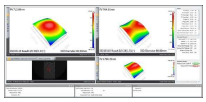
MS + IBS

In-house measurement capabilities

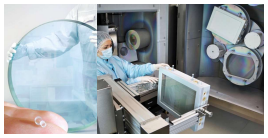
- Spectrophotometry (R,T)
- Absorption, Total losses
- Surface: flatness, roughness, defects
- Laser induced damage threshold (soon)
- Phase (GD, GDD)
- R&D department and laser metrology lab

Surface form measurements → Interferometry

- Optic sizes: Ø 3–300 mm
- Accuracy PV: Lambda/20 (32 nm)
- Surface form critical for optical image quality
- Detection and compensation of coating induced stress



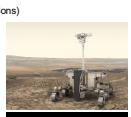
Substrate geometries at LASEROPTIK

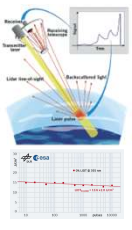


- Almost all substrate types, e.g. crystals, wafers, metals, fibers
- From very small (< 1 mm) to large (e.g. 2 m in length, 1 m in diameter)
- Employing **ALD** a variety of type shapes, e.g. balls, tubes, domes and more can be coated.
- Sourced from reliable European partners

40 years of experience with spaceborne

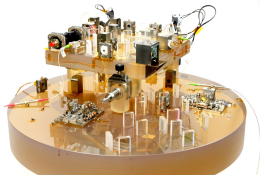
- "Heritage" status at ESA (several missions):
- Involved in several missions:
- ADM-Aeolus 1+2
- GRACE-FO
- EarthCare
- BepiColombo
- JUICE
- ExoMars

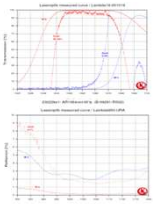




Deposition of spaceborne optics up to substrates with diameter 550mm

Polarising beam splitter for LISA OB telescope simulator





Stress-compensating coatings

- Dense sputtered coatings show compressive stress on substrates
- Uncoated plane substrates become slightly convex after coating
- Tailored coating on second side can compensate stress of first side coating
- Stoney equation relates substrate curvature to stress in coating

$$\sigma_f t_f = \frac{E_s h^2}{6(1-\nu_s)R}$$

- with σ_f the in-plane stress component in the coating, t_f the thickness of the coating, E_s Young's modulus of the substrate, ν_s Poisson's ratio for the substrate, h the thickness of the substrate and R the radius of curvature of the initial flat substrate after deposition of the coating.

Key Numbers

- 1984: foundation by Dr. Johannes Ebert
- 1998: first ISO:9001 certificate
- 100+ employees
- 40+ coating machines (18 IBS, 1 ALD)
- 5 coating methods
- 180,000 coated optics/year on average
- 24h-Express service
- 1,200+ coatings online in LaserOptikOnlinePortal

Ecological and social responsibility at LASEROPTIK

- company kindergarten „Laserstrolche" („laser vagabonds")
- profit shared with employees, family and sport activities
- created habitats within or around the company buildings, e.g. for owls, bats, falcons, salamanders and bees
- LASEROPTIK is powered by 100% green energy
- stork nest with offsprings every year since erection in 2009
- waste heat from the coating machines is used for heating