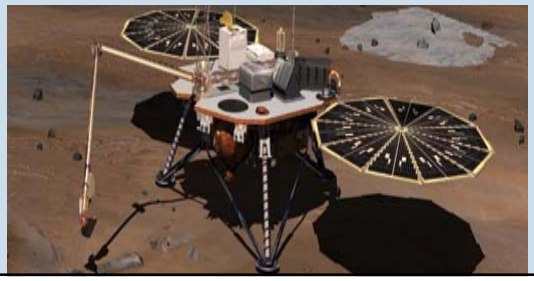
Optimal coating materials
for
low film stress
high environmental stability
excellent deposition behaviour



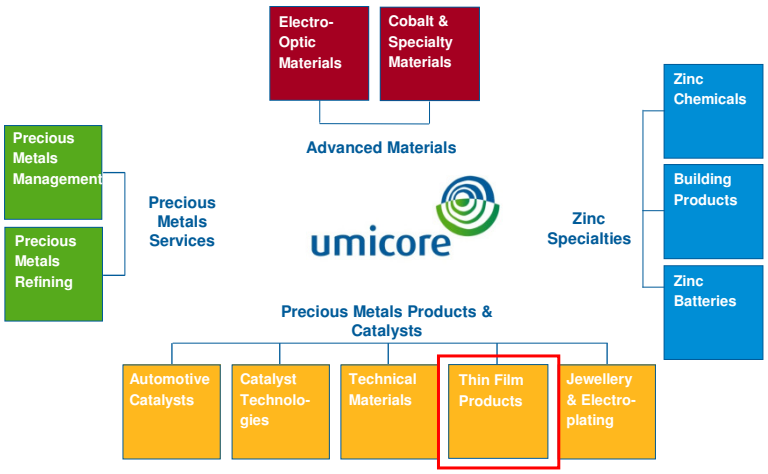
Agenda

- **Introducing UMICORE**
- **Optical Coatings**
- **The UMICORE Approach and products**
- **Film stress & UMICORE's answer**
- **Materials for dedicated applications**
- **Quality Assurance & Analytics Capabilities**
- **Process & Application Expertise**
- **Summary**

Section one

Introducing UMICORE

A decentralised, customer-focused organisation



Umicore Thin Film Products

- Founded in 2002, after the acquisition of Unaxis Materials, former **BALZERS MATERIALS** with there subsidies Balzers Liechtsten, Hsinchu Taiwan and Nashua USA.
- Organized along 3 Business Lines

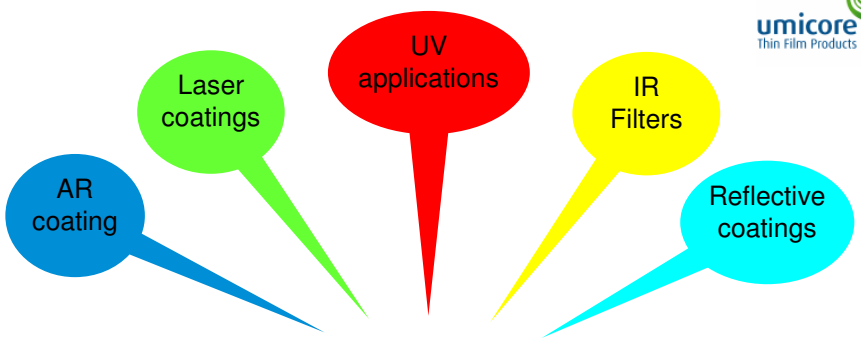

Optics & Wear Protection


Electronics & Data Storage


Large Area Coatings

Section two

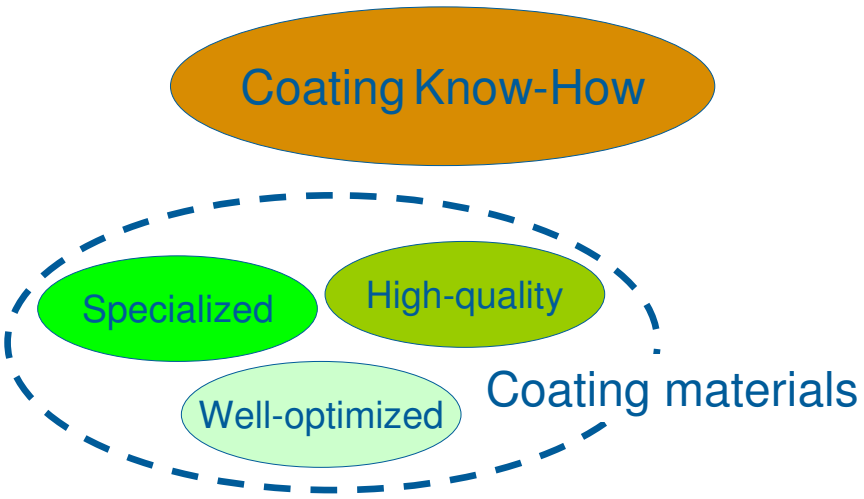
Optical Coatings



Coatings

- Essential for the optical & other functions
- Often located at exposed locations
- Frequently representing the most vulnerable part

Making coatings requires



Section three

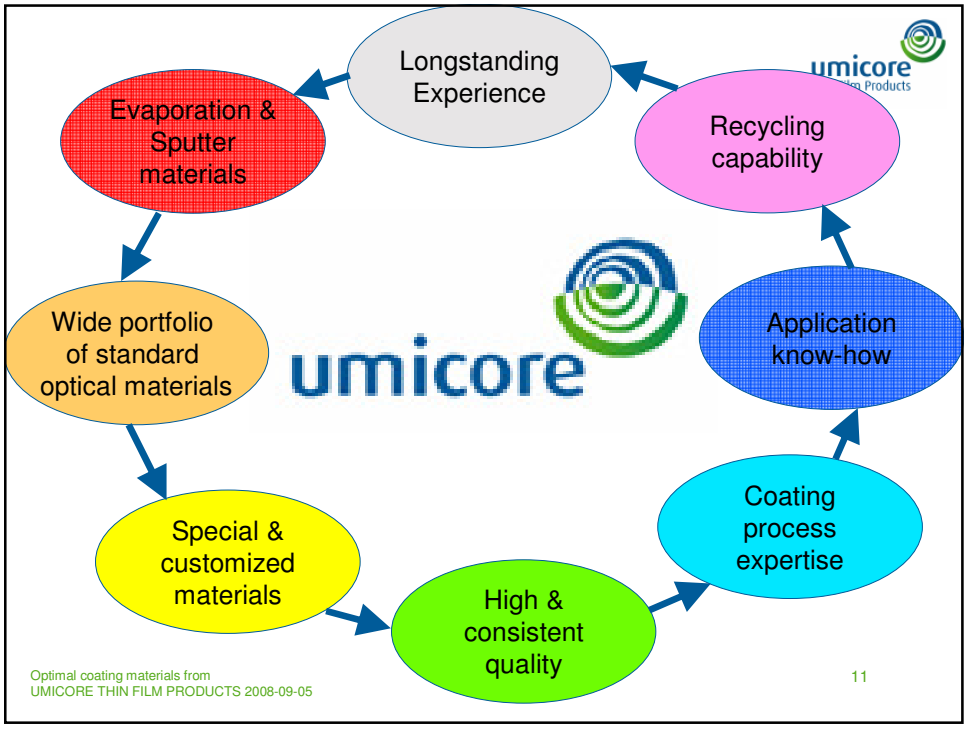
The UMICORE Approach & products

How contributes

UMICORE THIN FILM PRODUCTS

To your coating solutions

???


Longstanding Experience
Recycling capability
Application know-how
Coating process expertise
High & consistent quality
Special & customized materials
Wide portfolio of standard optical materials
Evaporation & Sputter materials
umicore
umicore
Thin Film Products
Optimal coating materials from
UMICORE THIN FILM PRODUCTS 2008-09-05
11


Evaporation Materials
umicore
Thin Film Products
Optimal coating materials from
UMICORE THIN FILM PRODUCTS 2008-09-05
12

Sputter Materials

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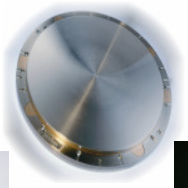
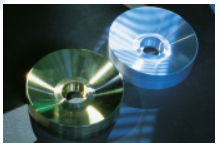
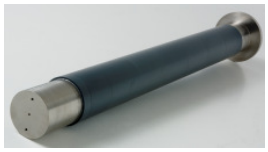
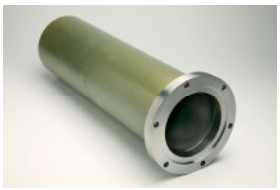
Thin Film Products





umicore
materials for a better life

Section four

Film stress & UMICORE's answer

Stress in optical films

- What influences film stress?
  - Chemical structure of coating material
  - Evaporation parameters
    - Residual and reactive gas pressure
    - Evaporation rate
    - Substrate temperature
    - Usage and adjustment of ion sources

UMICORE's approach to optimize materials

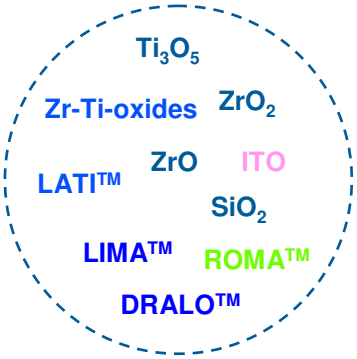
Umicore has a longstanding know-how to optimize materials to adjust them for specific requirements

- analyse single materials
  combine and tune them to form new materials
  like DRALO, LATI, ROMA, Zr-Ti-oxides, …
- adjust our production process to the new alloy
  run application tests

Materials for Optics & Coatings on Plastics

umicore Thin Film Products

UMICORE Specialized Materials

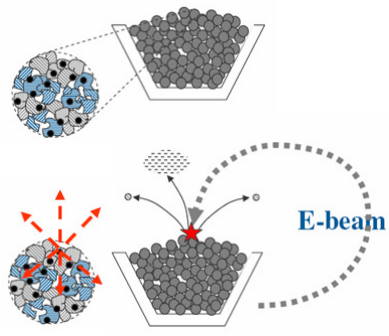


- High density
- Excellent evaporation
- High material yield from crucible
- Optimized mechanical stress
- Outstanding climate resistance
- Antistatic and anti-fogging

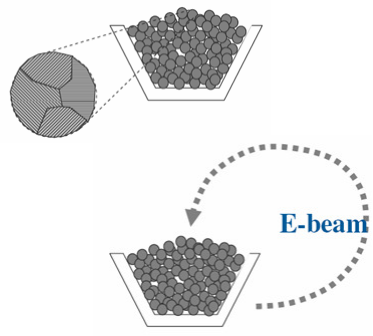
Materials for Optics & Coatings on Plastics

umicore Thin Film Products

Lanthania-titania (competitors)



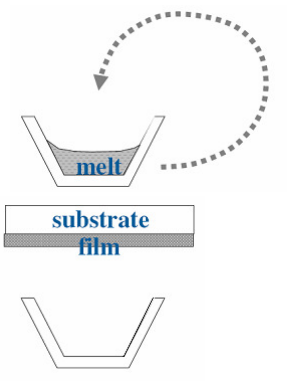
LATI™ (UMICORE)



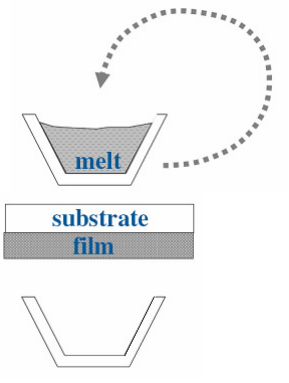
Materials for Optics & Coatings on Plastics

umicore Thin Film Products

Lanthania-titania (competitors)



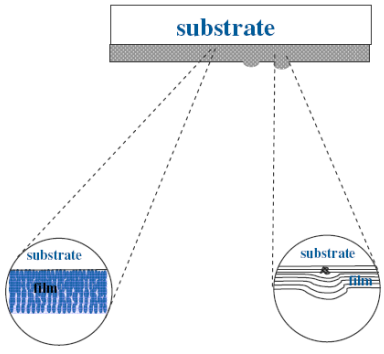
LATI™ (UMICORE)



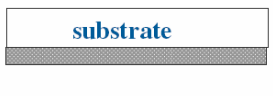
Materials for Optics & Coatings on Plastics

umicore Thin Film Products

Lanthania-titania (competitors)



LATI™ (UMICORE)



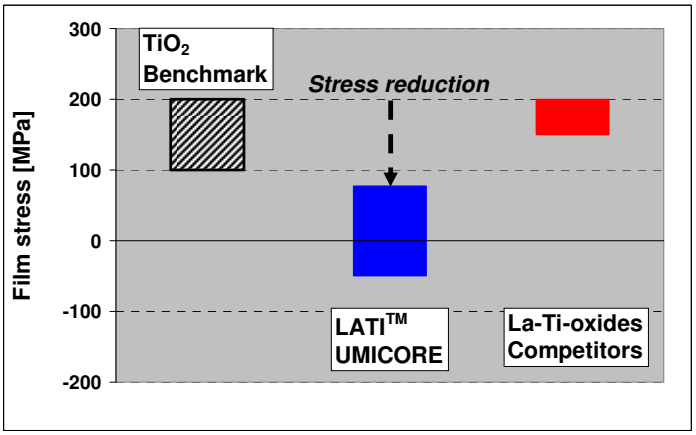
Materials for Optics & Coatings on Plastics

LATI™ – alternative to H4, $LaTiO_3$ and other lanthania-titania mixtures

- Much higher density
- Easy melting, no spitting
- More material from each crucible
- Optically homogeneous films

Materials for Optics & Coatings on Plastics

Optimized stress in LATI™ films



Materials for Optics & Coatings on Plastics

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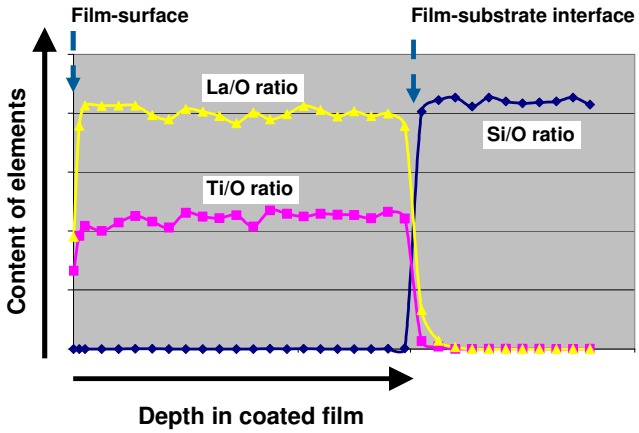
Thin Film Products

Homogeneity in LATI™ films



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materials for a better life

Section five

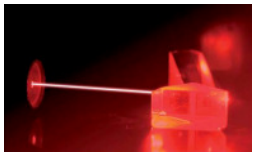
Materials for dedicated applications

→ Laser optics

Materials for Precision Optics & Laser Coatings

umicore Thin Film Products

- **UV to IR spectral range**
- **High-density**
- **Excellent process behaviour**
- **Optimized refractive index**
- **Reduced mechanical stress**



Materials for Precision Optics & Laser Coatings

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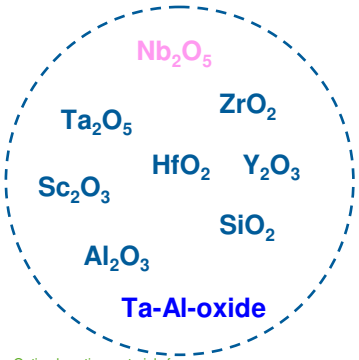
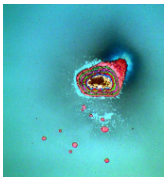
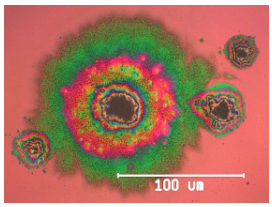
→ UMICORE Oxides

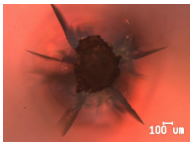


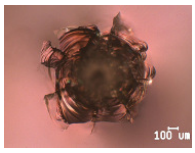
- Very low absorption and light scatter
- High laser damage threshold
- Good thermal resistivity
- Reduced mechanical stress

Laser damage ??







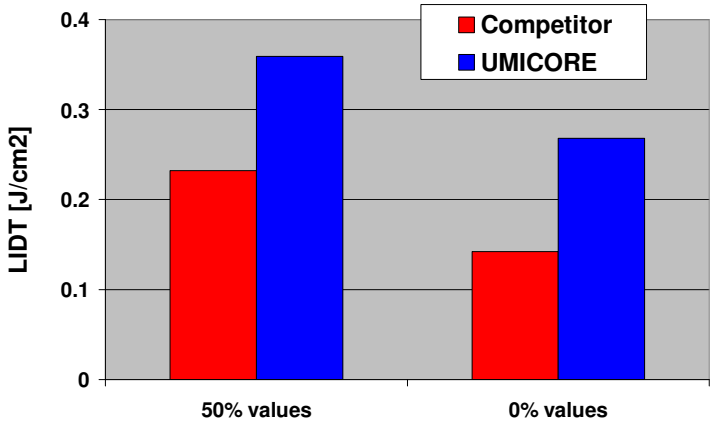


On coatings with HfO_2 from competitors

On coatings with Al_2O_3 from competitors

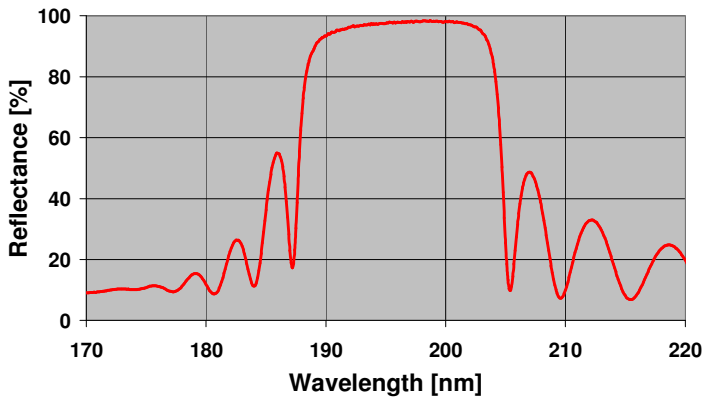
→ no issue with high-pure high-density laser coating materials from UMICORE

Laser damage threshold



Al_2O_3/SiO_2 HR laser coating
193nm, 200Hz, 13ns, 10'000-on-1

Low absorption

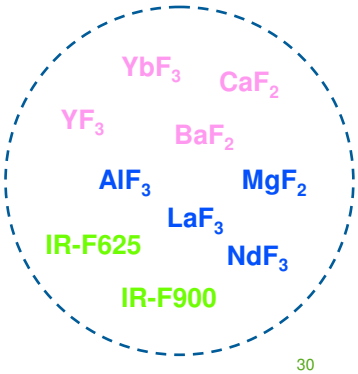


Al_2O_3/SiO_2 HR laser coating for 193nm
- deposited with UMICORE materials

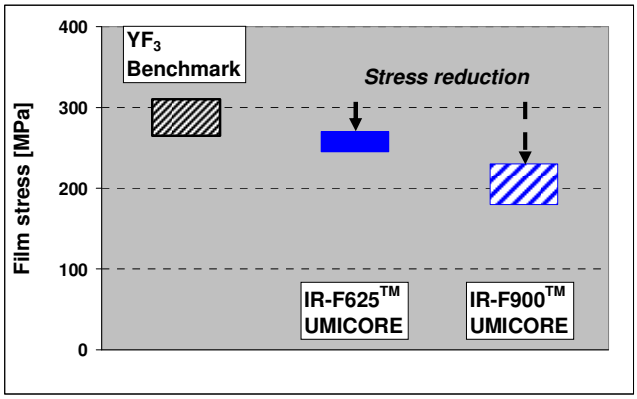
Materials for Precision Optics & Laser Coatings

→ UMICORE Fluorides

- Very low absorption and light scatter
- High laser damage threshold
- Deep Ultraviolet (DUV)
- Mid-Infrared (IR)
  - Reduced mechanical stress
  - Alternative to ThF_4



Materials for Precision Optics & Laser Coatings



Stress reduction for fluorides IR-F625™ and IR-F900™

Section six

Quality Assurance & Analytics Capabilities

High & Consistent Quality

ISO 9001 & ISO 14001 & OHSAS 18001 certified

The Swiss Association
for Quality and Management Systems

umicore
Thin Film Products

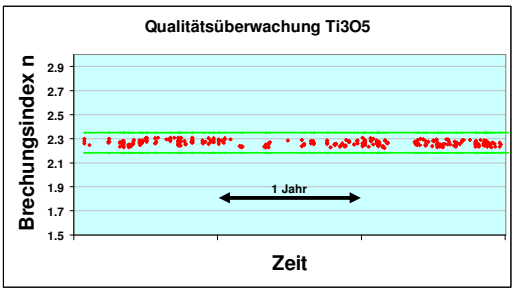
UMICORE Materials AG
FL-9496 Balzers

Whole Company

Thin Film Products

SQS Certificate
ISO 9001:2000 / ISO 14001:2004 / OHSAS 18001:1999

Permanent Material Analysis & Process Control



In-house Analytical Capabilities

Test Laboratory for Optics

Climate Exposure
Test Cabinet

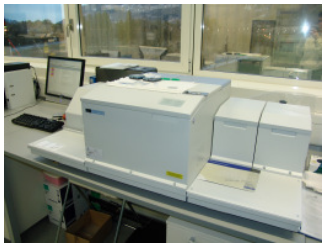
Salt Water Fog Test

Drying Cabinet

In-house Analytical Capabilities

Test Laboratory for Optics

Film Stress
Measuring Device



IR-
Spectrometer

Contact Angle Setup

In-house Analytical Capabilities

<u>Composition analysis:</u>	
• Energy-/Wavelength Dispersive X-ray analysis	EDX/WDX
• Glow Discharge Mass Spectrometry	GDMS
• Induction Coupled Plasma Spectroscopy	ICP (LA-ICP-MS)
• X-ray Fluorescence Analysis	XRF
• Combustion Analysis (C, N, O, S)	LECO
<u>Thermal analysis:</u>	
• Diff. Thermal Analysis with Thermal Gravimetry	TG-DTA
• Differential Scanning Calorimetry	DSC
<u>Structure / Microstructure / Material failures:</u>	
• Scanning Electron Microscopy	REM
• X-Ray Diffraction	XRD
• Particle Size Distribution	Laser Diffraction
• Pore measurement,	Porosimetry

Section seven

Process & Application Expertise

UMICORE Process & Application Know-How

- Production – type coating equipment (evaporation & sputtering)
- Inhouse staff with 15-20 years experience from coating industry
- Application testing of materials by dedicated equipment manufacturers
- Optical Design Know-How and software tools:
  - Film Star
  - Film Wizard

Summary

Summary

UMICORE has a long history and strong background in producing and analysing optical coating materials.

UMICORE provides customized solutions for specific applications like stress reduced materials.

UMICORE possesses an extensive quality system and assists their customer with specific data.

See you at booth 9191

www.thinfilmproducts.umicore.com