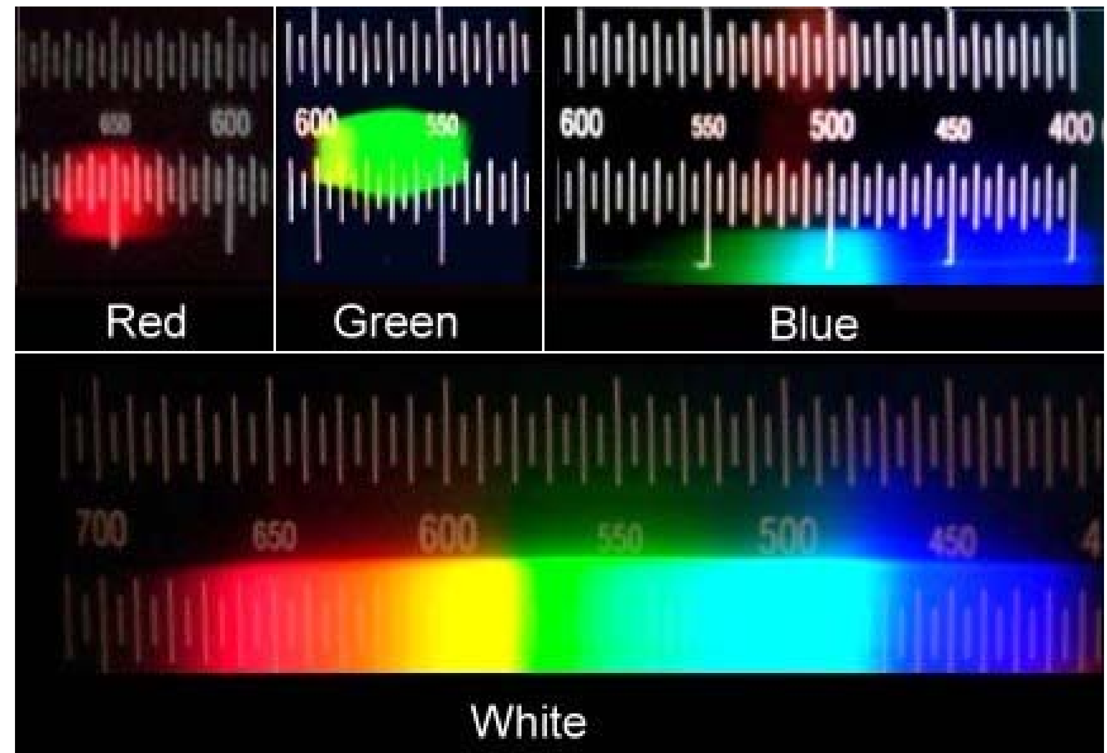
UV Beschichtungen

Norbert Kaiser

27. November 2008

Mainz



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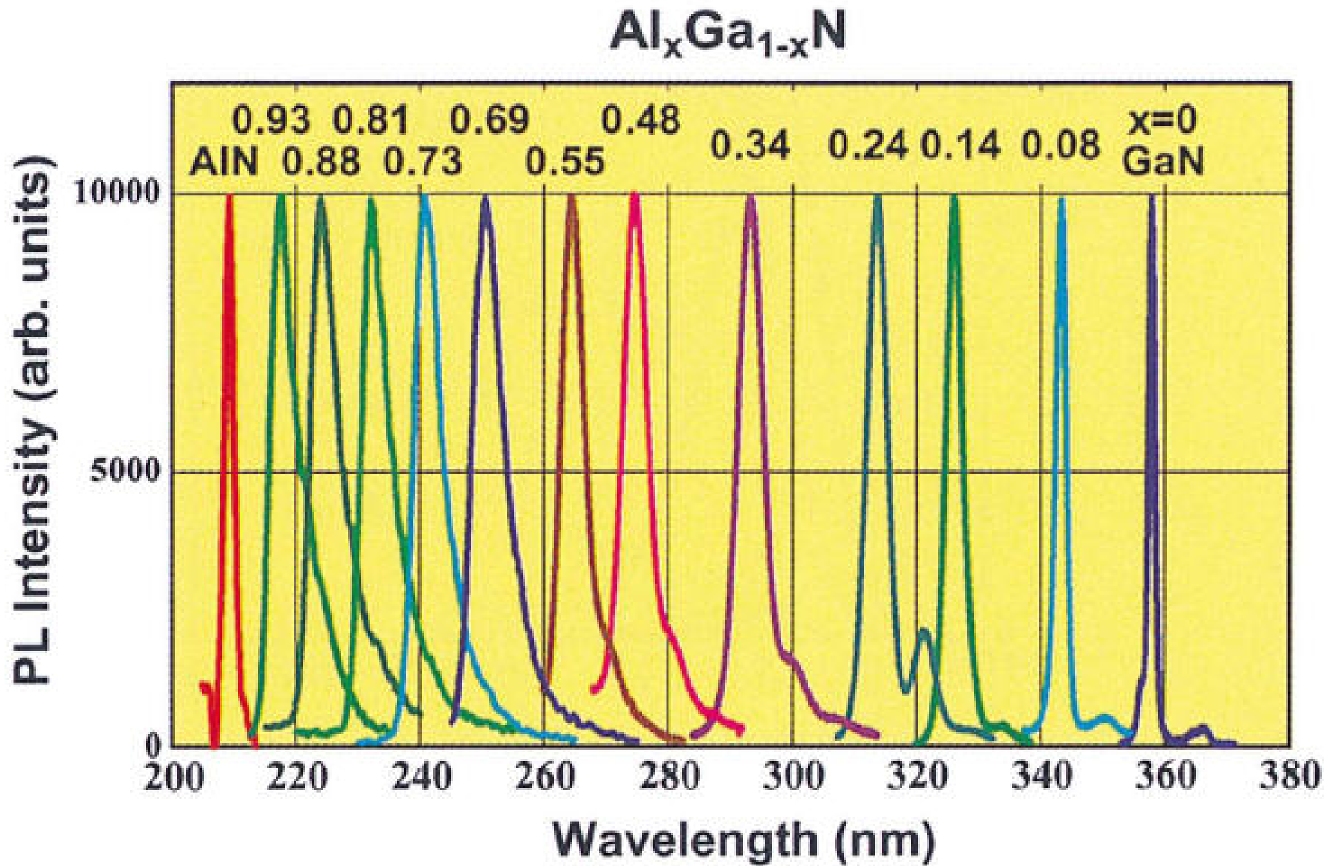
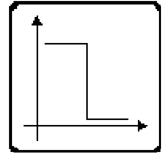
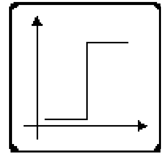
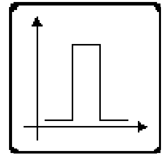
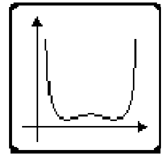
UV Beschichtungen - Wellenlängen

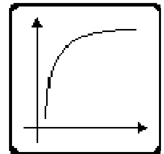






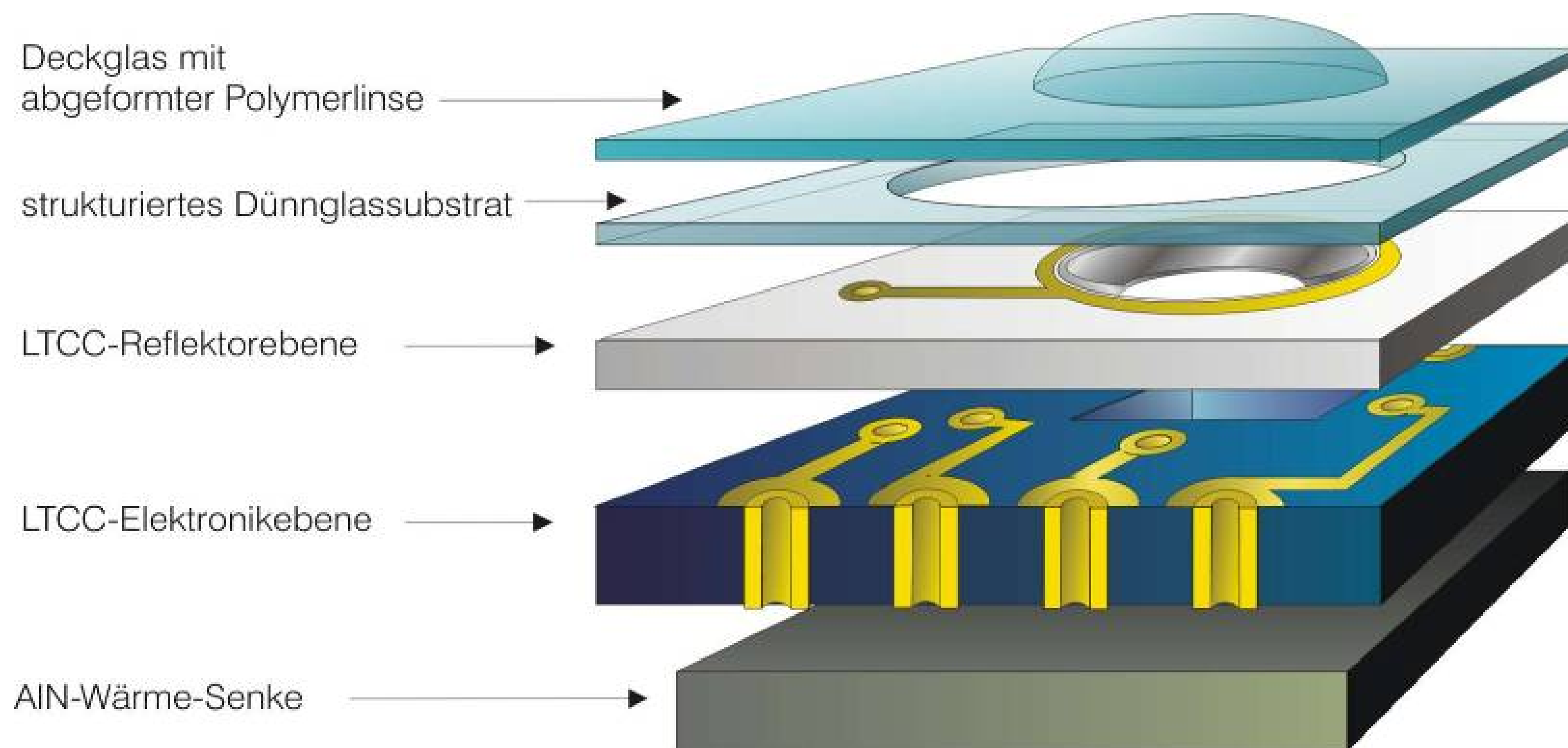






SchichtUV1

Qualifikation von Glaskeramik (LTCC) für Optische und Optoelektronische Anwendungen



Design-Skizze zu einem Beleuchtungsmodul auf LTCC-Basis

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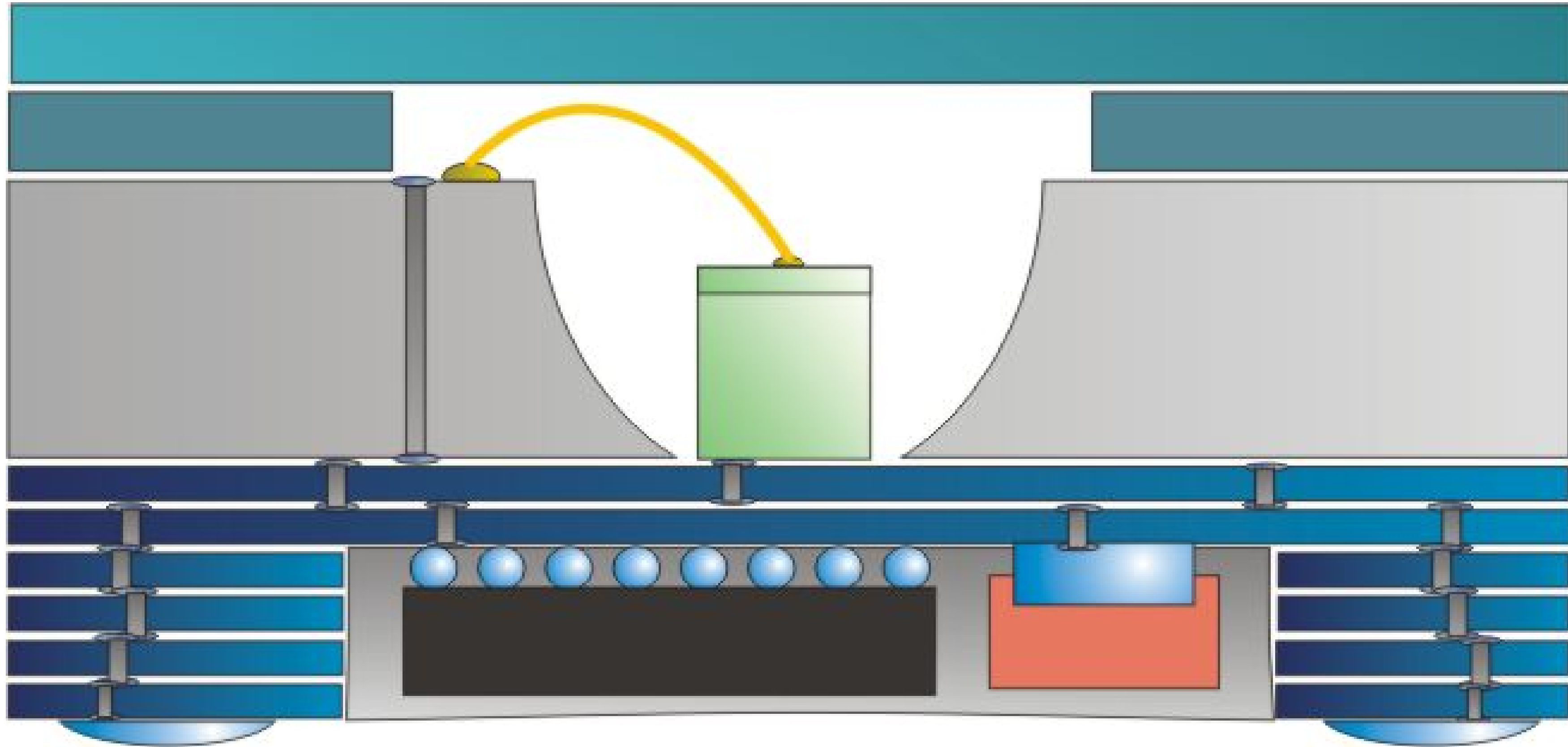
fanimat

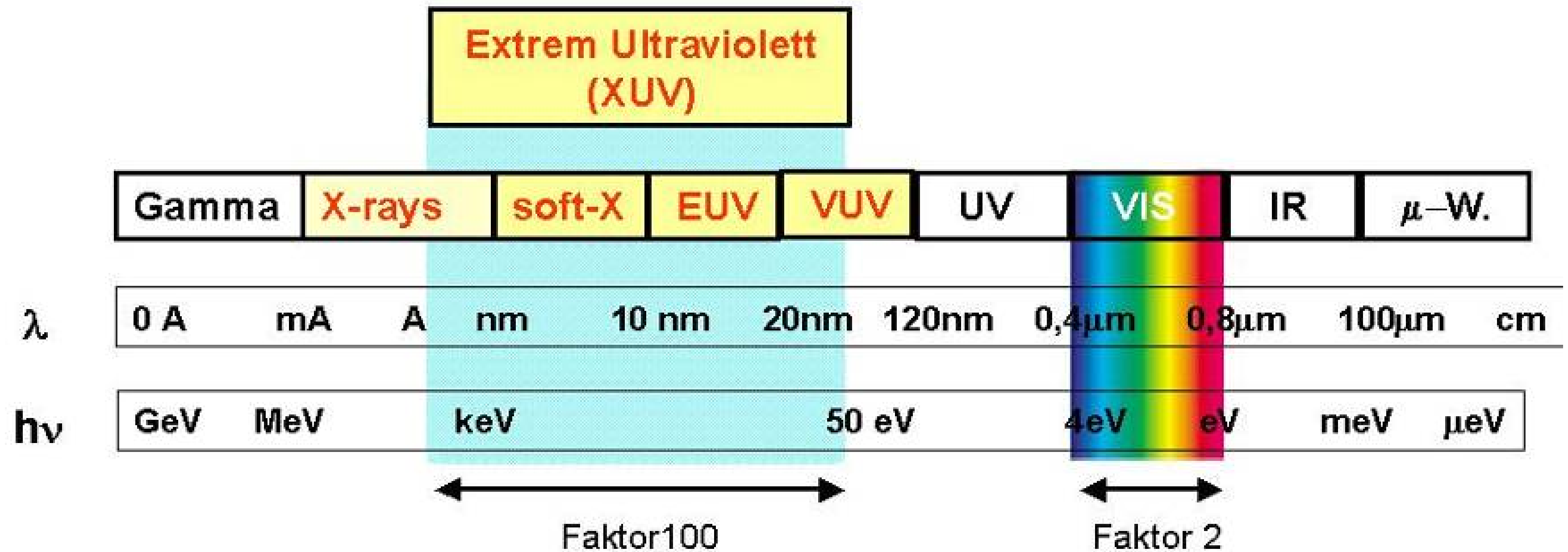
Deutsche IMAPS-Konferenz München 2004

Optoelektronischer Demonstrator - LED-Beleuchtungsmodul -



SchichtUV1

XUV



DUV - Deep UltraViolet:	200 nm – 280 nm
VUV - Vacuum UltraViolet:	100 nm – 200 nm
XUV – Extreme UltraViolet:	1 nm - 100 nm
EUV – Lithography Extreme UltraViolet:	around 13 nm

SchichtUV1

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XUV

elevation and ionization of electrons

photoionization of shell electrons

photoionization of core electrons

scattering at the core

$q = 10^{-18}$ m²; r = 1 nm

$q = 10^{-30}$ m²; r = 1 fm

scattering at core electrons

$q = 10^{-20}$ m²; r = 1 A

cross section (barn/atom)

10^{6}

10^{4}

10^{-6}

IR

Vis

UV

VUV

XUV

x-rays

γ-rays

10^{-1} | 10^{0} eV | 10^{1} | 10^{2} | 10^{3} keV | 10^{4} | 10^{5} | 10^{6} MeV | hν (eV)

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Innovationen durch kurze Wellenlängen:

- DUV-, EUV- Lithographie
- Mikroskopie im "Wasserfenster" (λ = 2.3 nm – 4.4 nm)
- Astronomie (λ = 5 nm – 50 nm)
- Spektroskopie, Plasmaanalytik
- XUV Laser
- Desinfizieren
- Trocknen, Härten

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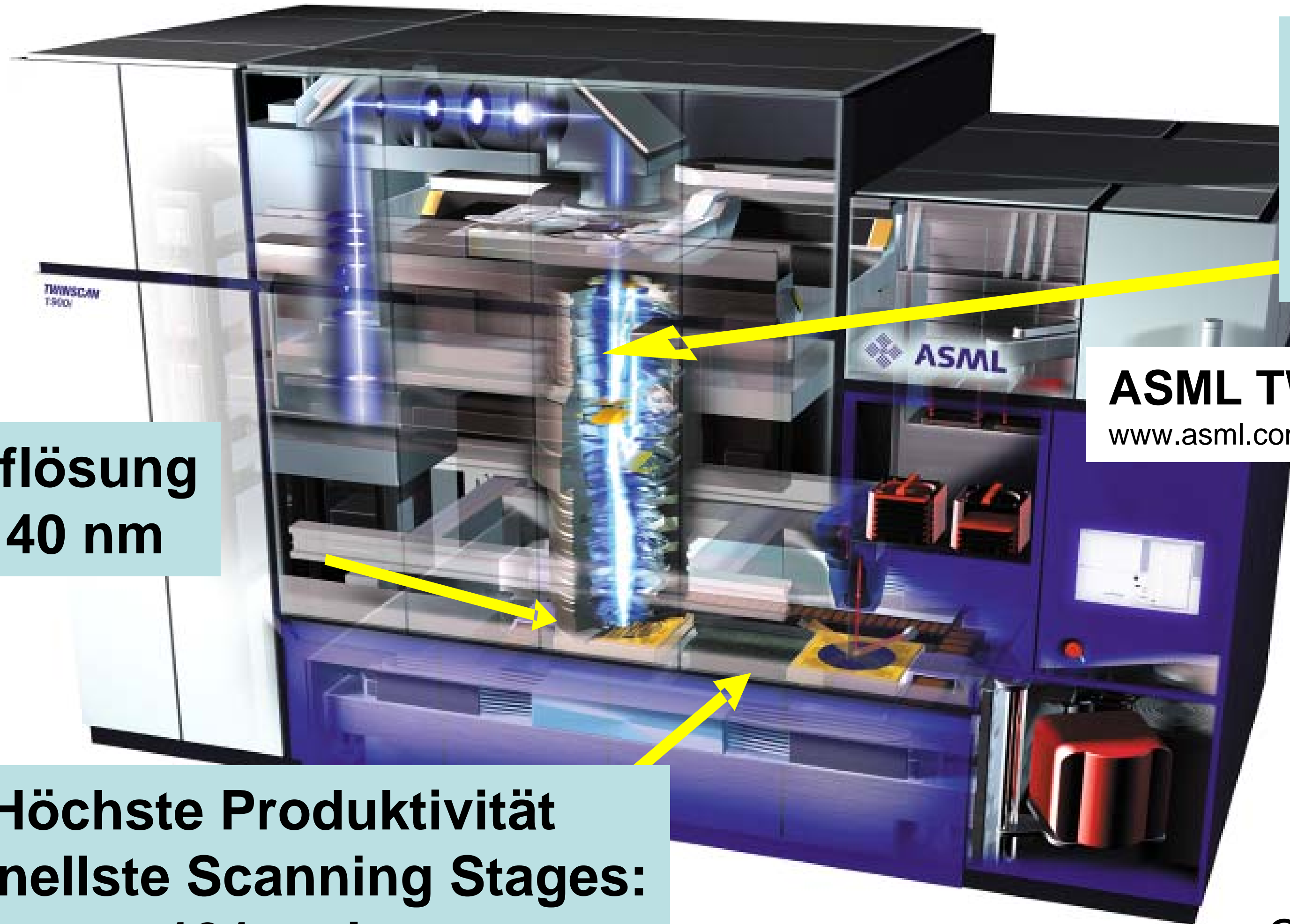
Die Maschine …

ZEISS

Der Waferscanner/stepper der neuesten Generation ist die…



193 nm
Höchste NA 1.35
ArFi katadioptrisches Objektiv

ASML TWINSCAN™ XT:1900Gi
www.asml.com

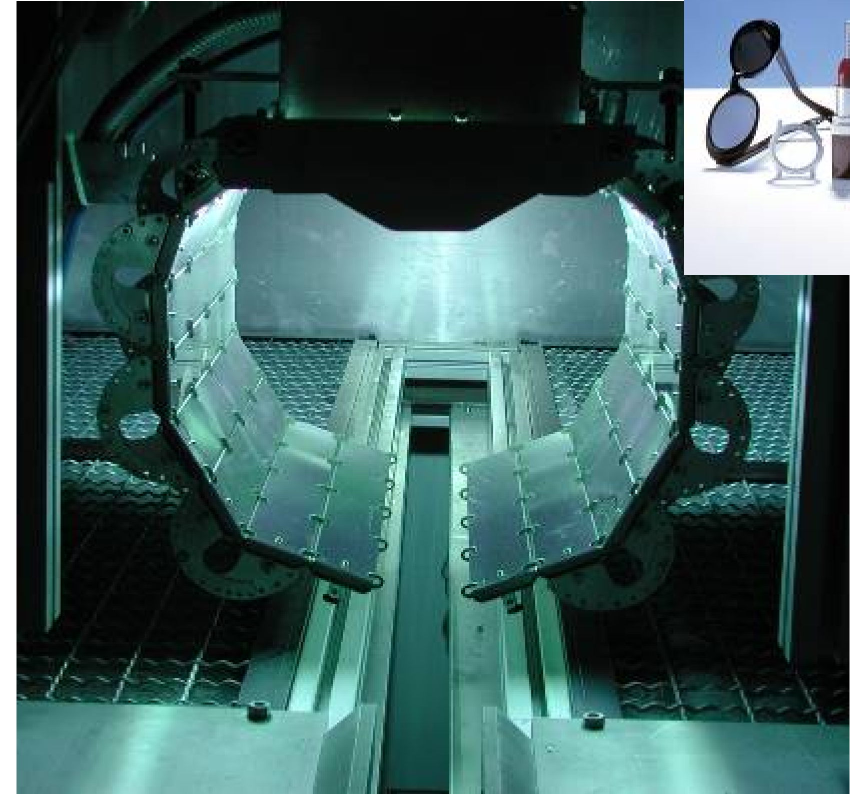
Auflösung
≤ 40 nm

Höchste Produktivität
Schnellste Scanning Stages:
131 wph
@ 125 Belichtungen / Wafer

Quelle: Christoph Zaczek

… Schlüsseltechnologie in der Halbleiterfertigung

Empfänger



Photochemische Polymerisation

Quelle: Oliver Treichel

E

Serienproduktion

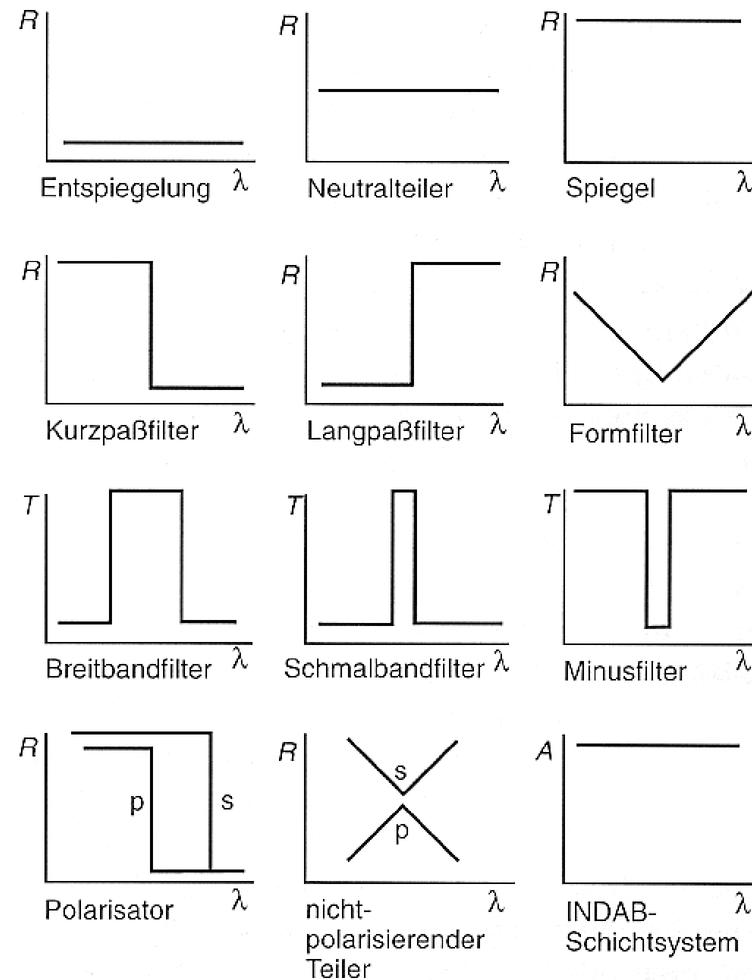
- **10 Kilometer Reflektorprofil pro Jahr**

Quelle: Oliver Treichel

Definition

Dünne optische Schicht

- dient zum Einstellen der optischen Eigenschaften (Reflexion, Transmission, Absorption) einer Oberfläche
- Funktion beruht auf dem Interferenzeffekt und/oder den intrinsischen Eigenschaften (Absorption) der Schicht- und Substratmaterialien
- Zusatzfunktionen: Kratz-, Umwelt-, Strahlungsschutz, Dekoration, …



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Spiegel - Metallspiegel

Reflexion (%)

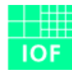
100
80
60
40
20
0

200 300 400 500 600 700 800 900 1000

Wellenlänge (nm)

Aluminium
Silber
Gold

SchichtUV1



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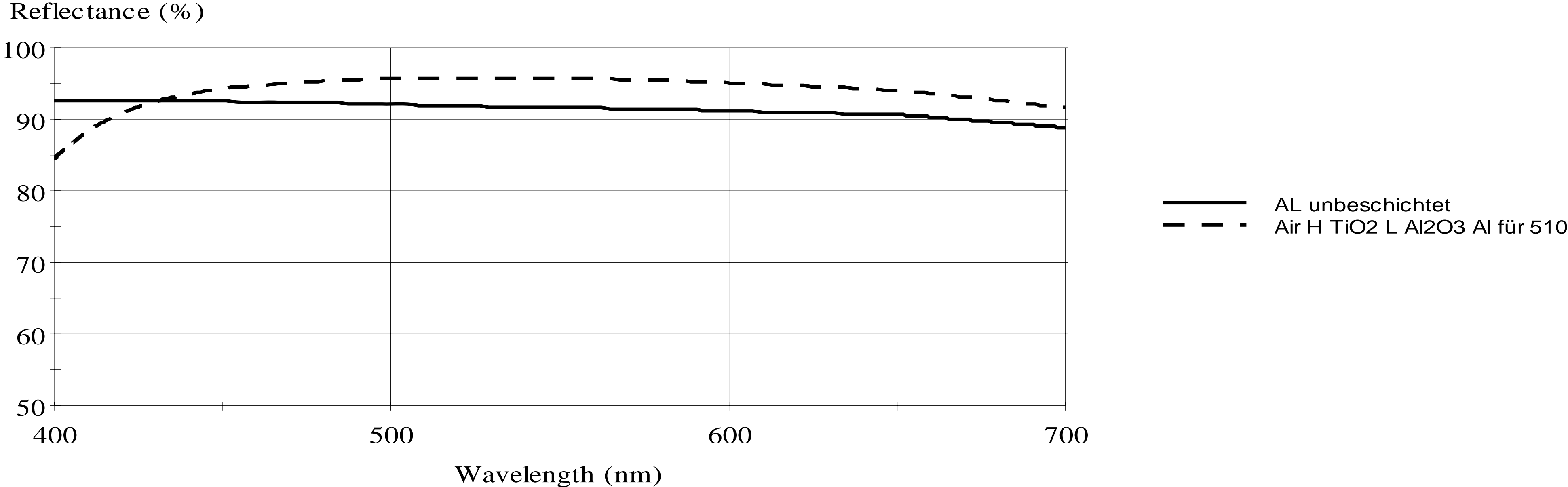
Spiegel – metall-dielektrische Spiegel



SchichtUV1

HR for the XUV /FUV/VUV region (50 – 140 nm)

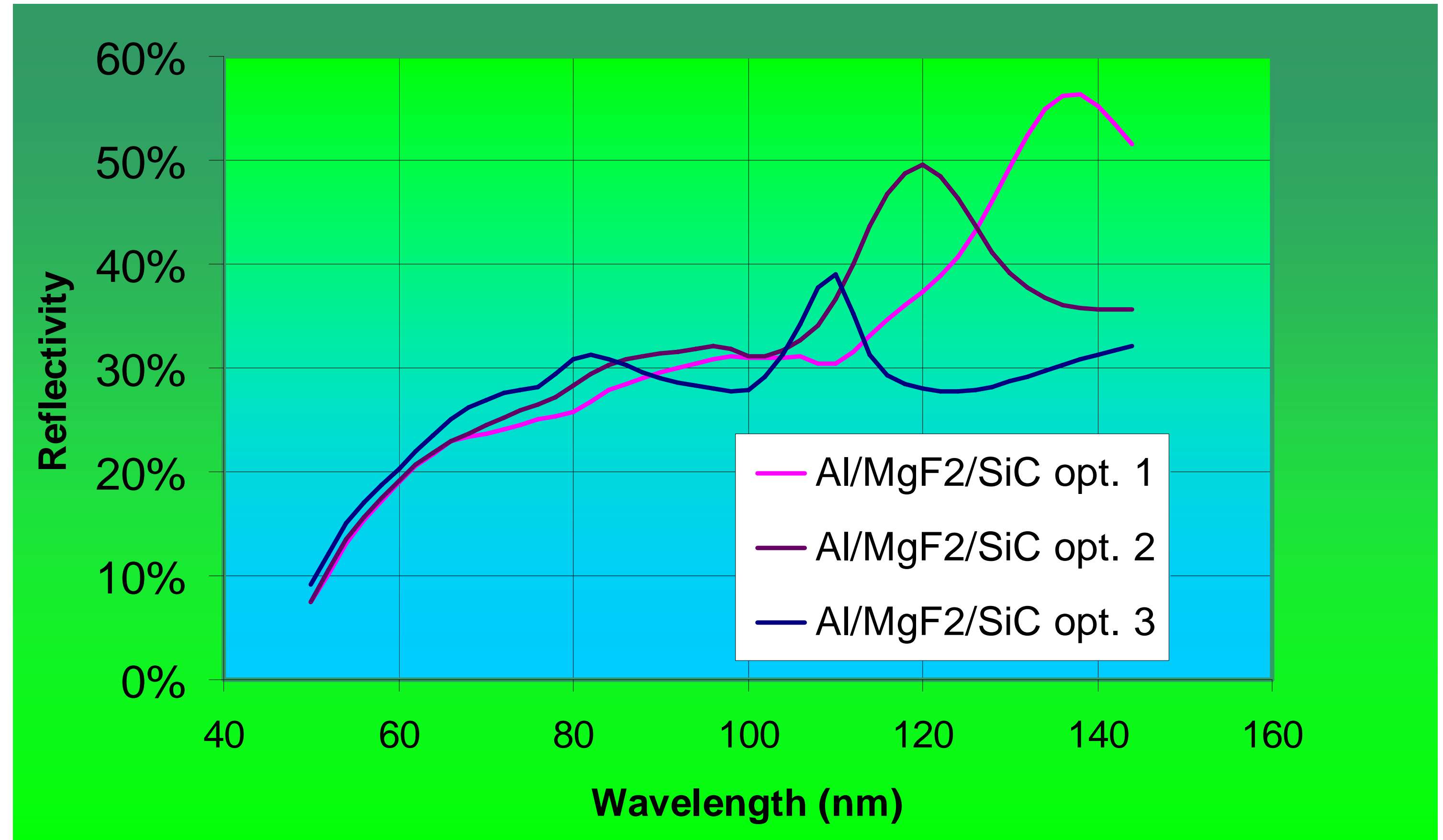
Application field:

Astrophysics,

Solar physics,

Atomosphere,

Hot plasma



Alu + Bilayers :

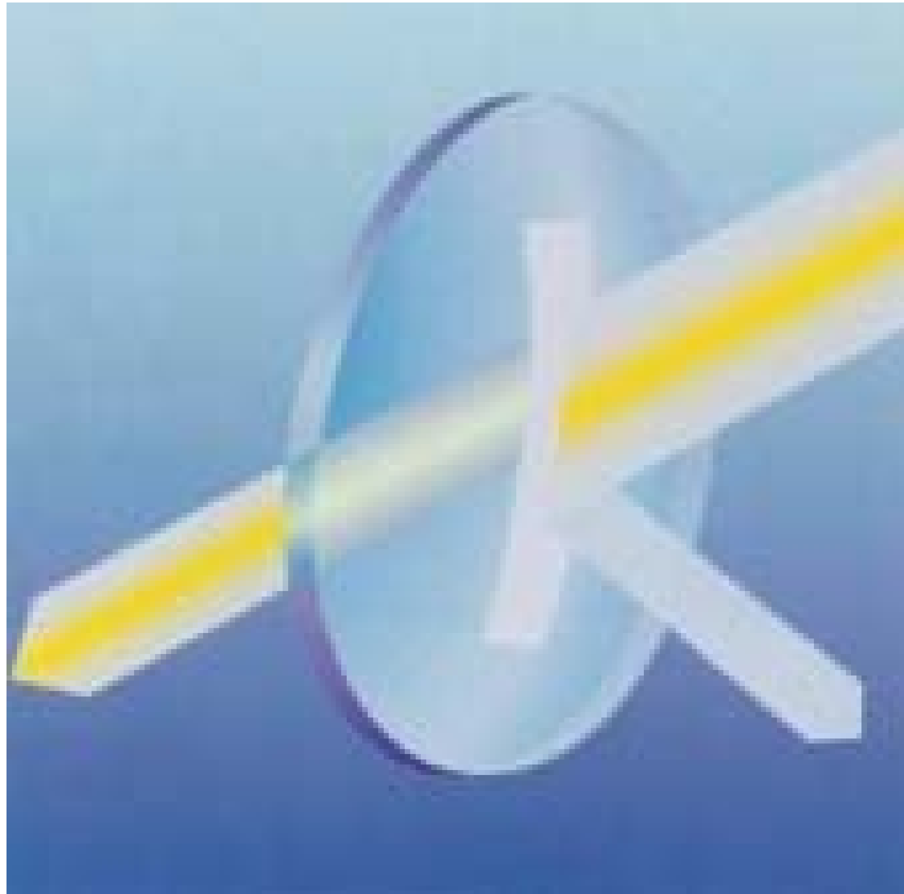
Al + MgF_2 + ...

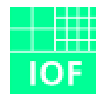
SiC, B_4C, Si_3N_4, Ir, Mo, Si....

Best record worldwide@ 90 nm : 34%,

IOF result @ 90 nm :32% (recently measured by PTB BESSY II)

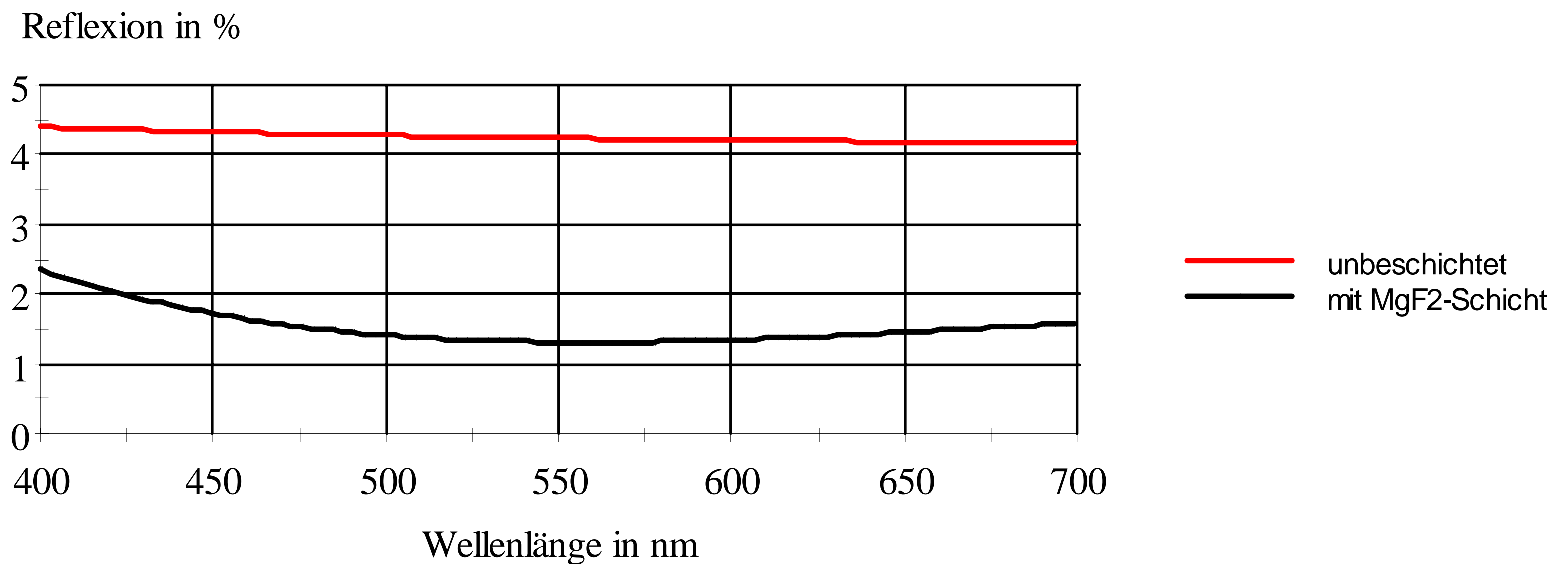
Reflexion





Design optischer Schichtsysteme

$$d_{\lambda/4} = \frac{\lambda}{4}\frac{1}{n_{MgF_2}} = \frac{550nm}{4}\frac{1}{1,38} = 99,64nm \quad (4)$$



Spektrale Reflexion einer Glasoberfläche ohne und mit $\lambda/4$-MgF_2-Schicht für senkrechten Lichteinfall (λ_0=550nm).

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AR

Reflectance (%)

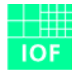
2.0
1.5
1.0
0.5
0.0

400 450 500 550 600 650 700

Wavelength (nm)

Einfach MgF2
Vb
Va
Air[L2HM]S
Air[L2H0,25L0,25H]S

SchichtUV1



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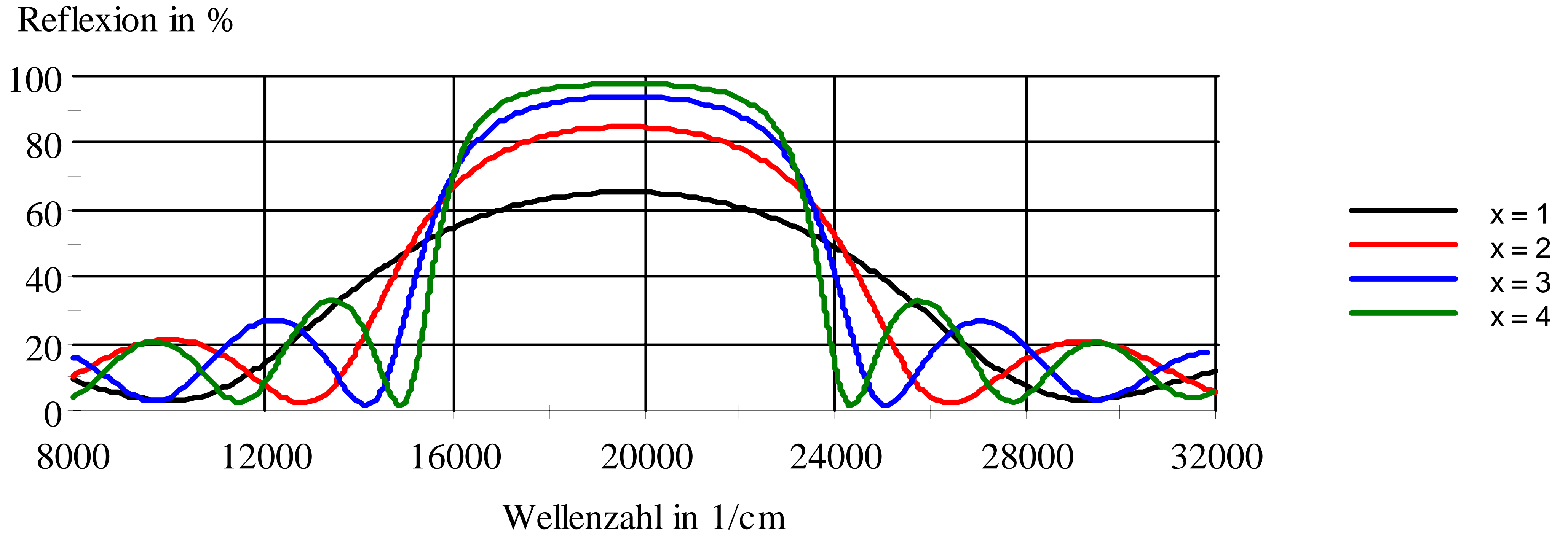
Spiegel – dielektrische Spiegel



Schic

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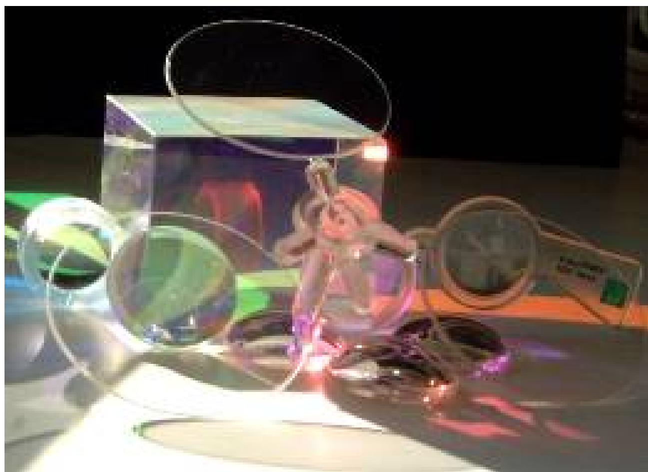
Schichtmaterialien für DUV / VUV – Lithographie

Oxide		Fluoride	
low optical index	high optical index	low optical index	high optical index
SiO_2	Al_2O_3	MgF_2	LaF_3
	HfO_2	AlF_3	GdF_3
	Y_2O_3	Na_3AlF_6	NdF_3
	Sc_2O_3	$Na_5Al_3F_{14}$	DyF_3

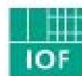
nur bis 248 nm geeignet; bis zu 193 nm geeignet; bis zu 157 nm geeignet

- begrenzte Auswahl geeigneter Materialien
- Brechzahlkontrast (niedrig- und hochbrechendes Material) gering

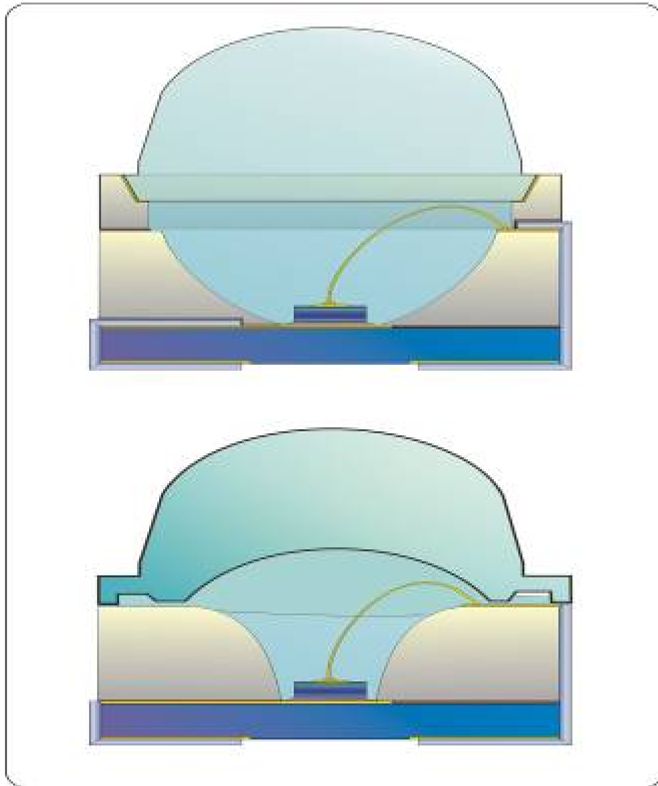
⇒ höhere Schichtzahl notwendig; schmalbandige Designs



Coating on plastics



Coating on plastics



Dicke jeweils 1mm

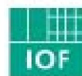
Transmission in %

100,0
90,0
80,0
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0

200 250 300 350 400 450 500

Wellenlänge in nm

- Plexiglas 7N
- Zeonex E48R
- PC Makrolon AI2647
- Zeonex 330R
- PA Grilamid TR 70LX

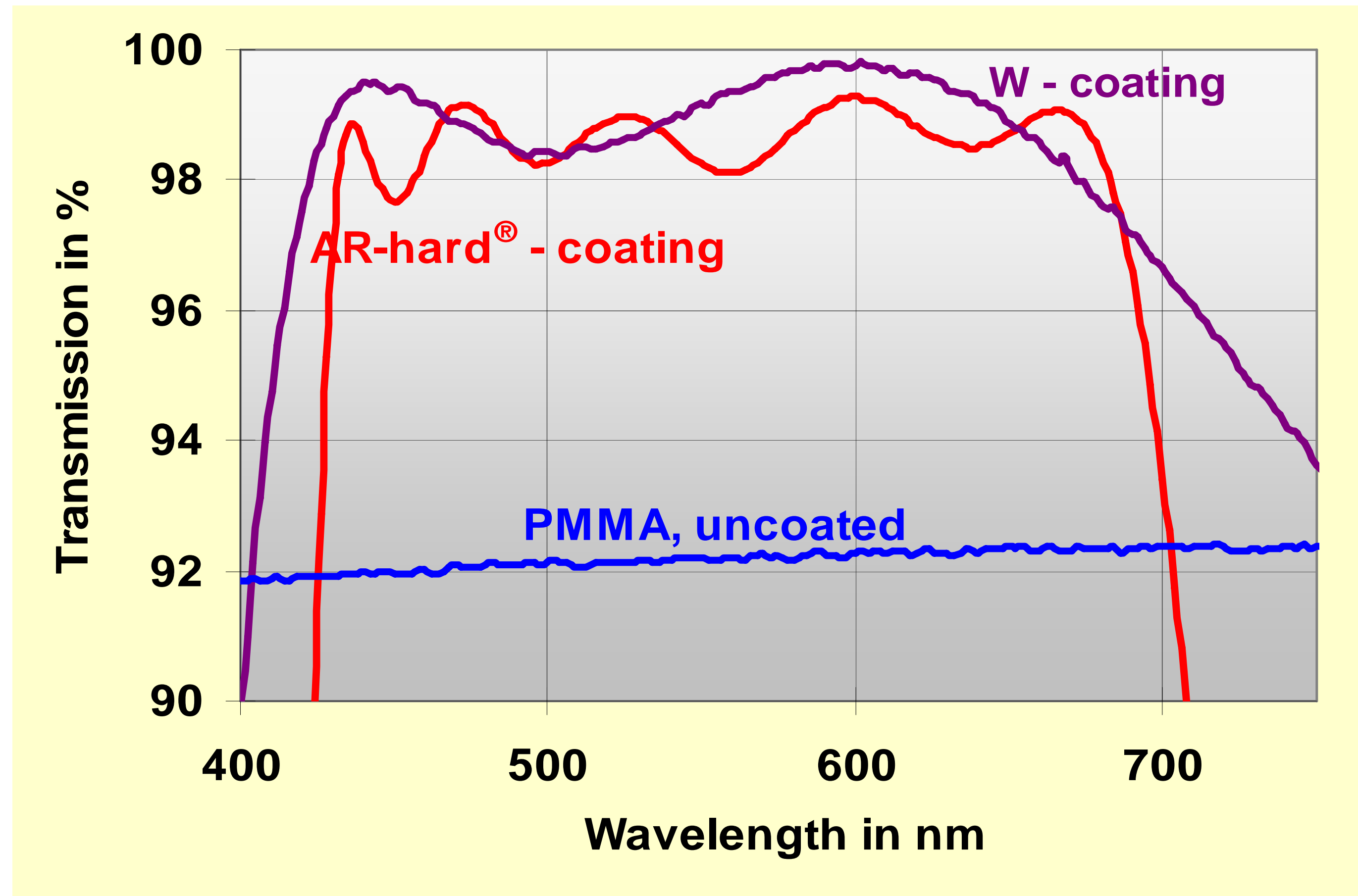


Antireflective coating for PMMA

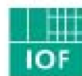
- „W-coating“ or scratch-resistant coating AR-hard®

- APS -technology

- 2005-2007
  5 license agreements

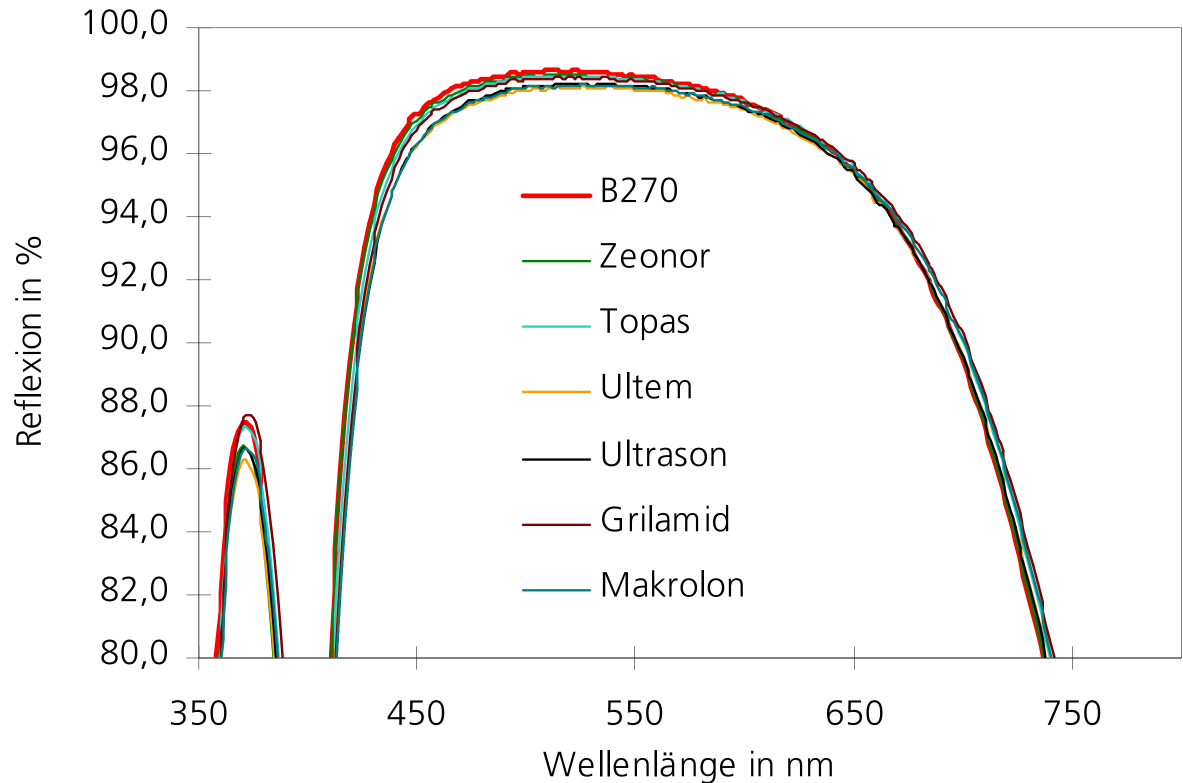


Patent DE 10201492A1



High reflective coating for plastic optics

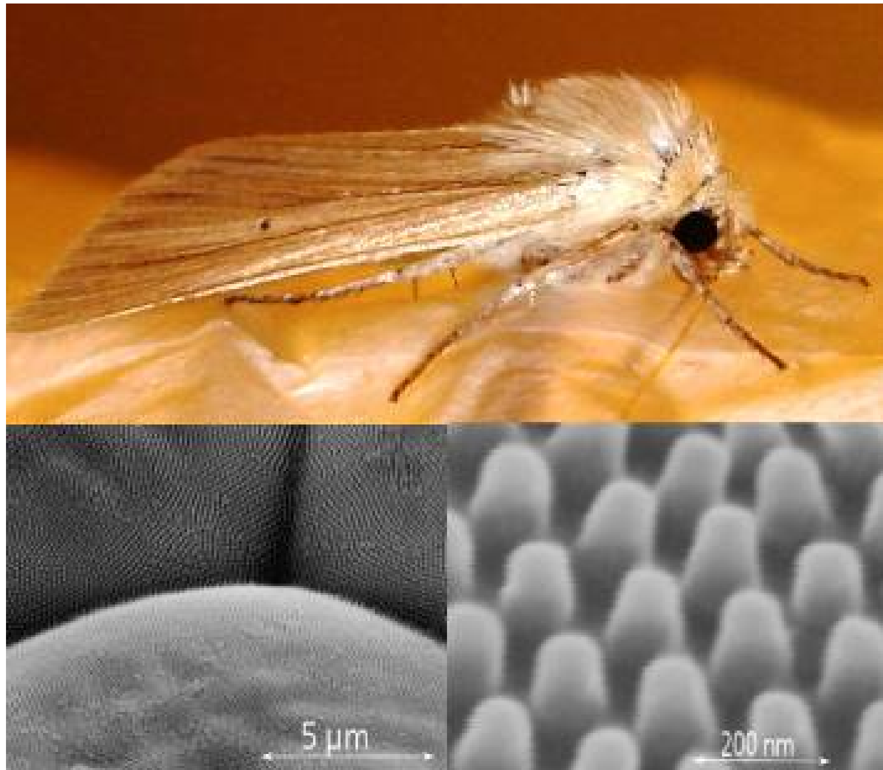
- Al and Ag-mirrors with high adhesion on various polymers
- Dielectric layers enhance optical properties and environmental stability



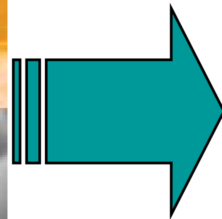
Enhanced Al-mirrors on various polymers and optical glass, R (VIS) >97%

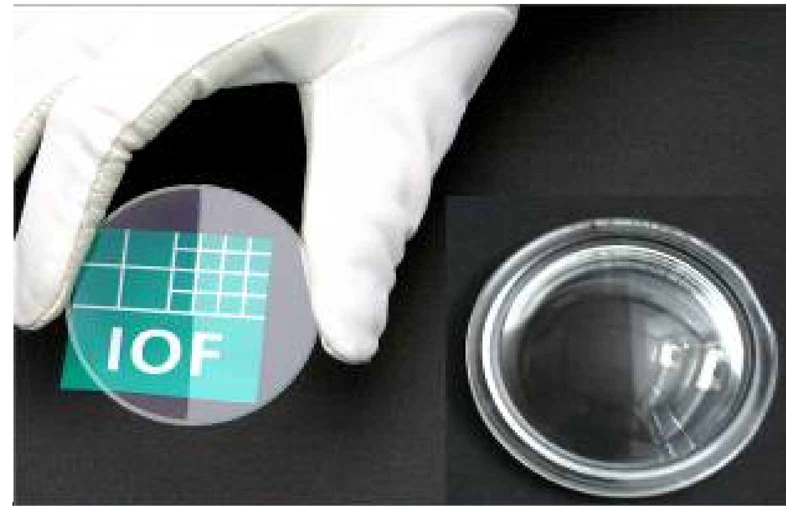
Project REBEKA, 2004-2007, FKZ: B409-04005

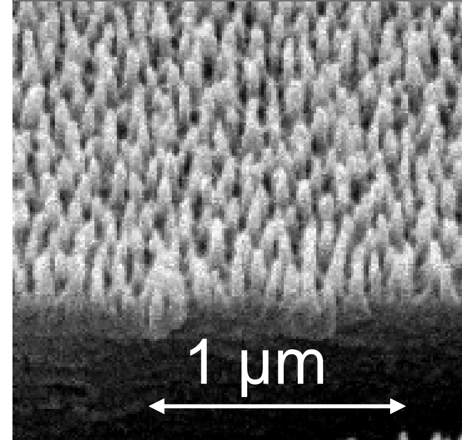
Stochastic antireflective structures AR-plas



Antireflective structure on moth eye



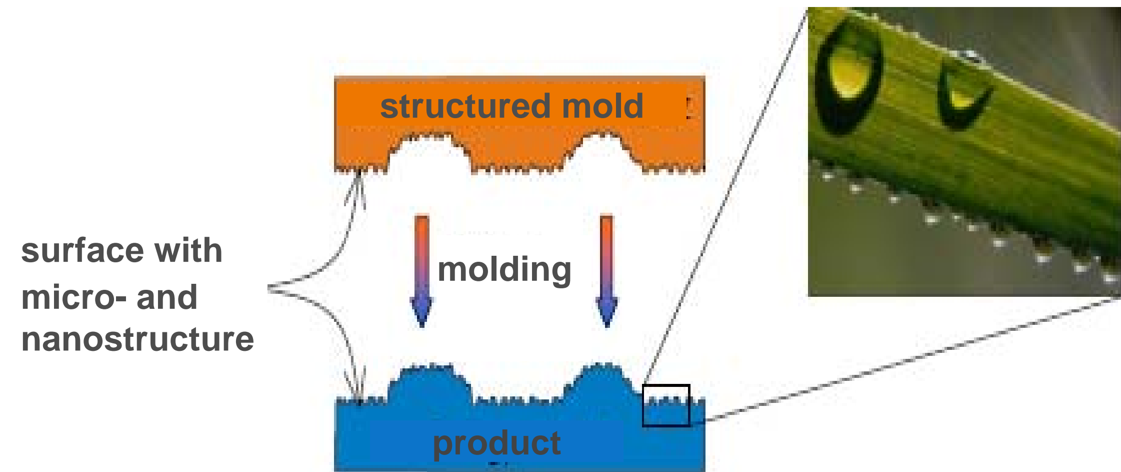


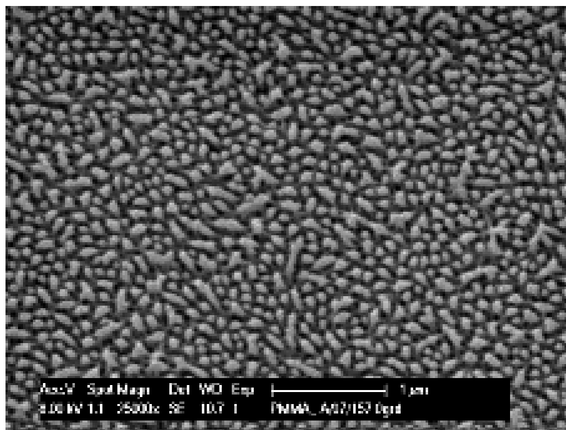


Antireflective structure on PMMA produced by plasma etching

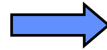
NanoReplica- Nanoprecise mold-fabrication and replication

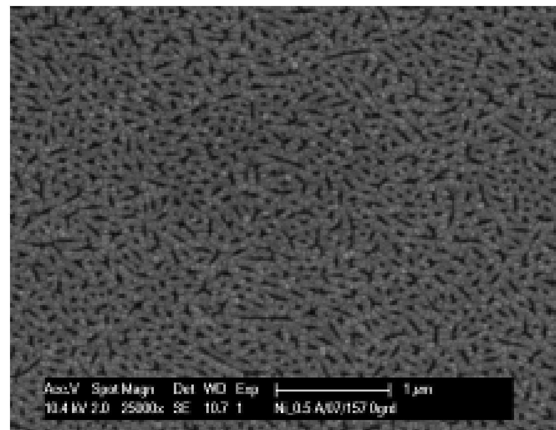
- Joint project: 09/2006 - 08/2010
- Direct Functionalisation by injection molding or hot-embossing of micro- and nanostructures
- Special task: replication of stochastic antireflective structures



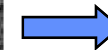


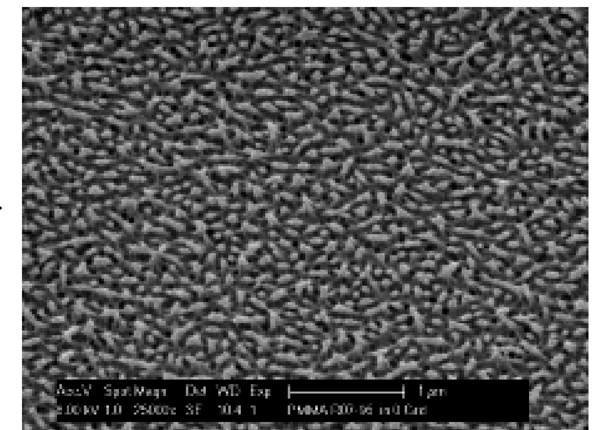
PMMA- master with positiv AR- structure





Ni- stamp with negativ structure





patterned PMMA- replica with positiv AR- structure

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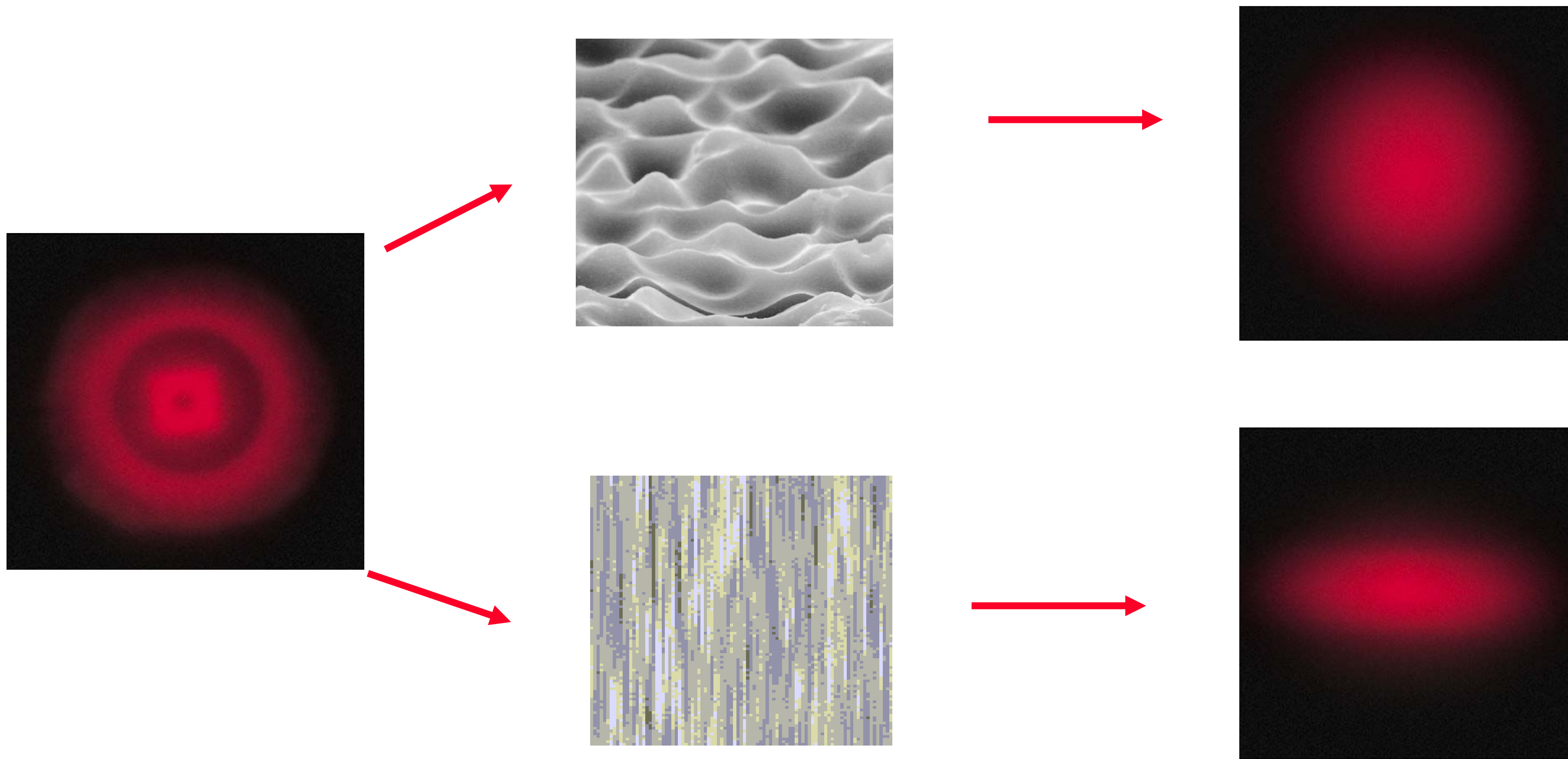
nano replica

Nanopräziser Formeinsatzbau und Replikationstechniken

- Optik : effiziente Lichtauskopplung
  Strahlformung



Johann Wilhelm Ritter (1776 – 1810)

- Geb. 16. Dezember 1776 in Samitz
- Deutscher Physiker und Philosoph der Frühromantik
- Ab April 1796 Student in Jena
- 1802 Entdeckung der UV Strahlung in Jena
- Gest. 23. Januar 1810 in München

SchichtUV1

Thank you for your attention