

# CONTENTS

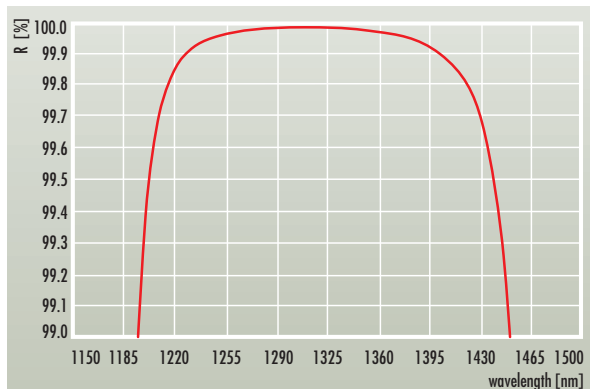
Title	page
ABOUT LAYERTEC / ABOUT THIS CATALOG	02
CONTINUOUS WAVE AND NANOSECOND LASER OPTICS	03
· Introduction to continuous wave and nanosecond laser optics	03
· Components for F <sub>2</sub> Lasers	04
· Components for ArF Lasers	06
· Components for KrF, XeCl and XeF Lasers	08
· Components for Ti:Sapphire lasers	10
· Components for diode lasers	12
· Broadband and scanning mirrors	14
· Components for Yb:YAG, Yb:KGW and Yb-doped fiber lasers	16
· High power Nd:YAG/Nd:YVO <sub>4</sub> laser optics	18
· Components for the harmonics of Nd:YAG and Nd:YVO <sub>4</sub> lasers	20
· Components for other Nd:YAG or Nd:YVO <sub>4</sub> wavelengths	22
· Components for Ho:YAG and Tm:YAG lasers	24
· Components for Er:YAG lasers and the 3µm region	26
· Components for optical parametrical oscillators (OPOs)	28
PICOSECOND LASER OPTICS	30
FEMTOSECOND LASER OPTICS	32
· Introduction to femtosecond laser optics	32
· Femtosecond laser optics for Ti:Sapphire and related lasers	34
– Standard femtosecond laser optics (bandwidth ~120nm)	34
– Broadband femtosecond laser optics (bandwidth ~300nm)	36
– Ultra broadband femtosecond laser optics (bandwidth ~1octave)	38
– Silver mirrors for femtosecond lasers	40
· Femtosecond laser optics optimized for third order dispersion	42
· High power femtosecond laser optics	44
· Overview about laser induced damage thresholds of fs laser optics	45
· Components for the second harmonic of the Ti:Sapphire laser	46
· Components for higher harmonics of the Ti:Sapphire laser	48
· Gires-Tournois-Interferometer (GTI) mirrors	50
· Optics for femtosecond lasers in the 1100 – 1600nm wavelength range	52

Title	page
FILTERS FOR LASER APPLICATIONS	54
LOW LOSS OPTICAL COMPONENTS	56
COATINGS ON CRYSTAL OPTICS	58
METALLIC COATINGS	60
· Front surface silver mirrors	60
· Front surface aluminum mirrors	62
· Special metallic coatings	64
SUBSTRATES	66
· High quality fused silica and CaF <sub>2</sub> components	66
· Substrate materials for UV, VIS and NIR/IR optics	68
· Transmission curves	69
· Standard substrates	70
· Prices	71
REGISTER	72

## LOW LOSS OPTICAL COMPONENTS

### HR MIRRORS

- $R > 99.98\%$  in the wavelength range 400 ... 1600nm
- Applicable for cavity ring-down spectroscopy
- Low scattering losses, e.g. total scattering  $TS = 1.5 \times 10^{-5}$  at 633nm (HR mirror for 633nm)\*



**Figure 1:** Calculated reflectance spectrum of a high reflectance mirror for the NIR  
 Central wavelength: 1300nm  
 Reflectance derived from cavity ring-down time measurement:  $R = 99.98\%$

- Coating technique: magnetron sputtering
- Optical parameters are stable against changes of temperature and humidity
- Substrates:
  - Special polished plane and spherically curved fused silica substrates from our own production (see pages 66–67)
  - Concave substrates with a wide variety of radii
  - Rms-roughness:  $\leq 1.5 \text{ \AA}$
  - Surface quality: 10–5 scratch-digs (MIL-0-13830) 5/1 x 0.025 (according to ISO 10110)
- Attractive prices for small and medium numbers of substrates per coating run
- Customer specific components (with respect to substrate dimensions as well as with respect to the coating design)
- Very high reflectances also for complex coating designs, e.g. negative dispersive femtosecond laser mirrors with  $R > 99.9\%$  (see pages 32–43)

\* Measurement performed at Jenoptik L.O.S. GmbH, Jena

## CAVITY RING-DOWN TIME MEASUREMENTS

Our mirrors were tested by cavity ring-down time measurements performed at several laboratories in Great Britain, France, The Netherlands and Germany. Some results are given in the table below.

As result of these investigations cavity ring-down spectroscopy systems for the analysis of trace gases were developed which use LAYERTEC mirrors. More information on the experimental setup and the recent developments can be found in the references given below.

Coating specification	Wavelength of measurement	R [%]	T [%]	Measured at
HR(0°, 380–390nm)	388nm	> 99.94	n. m. *	Universität Heidelberg, Germany
HR(0°, 410nm)	435nm	99.986	n. m. *	3) University of Bristol, UK
HR(0°, 640–790nm) + HT(0°, 488–532nm)	780nm	99.983	n. m. *	2) University of Grenoble, France
HR(0°, 1300–1600nm)	1313nm	99.95079 ± 0.00005	0.05	1) University of Grenoble, France
HR(0°, 1320nm)	1313nm	99.981 ± 0.002	n.m. *	1) University of Grenoble, France
HR(0°, 1390nm)	1390nm	99.992	0.0016	University of Groningen, The Netherlands
HR(0°, 1550nm)	1520nm	99.987	n. m. *	5) University of Bristol, UK
HR(0°, 1650nm)	1623nm	99.985	n. m. *	5) University of Bristol, UK
HR(0°, 1650nm)	1648nm	99.983	n. m. *	4) University of Bristol, UK

**Table 1:** Reflectance and transmittance values of LAYERTECs low loss mirrors;  
Reflectance measured by cavity ring-down time spectroscopy

\* n. m. ... not measured

### References:

- 1) D. Romanini, A. A. Kachanow, F. Stoeckl, "Diode laser cavity ring-down spectroscopy", Chem. Phys. Letters, 270 (1997) 538–545
- 2) D. Romanini, A. A. Kachanow, J. Morville, M. Chenevier, "Measurement of trace gas in atmosphere using CW CRDS techniques", Proc. of the LASER 99 Congress ENVIROSENS, Munich 1999
- 3) M. I. Mazurenka, B. L. Fawcett, J. F. M. Elks, D. E. Shallcross, A. J. Orr-Ewing, "410nm diode laser cavity ring-down spectroscopy for trace detection of NO<sub>2</sub>", Chem. Phys. Letters 367 (2003) 1–9
- 4) B. L. Fawcett, A. M. Parkes, D. E. Shallcross, A. J. Orr-Ewing, "Trace detection of methane using continuous wave cavity ring-down spectroscopy at 1.65µm", Phys. Chem. Chem. Phys. 4 (2002) 5960–5965
- 5) A. M. Parkes, B. L. Fawcett, R. E. Austin, S. Nakamichi, D. E. Shallcross, A. J. Orr-Ewing, "Trace detection of volatile organic compounds by diode laser cavity ring-down spectroscopy", The ANALYST (2003), 128, 960–965