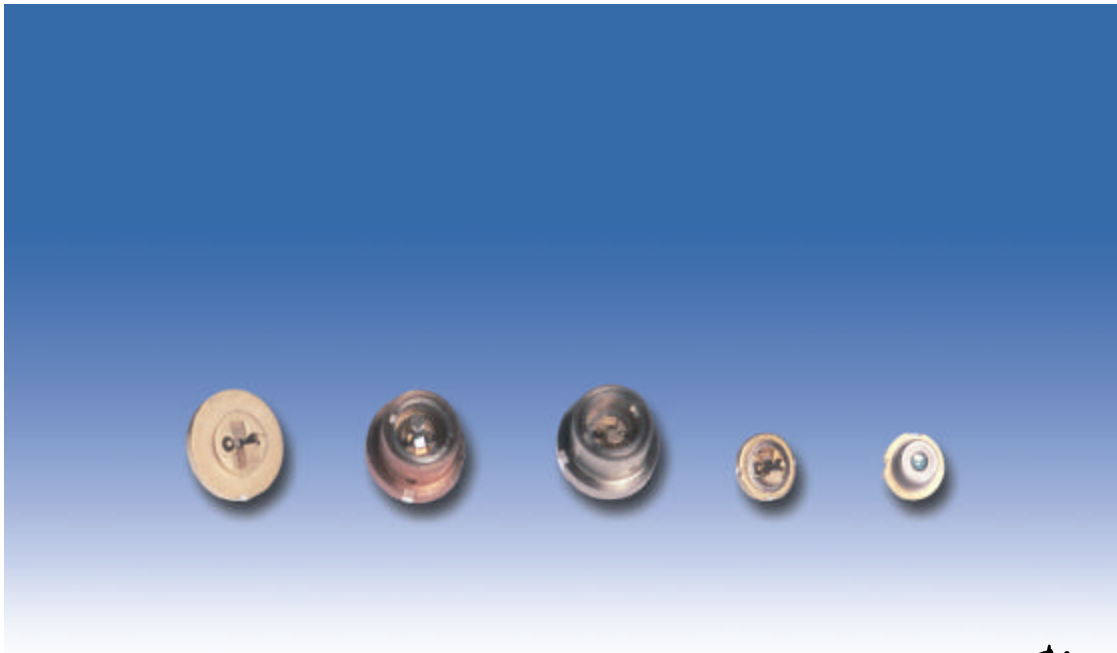


US-Patent 6,297,066
US-Patent granted



*to meet the requirements
of your special
experiment*

ARC Diodes

Antireflection
Coated Diode Lasers



Reflectivities
 $R < 5E-4$ specified
 $R < 5E-5$ typical



Classes of anti-reflection coatings

The quality of the anti-reflection coating has a critical influence on the performance of the diode laser for external cavity applications. We have defined 4 classes of quality:

Class A: Reflectivity Range of $3E-1$.. $5E-3$ (30% .. 0.5%)

These reflectivity values are used for increasing the output power of diode lasers in connection with extending the length of the laser chip. The influence of the output power is given in formula (1) published by Hildebrandt et al.[1]. There is a minor effect on the threshold current as described in formula (6) whereas the actual value depends on the cavity length. With these values, there are only small ranges in the order of 2 .. 4GHz where the diode laser is properly coupled to the external cavity. Theoretically, the width of the coupling range can be estimated by linewidth calculations which are published by G. Agraval [2]

Class B: Reflectivity Range of $5E-3$.. $5E-4$ (0.5% .. 0.05%)

There is a considerable influence on the threshold of the diode laser with these reflectivity values. With decreasing the reflectivity values from 0.5% to 0.05%, the coupling of the laser chip with the external cavity increases until there is a good coupling reached for Littrow cavities around 0.05%. Within this intermediate regime, the benefits of AR-coating start to show up as described in our Technical Documentation No. 5 [3]. For typical chip length of diode lasers, there is a doubling of the threshold current to be found for a reflectivity of 0.05%.

Class C: Reflectivity Range of $5E-4$.. $5E-5$ (0.05% .. 0.005%)

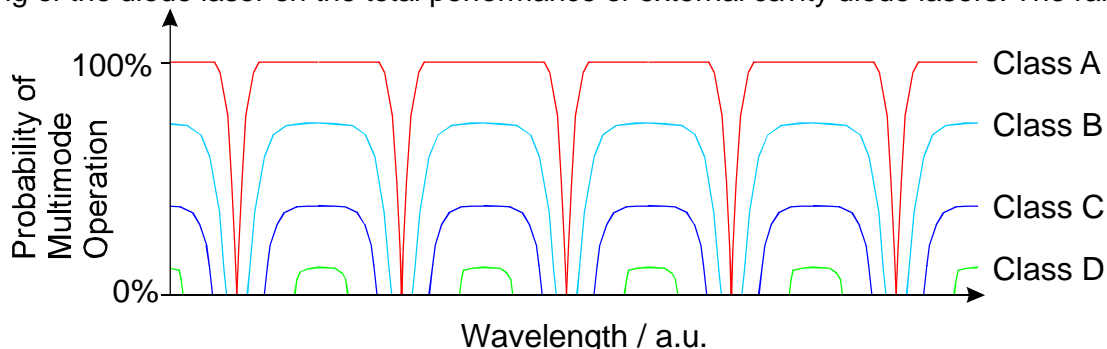
With reflectivity values of 0.05% or below, an excellent coupling of the laser chip to the external cavity is guaranteed. We suggest our customers only to use diode lasers with 0.05% reflectivity or below within a Littrow external cavity diode laser. For these reflectivity values, the internal cavity of the laser chip typically does not show any threshold within the operation current of the diode laser. This is a necessary condition for a turnkey laser system.

Class D: Reflectivity Range of $5E-5$ or below ($<0.005\%$)

These values are needed for external cavity diode lasers in Littman/Metcalf configuration. Due to the high selectivity of the external cavity with double passing of the grating, there are lower reflectivity values for the diode laser necessary.

Effect on the tuning behavior

Paul Zorabedian proposed the concept of the probability of multimode operation for external cavity diode lasers [4]. This concept allows a visual demonstration of the influence of the anti-reflection coating of the diode laser on the total performance of external cavity diode lasers. The range where



a non anti-reflection coated diode laser can be used within an external cavity laser system is very small and difficult to find. With a successive lowering of the reflectivity of the diode laser, the performance of the external cavity diode laser system drastically increases. For an excellent performance of an external cavity diode laser, it is needed to use diode lasers with a reflectivity according to class c) or d).

[1] Hildebrandt, Sacher et al. Appl. Opt. 42, 2110, 2003, Download: <http://data.sacher-laser.com/publications/ao2003.pdf>

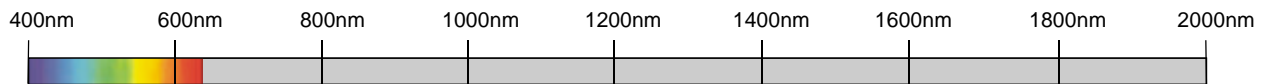
[2] Agraval, IEEE JQE-20 468-471, 1984

[3] Sacher, Technical Documentation No. 5, Download: <http://data.sacher-laser.com/techdocs/wavelength.pdf>

[4] Trutna, Zorabedian, Hewlett-Packard J. 44, 35, 1993



What makes our AR coated diode lasers special?



[Wide range of wavelength available from stock](#)

Sacher Lasertechnik offers anti-reflection coated diode lasers beginning with the 370nm up to 420nm regime and then from 630nm up to 1650nm. Most diodes are available from stock. Please contact us for your desired wavelength.

[High output power](#)

Sacher Lasertechnik has developed an extremely reliable and stable coating method for diode lasers. This enables us to provide antireflection coatings for high power diode lasers. The results are laser amplifiers for laser systems with the highest available output power.

[AR coating for laser bars](#)

Sacher Lasertechnik has extended its coating technology on the anti-reflection coating for diode laser bars for industrial customers. Please contact us for details.

[Technical Library](#)

http://www.sacher-laser.com/AR_Coating.php

<http://www.sacher-laser.com/TechDocs.php>

<http://www.sacher-laser.com/PubDocs.php>

Quality Management

[Individual Testdata](#)

Each anti-reflection coated diode lasers is processed and optimized individually according to our patented method. After performing the coating procedure each laser is tested according to the method of Kaminov et al. [5].. The results are summarized in the data sheet which is supplied together with the diode laser [6].

[Lifetime Data](#)

We performed a lifetime test with our antireflection coated diode lasers according to the accelerated aging method as described in Technical Document No. 8 [7]. As result, we found that the mean time to failure is not affected by the antireflection coating as long as the diodes are driven under reasonable conditions.

Manufacturing of AR-coatings

[Patented Manufacturing method, US-Patent 6,297,066](#)

Our patented coating method [1] is the result of more then 18 years of research and experience. The first antireflection coatings for diode lasers in Marburg have already been performed in 1986 within the group of Prof. Göbel at Marburg Univ.

[Plasma assisted deposition method](#)

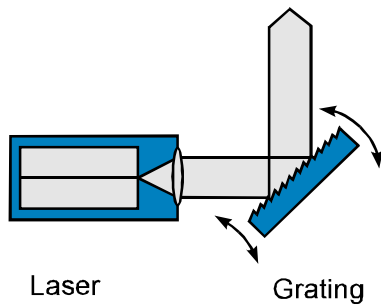
In general, anti-reflection coatings consist of several dielectric layers, which result in low reflectivity values over the entire gain region of a diode laser. We only use state of the art deposition methods such as plasma assisted deposition. This superior deposition method ensures best reliability, especially under high power conditions.

[5] Kaminov et al. IEEE J. Quantum Electron. QE-19, 493, 1983

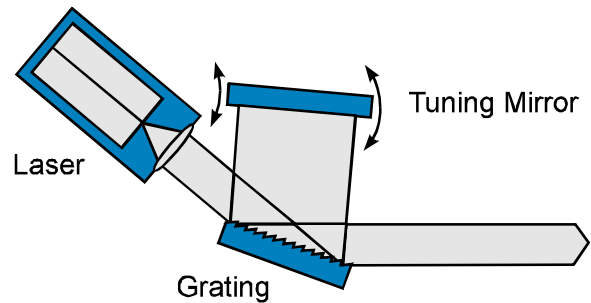
[6] Sacher, Technical Documentation No. 7, Download: <http://data.sacher-laser.com/techdocs/testdata.pdf>

[7] Sacher, Technical Documentation No. 8, Download: <http://data.sacher-laser.com/techdocs/lifetime.pdf>

Littrow - Configuration



Littman/Metcalf - Configuration



Application Example

[External Cavity Diode Laser](#)

The principle application of our anti-reflection coated diode lasers is in external cavity diode lasers. Typical laser configurations are Littrow- and Littman/Metcalf-cavity. With our AR-coated diode lasers, Littrow- and Littman-lasers gain the ability to tune modehop-free over the entire amplification range of the diode laser which is needed for state of the art measurements in spectroscopy such as trace gas analysis as well as for metrology. Please check our web-page for details.

[Incoherent Light Source](#)

An alternative approach to spectroscopy is using a broadband emitting superluminescence diode instead of tuning the wavelength of a laser system. By this method, a fast single shot measurement can replace long term tuning runs of laser systems.

About Sacher Lasertechnik

[Company Profile](#)

Sacher Lasertechnik is leading manufacturer of tunable external cavity diode lasers (ECDLs) with more than 10 years of experience. The product range includes anti-reflection coated diode lasers, ECDLs in Littrow and in Littman/Metcalf configuration as well as driver electronics for the LD and sophisticated measuring electronics. Please contact us with your measurement requirements. We would be proud to support you with our competence.

[Please contact us or our local representative](#)

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