PRINZ OPTICS GLAS PLUS

Filtering Light to Your Wishes and Needs

White Paper

Coated glass & glass coatings for technical applications

November 2018

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The ability to influence natural and artificial light radiation through optical filtering is based on physical laws: when light falls on a colour effect filter, part of the light is absorbed or reflected; the remaining part of the spectrum is transmitted.

The transparency of glass can thus be controlled in a targeted manner in the required wave-length region specific to the application. The area affected generally lies in wavelengths of between 250 and 1600 nanometres (UV / VIS / NIR).

Optical filters made of glass for technical applications are used in science, medicine and industry - especially in the automotive sector - as well as in sensor technology.

The production is carried out by different coating processes. In general, these processes are also suitable for coating substrates, as they are used in other areas of application.

Coating possibilities and processes

1. For external coating of glass vessels and reactors as well as for internal coating of tubes, balls and pistons

Coating processes: Sol-gel dip process

In this liquid coating process, the object is immersed in a coating solution. The controlled, continuous extraction produces a homogeneous coating with adjustable layer thickness. In the classic sol-gel dipping process, the coating solution reacts with air humidity, resulting in gelation and layer formation.

Other coating media are organic and inorganic varnishes that solidify when the solvent evaporates.

Coating of automotive lamps

Coating materials are metal oxides, such as $SiO2$, $TiO2$, $ZrO2$, $Fe203$, $SnO2$, ZnO. The suitable substrates are glass and metal. The layer thicknesses can be 30 to 200 mm at a baking temperature of > 400°C

Coating processes: Flooding

A simple process without any complex system technology. Coating times are short, large order quantities are possible. The layer properties correspond to those of the dipping process.

To ensure a homogeneous layer thickness profile, the substrate must be wettable and have a flat surface (without flanges).

Coating of glass by flooding

The coating thickness, however, can only be controlled by adjusting the concentration of the coating solution; the course of the coating is potentially more inhomogeneous than with the dipping process.

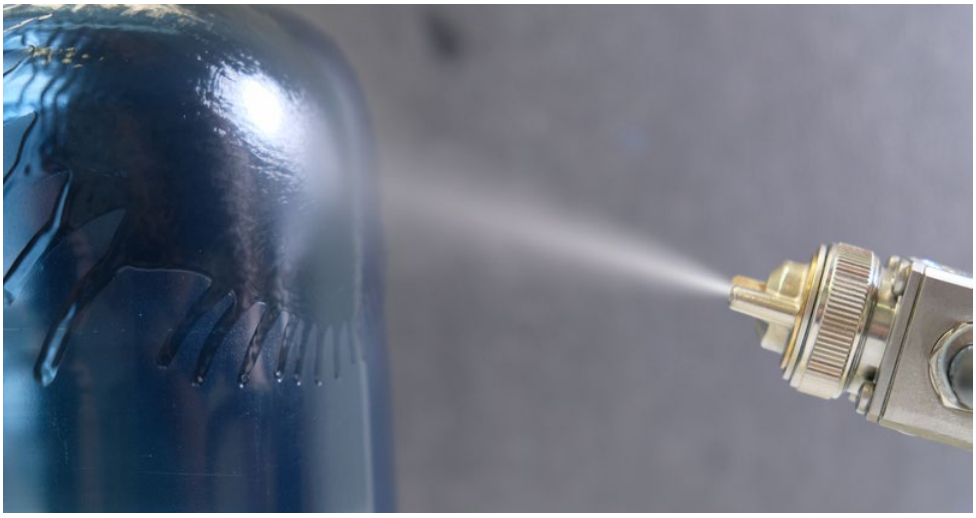
2. For the application of inorganic/organic, functional varnishes by the classic spraying process and for the application of bonding agents in the coating of organic materials

Coating processes: Spraying

In this process, coating solutions are atomised under pressure in a nozzle. The aerosol is accelerated by the air flow, bounces against the substrate surface and forms a layer. After the solvent has evaporated, a hardening and cross-linking process occurs.

The coating solution must be adapted to the spraying process. The strong air flow requires a clean environment.

This process enables a homogeneous coating on complexly shaped surfaces. The layer thicknesses can be 1 to 20 µm per individual layer but are less homogeneous than with immersion and flooding processes. It is possible to internally coat hollow items. The system technology is simple, high order rates are possible.



Glass coating: Spraying

3. For the heat-insulating coating of oven panes. For coating for electric surface heating of glass surfaces and reactors and for coating for the purpose of electrostatic discharge (e.g. on glass tubes through which powder is transported)

Coating processes: Spray pyrolysis

In this special application of the spraying process, a coating solution that is heat-resistant up to 600°C is sprayed onto a glass surface heated above 500°C. The aerosol is broken down, the organic matter evaporates and an oxidic layer crystallises on the substrate; its structure differs from that of an dipped sol-gel layer. High thermal shock resistance of the glass is required.

With a tin oxide coating, the smallest possible sheet resistance is approx. 10 Ohm/sq with high heat reflection and electrical conductivity.

The process technology is simple, no vacuum is necessary.

4. For the production of colour conversion layers for automotive lamps and for interference coating of colour filters (dichroic glass) and for light scattering coating/matting (as an alternative to etching and sandblasting) and for antimicrobial coating with nano-silver and for hydrophilic/hydrophobic as well as catalytic coating.

Coating processes: Spraying with organic, inorganic paints and slurries

This coating can be applied to the substrates glass, metal and plastic. The surfaces should be as even and homogeneous as possible.

Complex geometries (jars with flanges, sharp edges or point-shaped elevations/indentations) create interference zones during coating.

The layer thicknesses are 0.5 to 3 µm; layer thickness variations are small; the drying temperature is up to 180°C.

5. For the generation of functional layers

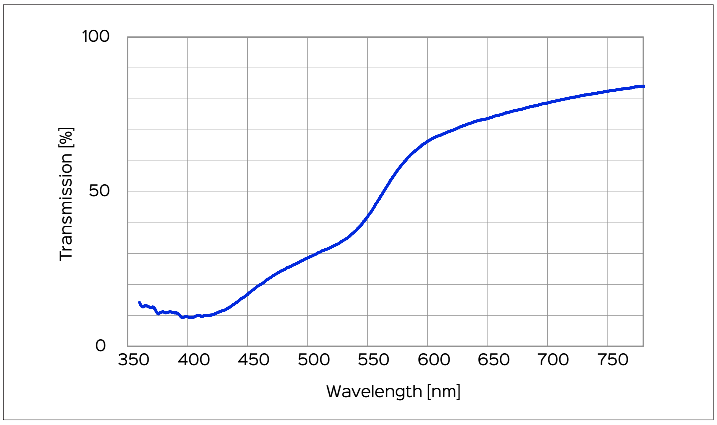
5.1 For filters with conversion effect

The coatings allow a variety of colourations, e.g.

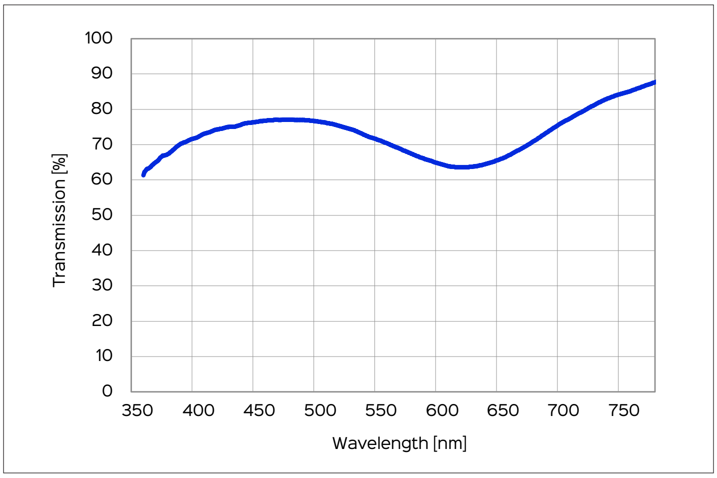
- amber/orange for a warm light colour
- blue for a cold light colour
- pink to reduce the green component in LED lighting
- silver for mirrors

Coating processes: Lustre coating

High reflection is achieved with this coating method. Precious metals are often used for colouration.



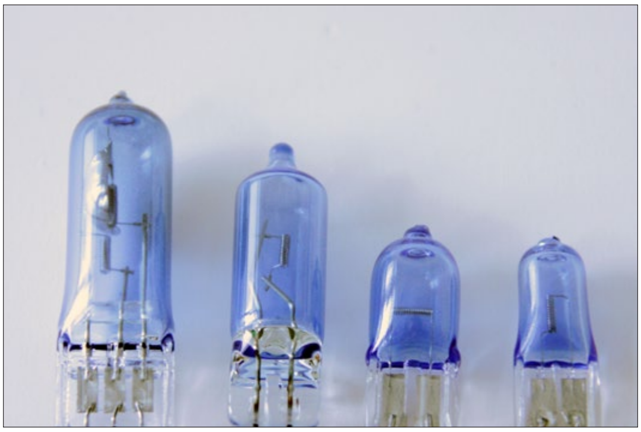
Transmissions curve luster colour amber



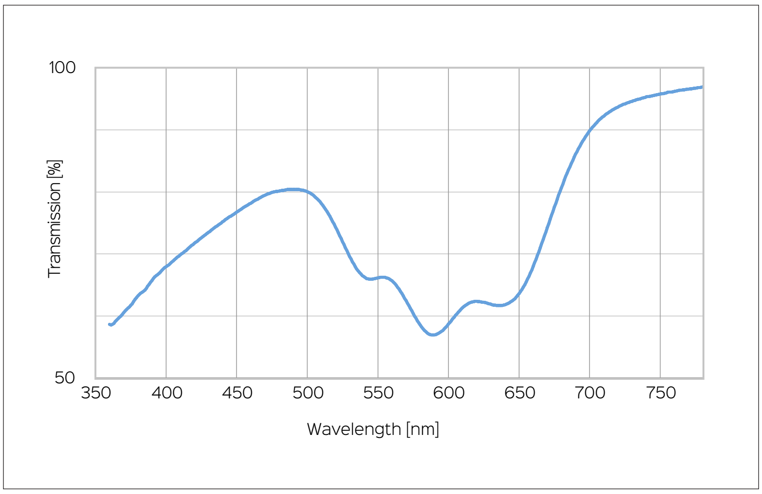
Transmissions curve luster colour blue, automotive application

Coating processes: Pigment-based layers

The coating solution is a suspension of ceramic particles and a binding agent. After the layer burn-in, a matrix of the SiO_2 coat former and the colour pigment is formed. The colour intensity is high, the temperature resistance is 700°C.



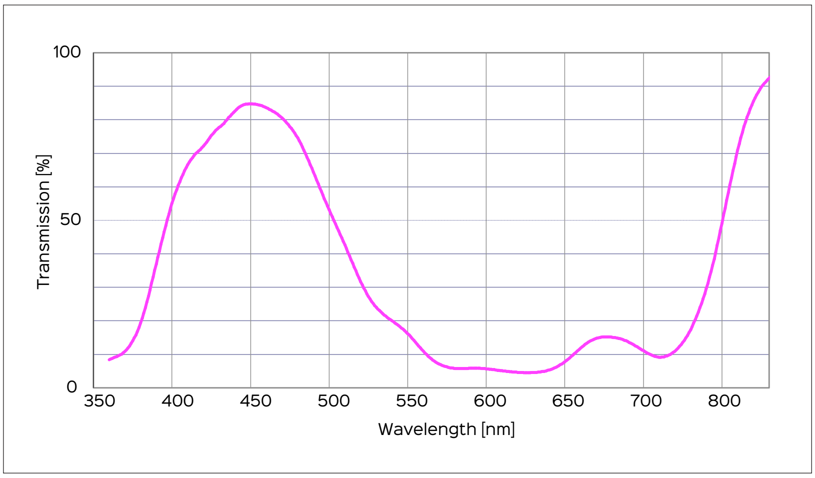
Pigment-based coating of automotive lamps



Blue spinel pigment coating

Coating processes: Organic paints/varnishes

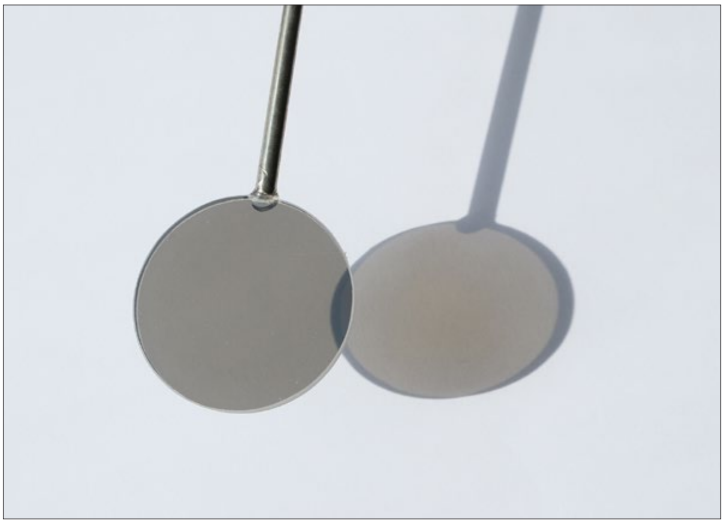
Organic pigments enable transparent to opaque coatings in a variety of colours. In contrast to oxidic coatings, they are less resistant to weathering and temperature.



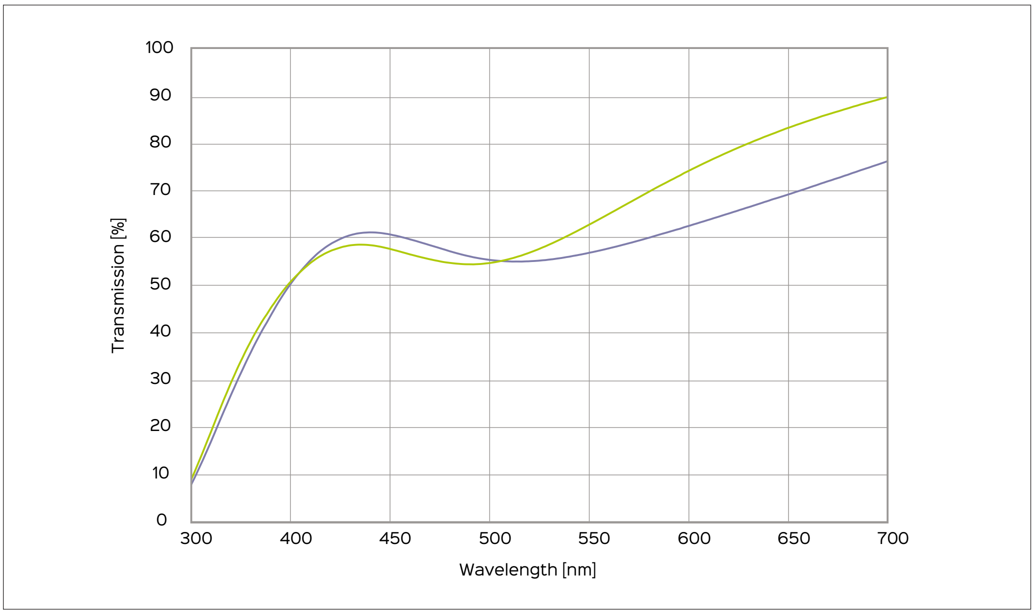
Transmission curve organic Ormocer© colour blue

5.2 Grey filters

These filters serve in reducing the light intensity. In the case of lustre coatings, higher reflection (gloss) is the result; with pigment-based coatings, the reflection is low.



Grey filter

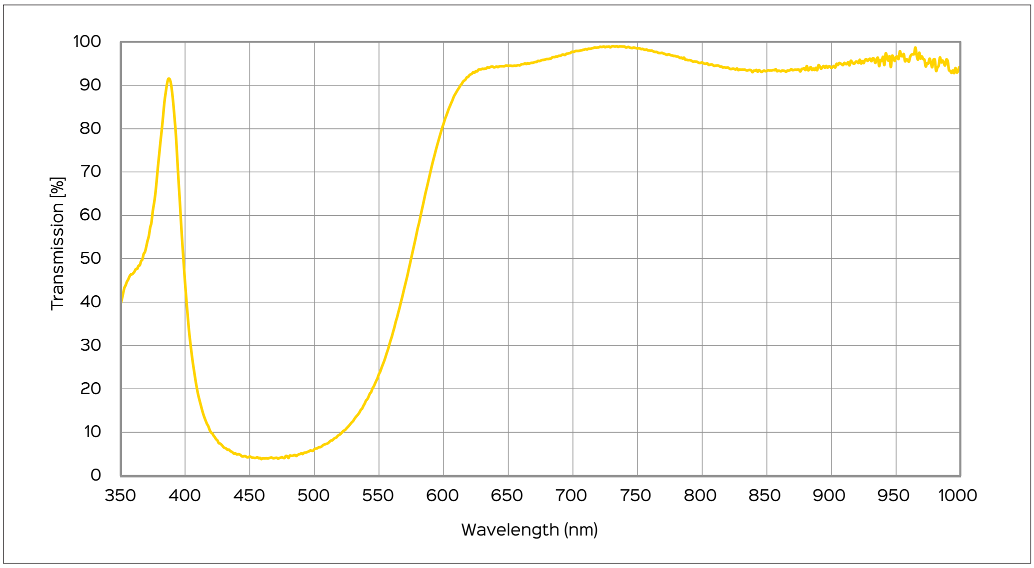


Transmission curve grey filter with anti-reflective coating

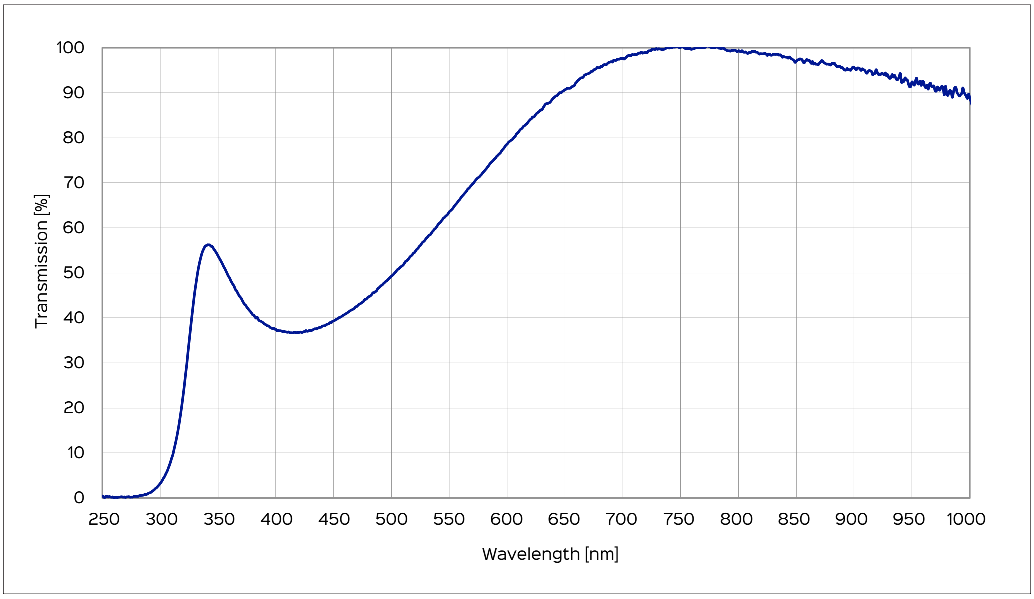
5.3 Interference filters

The colour effect filter is created by an interference layer package. In the conversion filter, which is also generated by an interference layer package, the transmission is higher, but with a lower colour effect.

The coating is carried out using the sol-gel process.



Interference filter FE orange

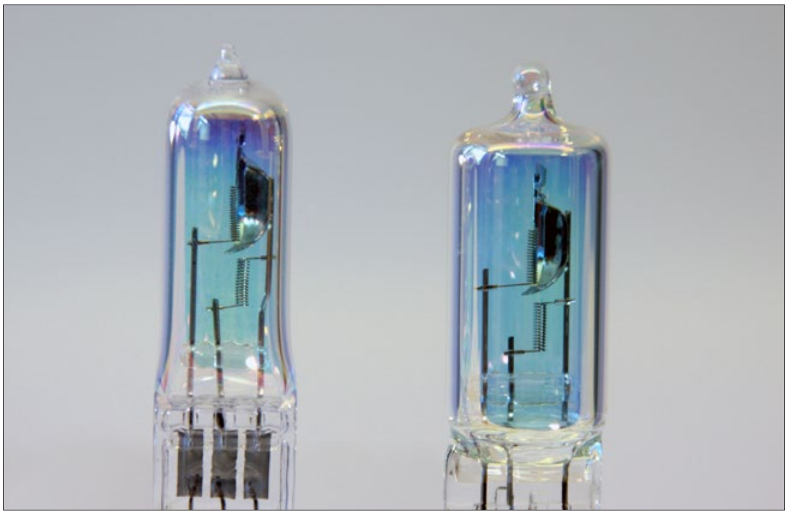


Interference filter KW 100

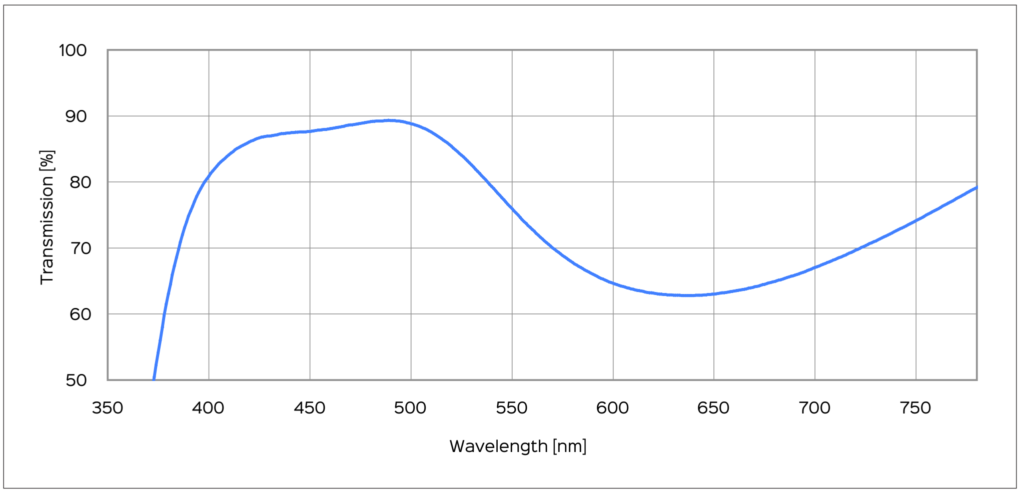
5.4 Combination filters

These filters are characterised by the simultaneous use of reflective and absorbent layers. By installing an absorption layer in the interference layer package, the angle dependence is reduced.

The coating is carried out using the sol-gel process, with pigment-based layers or lustre coatings.



Combined automotive coating



Combination filter

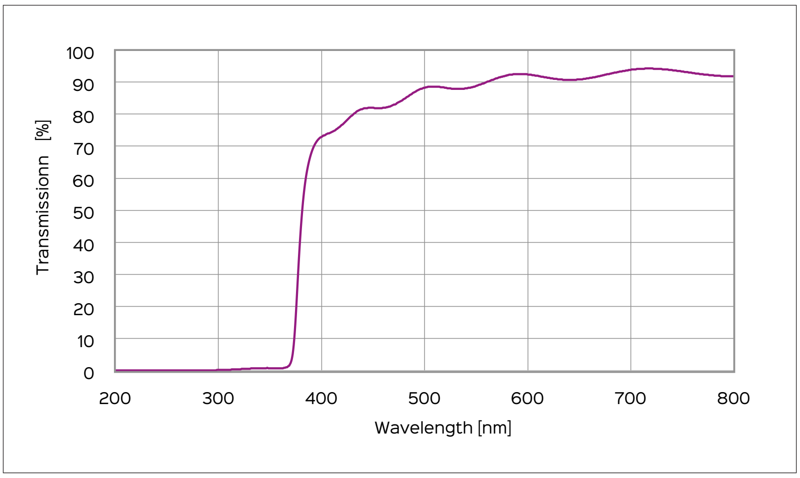
5.5 UV absorption filters

When illuminating sensitive objects, for example, these filters block or reduce UV radiation. They are used in semiconductor technology and for system light sources (projection lamps).

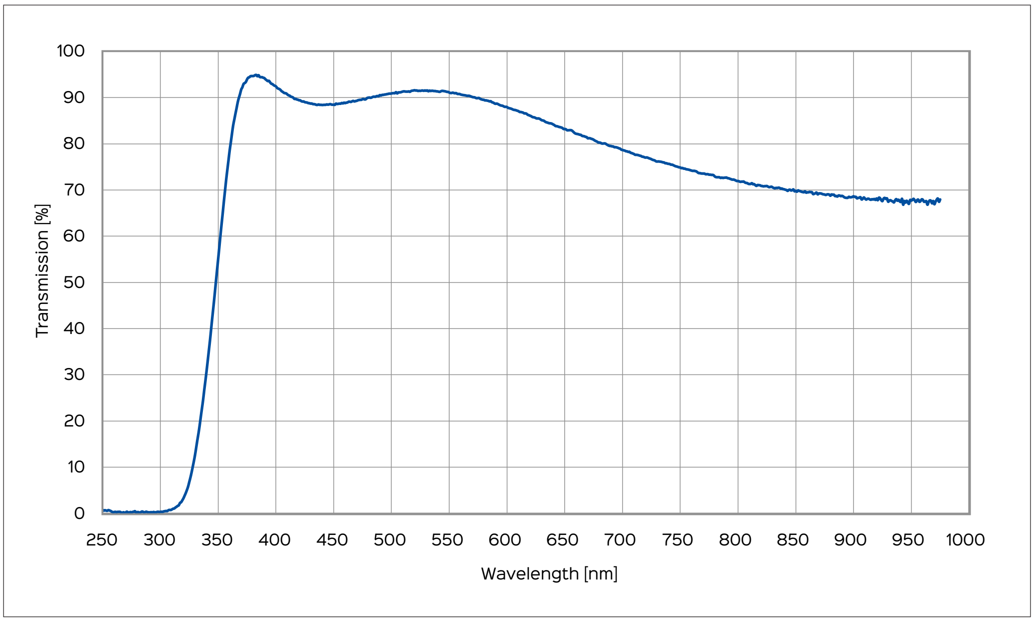
The coating is carried out using the sol-gel process, with

ZnO: for transparent layers with a slightly yellowish colour, temperature stability up to > 600°C, yellows upon heating (thermochromic),

AZO: electrically conductive ZnO with aluminium doping, for use in LCD / TFT as ITO replacement.



Transmission of ZnO coating on flat glass



Filter type: UB 2 on Borofloat 3.3

Fe_2O_3: for the typical amber glass coating for use in the pharmaceutical industry and in laboratory reactors and equipment.

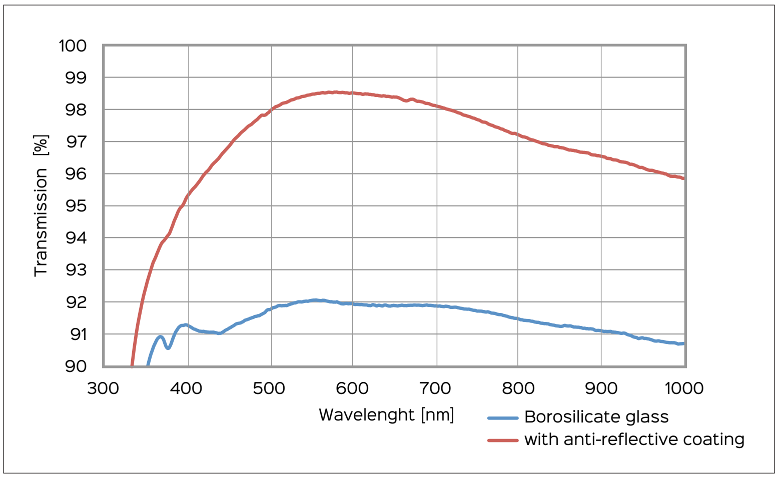
TiO_2: for UV absorbers in lighting technology, which have a higher reflection than ZnO. The temperature stability ranges up to 550°C; a phase transformation from anatase to rutile type occurs at 600°C.

5.6 Anti-reflection coatings

- Display glass
- Covers for sensors
- Protective glass for laser optics
- Glass for LIDAR applications

require(s) minimised reflection (<=1%),
an increased transmission (>=97%) and
a reduced transmission of UV radiation.

The coating is carried out using the sol-gel process.



Borosilicate glass with single-layer anti-reflective coating

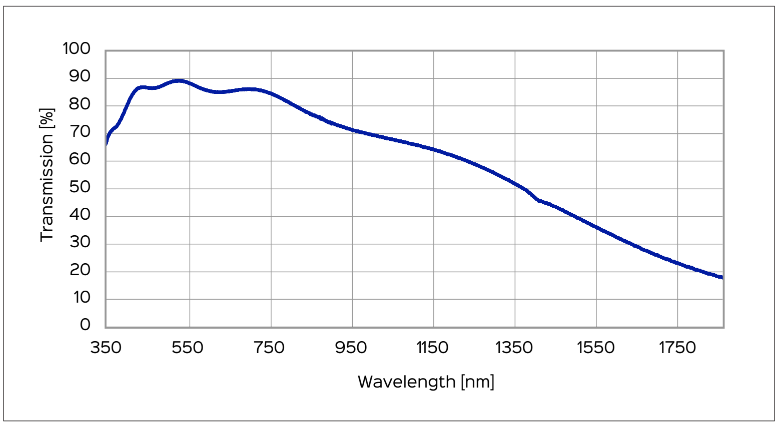
5.7 Electrical conductivity

on surfaces of

- laboratory glassware with heating layers
- glass pipelines for electrostatic discharge
- IR-reflective coatings
- displays, electrodes etc.

is made possible by coating with

- ATO (antimony-doped tin oxide): antistatic, blue inherent colour;
- FTO (fluorine-doped tin oxide): lower specific resistance than ATO
- ITO (indium doped tin oxide): significantly lower sheet resistance than ATO;
- AZO (aluminium doped zinc oxide).



Transmittance spectrum of tin oxide

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6. Customer-specific developments: Consultation - Projection - Realisation

The wide range of coating offers, in connection with the respective know-how, provide the prerequisites for taking on customer-specific developments in all areas of surface coating.

With our laboratory and production facilities, as well as experts in laboratory and production plants, we at PRINZ OPTICS and GLASS PLUS are glad to advise you on:

Our technological centre

- Dispersing technique

Agitator ball mill, batch mill (batch size 6 kg), laboratory dispersing unit (1 kg)
Ultrasonic dispersing
Planetary ball mill
Screening technology

- Dip coating systems (dimensions up to 1150 x 850 mm)

Spraying technique

- Hot coating (pyrolysis spray)

Painting cabin
System technology for internal coating of hollow bodies

- Flooding

Coating plants for internal coating

- Heating processes

Convection ovens
Radiation furnaces

Our measuring laboratory

- Luminous flux measurement (1-metre integrating sphere)
- Colour coordinate measurement
- Transmission, reflection and absorption measurements with diode array spectrometer
- Ellipsometry
- Particle size measurement with DLS
- Lux measurement
- Precise geometry measurement, profile projector
- Scratch test, roughing machine
- Taber abraser test
- Climatic test chamber

Consultancy and services

In the case of questions on how to use coated glass and how to realise relevant projects, PRINZ OPTICS and GLASS PLUS provide appropriate services: from photometric advice, optical measurements, the construction of models, and custom products to project management.

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