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Controlled **Reflection**

Projector lighting systems call for high-quality, long-life components. Schott develops tailor-made lighting units in collaboration with its customers.

Digital projectors have become commonplace for professional presentations. They are equally suited for the presentation of charts, film sequences and color pictures, and can help visualize complex processes, break down language barriers and enhance the spoken word. The once bulky equipment has become much smaller and more lightweight while projection light output has been increased continually and is now over 4,000 ANSI lumen.

In the home sector, projectors bring cinema viewing into the living room. Projectors can be fitted to the ceiling with almost invisible fixtures and project either onto a wall or a screen that can be lowered automatically. Compensation for trapezoidal distortion is also automatic. All this is possible due to the interaction of digital high-performance electronics and high-power optics.

Lighting Components Withstand High Loads

Home projectors now use extremely powerful projection arc lamps that can generate light outputs of well over 1,000 ANSI lumens and are bound to become extremely hot. The quartz bulb of the lamp reaches temperatures of up to 1,100 degrees Celsius, and reflectors can be subjected to 600 degrees Celsius. Regular glass reflectors, like those used in conventional lighting systems, are unsuitable. Temperature differences of 350 to 400 degrees Celsius, which occur when switching lamps on and off, are especially hard on glass reflectors. These differences in temperature subject the glass to mechanical stresses and strains of up to 40 Mpa. Due to thermal expansion, hairline cracks in conventional glass reflectors would then expand and cause breakage. That is why reflectors made of heat-resistant borosilicate

The small high-performance reflectors in the home projection systems have to withstand temperature differences of up to 600 degrees Celsius without suffering any damage.

glass are used with lamps having a power consumption of up to 200 watts, where even higher temperature differences can occur.

Reflectors Made from Glass Ceramics

To be able to control even higher levels of electrical power safely, Schott developed a special glass ceramic material for high-power lamps that can withstand both the high thermal load and thermal shocks. Tests showed that with glass ceramic reflectors the strain was less than 5 MPa. The main property of Schott glass ceramics is its zero thermal expansion. The material has proven itself for decades in numerous space applications, where extreme temperature differences have to be overcome, and in large-scale telescopes. Last but not least, over fifty million "Ceran" glass ceramic cooktop panels made by Schott have been in use throughout the world for over 25 years. Here too, the resistance of the material to changes in temperature plays a major role.

Coating Provides Thermal Compensation

In addition to zero thermal expansion, dissipation of the considerable heat generated is an important criterion for the realization of a "cold light reflector." Despite all efforts to improve the efficiency of halogen and gas discharge lamps most of the electrical energy is still not converted to visible light but to radiated heat (over 87 percent). This energy cannot be allowed to be focused or absorbed by the reflector, as it would lead to excessively high thermal stress to the projection module or lighting unit. Consequentially the reflector should preferably only emit visible light to the front and allow the invisible infrared radiation to pass through the back of the mirror where it can be diverted and dissipated. With a special glass-ceramic material developed for this particular field of application, in conjunction with a special coating, Schott has taken a great step toward achieving these objectives. Not only did certain technical criteria have to be met, it was also necessary to mass produce at very high quality to meet forecasted demand. That is no easy task as glass-ceramic components, as opposed to cheap reflectors, are manufactured according to a highly sophisticated process.

At light outputs of well over 1,000 ANSI lumens home projectors produce bright, large-format pictures.

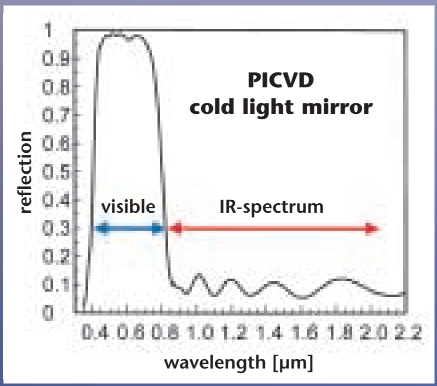
The four production stages of a high-tech reflector (from right to left): pressed green glass, ceramized blank with zero thermal expansion, PICVD-coated dish, finished reflector.

Manufacturing Process

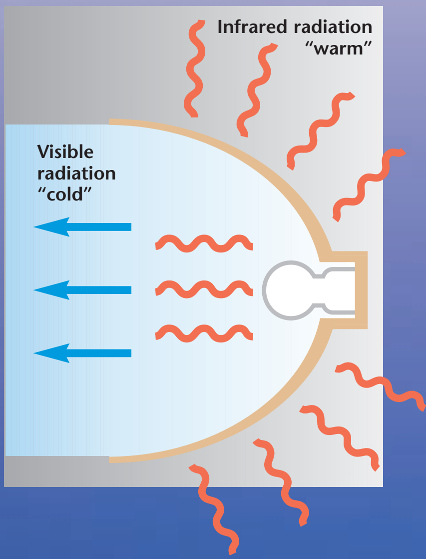
After a series of calculations and tests in the Light Engineering Laboratory, the parabolic contour of the reflecting surface has to be reproduced precisely in the glass by means of a pressing process in order to achieve high luminous intensity. The geometry of the blank must be precisely maintained throughout the entire production process, including the final cooling phase. This applies not only to the manufacture of so-called green glass, but also to downline ceramization, in which the pressed component is cooled down and then reheated to approx. 800 degrees Celsius. Only then does the product acquire its specific property of zero thermal expansion. For the special coating process, which is extremely sensitive to roughness – even in the microscopic range – the surface of the glass ceramic blank also has to be devoid of minute bubbles, crystals, and deposits. Here maximum care is required during the individual process stages in order to minimize errors. Any deviations would add up, having a negative effect on luminous intensity, reducing the efficiency of the lamp-reflector system as a whole.

Coating Technology

The PICVD process (Plasma Impulse Chemical Vapor Deposition), specially developed by Schott, is particularly suitable for coating three-dimensional substrates. Initially developed for refining glass fibers for lightguides, this method is used meanwhile for coating ophthalmic glasses, energy-saving halogen lamps, and high-quality lamp reflectors. In this application up to 100 highly heat-resistant layers with thicknesses between 20 nm and 300 nm provide the reflectors with the required properties. The layers are made from titanium dioxide and silicon dioxide. Depending on the specification and application of the lamps, layer systems are developed and produced individually in close collaboration with the lamp manufacturers. The Light Engineering Laboratory at Schott Auer in Bad Gandersheim, and support provided by Schott's central research labs in Mainz, make it possible to implement customers' requirements quickly. The manufacturing technology, which has proven itself for years, even allows very small batches and ensures consistently high quality and reliable delivery ■



Degree of reflection at different wavelengths, taking a halogen lamp with PICVD-coated reflector as an example.



How a reflector focuses cold light and dissipates heat. The visible portion of light that can be used for projection is reflected optimally by up to 100 layers of titanium and silicon dioxide while most of the infrared radiation passes through the reflector. The heat is dissipated by a fan at the back.