Laser Diffuser Technology Propels Light-Based Therapies Forward

Precision glass-based diffusers deliver uniform laser light for minimal invasive surgery, supporting the fight against cancer, and treating skin and gums conditions

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Whether supporting minimal invasive surgical procedures or killing cancer cells, light-based therapies play an important role in improving the health of patients. As these therapies become more complex and precise, they demand more from the components used to deliver laser light to the area being treated. Advanced diffusers can meet the exact needs of these applications, making treatments more efficient and easier to perform. These glass-based diffusers uniquely combine extremely homogenous light output at high powers with the ability to transmit visible, infrared, and ultraviolet wavelengths with high efficiency.

THE NEXT STEP FOR LIGHT-BASED TREATMENTS

Over the past few decades, lasers have become an important tool for treating a variety of conditions. Some of the most advanced light-based therapies are being used in the fight against cancer. For example, laser-induced thermal therapy (LITT) uses optical fibers to deliver laser light directly into tissue to coagulate a tumor, while photodynamic therapy (PDT) uses a photosensitizing agent that kills nearby cells when exposed to light. Investigational next-generation treatments target cancer by using photosensitizing compounds and laser light to activate photosensitizers that are attached to an antibody.

Light-based cancer treatments require delivery of precise light intensities over an evenly distributed area. A diffuser combined with an optical fiber will scatter the focused laser beam, spreading it out in a homogenous manner to make sure each cell receives the required amount of light. Ensuring that the entire area receives the same treatment is also important for laser-based procedures used for dermatology applications such as lesion removal, hair reduction, psoriasis, and leg vein treatment as well as dentistry procedures that use lasers to destroy the bacteria that cause gum disease.

SCHOTT’s single-use fiber diffusers offer a variety of customized options for delivering homogeneous diffused light over long distances. They use glass-based materials that incorporate unique scattering elements to deliver up to 20 watts of laser light with high light efficiency and excellent homogeneity. The ability to handle high powers is critical because plastic components will melt or could cause tissue burns if they overheat.

The glass-based materials exhibit high performance while being naturally biocompatible and highly durable. Although many of today’s diffusers are designed to transmit visible wavelengths, these glass-based diffusers are enabling new biomedical applications by extending the operation range into the infrared up to 2 microns and into near ultraviolet wavelengths.

A VARIETY OF DIFFUSER SHAPES

The fiber-based diffusers are available in a variety of geometries that are each useful for different applications. Cylindrical diffusers, which emit diffused light from the sides of the fiber but not the distal end, provide homogenous diffused light for the entire length of the diffuser, which is typically 5 to 50 millimeters long. The cylindrical shape makes it easy for the doctor to ensure that all cells get the same dose of light for PDT. With outer diameters as thin as 100 microns, cylindrical diffusers can also be used for LITT and laser treatment of varicose veins. Testing has shown that these diffusers can deliver laser light with power up to 1500 mW/cm² with efficiencies of over 80 percent for visible light and near-IR laser radiation.

Front-emitting diffusers radiate light only from the tip, or front, of the fiber. This shape ensures that the directional output from the fiber is broadened in a very precise manner to ensure an even intensity over the whole area. These
diffusers are used to perform PDT on tumors that are close to the skin and for various dermatology treatments. The diameter of front-emitting diffusers can be adjusted to match that of delivery fiber, with typical outer diameters ranging from 400 to 1,000 microns. Also available are spherical diffusers featuring ball-shaped components added to the tip of a fiber to create a 360-degree radiation pattern. This evenly applies light inside hollow areas such as the inside of the bladder. Typical diameters for this geometry are between 0.3 and 1.0 mm, and powers can be up to 20 W.

Diffusers with custom outputs are also available. For example, emission for the cylindrical or spherical diffusers can be limited to a certain angle to deliver diffuse light to a spatially constricted area. Optical components can also be added to a cylindrical or front-emitting diffuser to create a certain light homogeneity or to create diffused light output with a specific shape. Biocompatible coatings can also be applied to the diffusers to fulfill medical requirements included in standards such as DIN ISO 10993 or USP Class VI.

A PARTNER IN LIGHT DELIVERY

Although diffusers may seem like a simple component, achieving extremely homogeneous radiation characteristics with high powers and high efficiency is challenging. Development of the proprietary glass-based material was a result of SCHOTT’s 130 years of experience in glass-processing and in transporting light through glass. Manufacturing the diffusers requires advanced glass bonding capabilities so that the finished component is durable and loses little light at a variety of wavelength ranges.

Collaborating with SCHOTT to incorporate these advanced diffusers into new instruments gives you an experienced lighting and glass partner with extensive experience in the medical device industry and a full range of services. The company’s experts can help with early-stage development, device design and prototyping, application engineering, and customization. SCHOTT is also well-versed in microassembly of complex components or light guides and in adding biocompatible surface treatments and coatings. When it comes to production, the company can provide high-volume serial production that is price competitive, an ISO class 7 cleanroom, and medical production facilities with ISO 13485 certification that are registered with regulatory authorities.

In summary, advanced fiber diffusers are meeting the precision laser delivery needs for a variety of light-based medical treatments. Partnering with SCHOTT gives you a light and glass expertise that can help guide your ideas from development all the way to production.
**SCHOTT** is a leading international technology group in the areas of specialty glass and glass-ceramics. With more than 130 years of development, materials, and technology expertise, we offer a broad portfolio of high-quality products and intelligent solutions. SCHOTT is an innovative enabler for many industries, including the home appliance, pharmaceutical, electronics, optics, life sciences, automotive, and aviation industries.

**SCHOTT Lighting and Imaging** specializes in design and manufacturing of fiber optic, LED, optical, and hybrid product solutions for use in medical, dental, scientific, industrial, defense, aviation, and automotive applications. In the medical field, SCHOTT specializes in custom solutions for OEM manufacturers such as small diameter image guides and light guides for endoscopy applications, fused fiber optic tapers and faceplates for X-ray applications, and flexible wound fiber bundles for MRI applications. We can manufacture flexible fiber bundles for both lighting and imaging applications as well as fused fiber optic faceplates and tapers to target medical and industrial X-ray inspection and custom displays when coupled to OLEDs.