Fiber Optic Image Bundles Provide A Solution When High Tech Approaches Fail

Flexible Fiber Optic Image Bundles Provide a Critical and Dependable View Even in Hazardous and Emergency Conditions

By Michael Dargie, SCHOTT

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In today’s high-tech world, we rely on electronics, digital cameras, and displays to help us monitor the world around us and detect when problems are present. However, when power goes out, it can leave military vehicles, airplanes, or high-risk facilities vulnerable.

Wound Fiber Bundles (WFBs) by SCHOTT, which were invented decades ago, offer a completely passive way to transfer images from remote locations, providing a reliable view even when power isn’t available. Although it has been around for a long time, this technology is used in environments too extreme for cameras and electronics, and because of their flexibility, WFBs can be used to provide a view into hard-to-access areas.

Why Are Wound Fiber Bundles Unique?

When people think of fiber optics, they often think of the single quartz/fused silica fibers used to transfer laser light in telecommunications. WFBs are quite different in that they are bundles of hundreds of thousands of flexible glass fibers that each transmit light used to form an image. These fibers, which each measure just 10 microns in diameter (around a tenth of the size of a human hair), have a stepped-index – meaning the core is of a higher refractive index than the cladding. The fibers consist of glasses selected for a large refractive index difference between the core and cladding, producing a high numerical aperture (NA = .63). The higher NA means the fibers accept a greater amount of light relative to telecommunications fiber, which is important for relaying high-quality images.

To make WFBs, the core and cladding glasses are heated together in a furnace and then pulled into a thin rod, or monofiber, that is 3 millimeters in diameter and about a meter long. Thirty-six of these rods are then placed into a square pattern (six monofibers on each side) that is heated again and drawn so that the fibers are each 10 microns in diameter and the entire bundle is 60 microns square. These can then be stacked or placed side by side to create larger bundles. The final bundle shape can be square or rectangular to meet a specific application’s needs, such as the sensor dimensions of a camera. Epoxy is applied at each end to maintain bundle coherence, and then a sheathing and end terminations are added.

Although various custom setups are possible, WFBs are typically either used with an eyepiece and objective lens for completely passive imaging or connected to a sensor or digital camera. One end of the bundle can also be split into up to four smaller bundles to relay multiple simultaneous views to a single screen or camera.

How Can WFBs Help in High-Risk and Emergency Situations?

For military vehicles such as armored vehicles and tanks, situational awareness is critical for safety. Because WFBs are completely passive, they allow personnel to maintain an outside view even if the vehicle is hit or becomes damaged. This fiber optic technology can also be used to provide multiple views out the rear of a vehicle so that soldiers can survey for combatants or cover before leaving a vehicle.

WFBs can also be used to provide a view outside if an airplane has an off-runway landing or other emergency. Although airplane doors serve as important escape routes, it is important to see that the area outside is safe prior to exiting the aircraft. Smaller jets and airplanes use doors that do not have windows because they drop down vertically to offer stairs to exit the plane. In this situation, WFBs can let crew members or passengers see outside even if there is no power or if the plane is damaged.

This imaging solution is also used aboard trains to see around corners to check for clearances, vandalism, or other problems. The rugged WFBs can be placed on the outside of the train while a digital camera is kept in a safe spot inside. These rugged fiber bundles do not need any maintenance, so placing them in hard-to-access areas is not a problem.

How Are WFBs Used in Places Unsuitable for Cameras?

WFBs are ideal for monitoring hard-to-reach areas as well as high-temperature, high-vacuum, or high-pressure environments. For example, they are used to see inside large vacuum chambers that researchers use to conduct high-energy physics experiments or to test devices designed for operation in space. While cameras could be destroyed inside this vacuum, WFBs can be placed inside the chamber and used to transfer images to a camera.
outside. They can also project an image onto a fused fiber optic plate that acts as a vacuum window into the chamber, providing scientists with a direct view of processes or experiments occurring inside.

WFBs can also be incorporated into machine vision systems such as the ones used with high-speed pick-and-place machines or in environments not suitable for cameras or electronics. The flexible nature of WFBs means that they can withstand the machines’ high rates of acceleration and deceleration while transferring images to a camera that is kept stationary.

When electronic devices might cause interference, WFBs are a good solution. For example, the high magnetic field of an MRI prevents metal devices from being used in the area. WFBs can be used inside the field since the fiber, sheathing, and end tips can be both nonmagnetic and metal-free.

**What Else Do I Need to Know About Using WFBs?**

When considering WFBs, it is important to understand their specifications and the customization that is available. The fiber optic bundles are available in lengths up to 4.5 meters and have imaging areas from 2 to 40 millimeters square. They have a resolution of 45 line pairs per millimeter and 40 percent transmission at wavelengths from 500 to 1,200 nanometers.

Various types of sheathing or covering materials can be used to meet specific application needs. Selection often considers mechanical ruggedness, chemical durability, flexibility, and aesthetics among other factors.

The epoxies used at each end to maintain fiber coherency can withstand continuous temperatures up to 100° C, and if the environment has higher temperatures (such as an oven), a cooling housing can be placed over the end of the bundle. Various epoxies, including nonmetallic or nonmagnetic materials, can be used to meet specific needs.

A large selection of objective lenses and cameras can be connected to the WFBs, often using standard C mounts. If the WFB is transferring images to a C-mounted camera, a relay lens is used to relay the image from the bundle onto the camera’s sensor. Custom end terminations are also available.
WFBs offer a versatile and durable way to see into narrow and hazardous conditions and can provide an all-optical view that works even when there is no power. With our experience in fiber optic imaging, we can help design a solution that works in even the most challenging environments.

Contact Michael Dargie at michael.dargie@us.schott.com or 508-765-3208, to discuss how SCHOTT’s WFBs can be used to meet the needs of your specific application.

About SCHOTT

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 leached fiber optic image bundles 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.