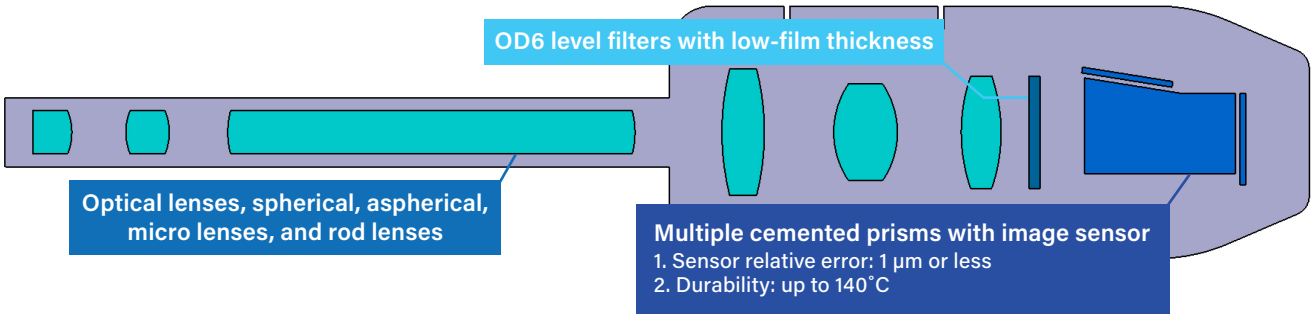
TAMRON

Optical Lens and Filter Advances Improve Medical and Bioscience Device Performance

Notch filters, optical coatings and custom lens assemblies can optimize the optical performance of critical instruments.

Today's advanced optics deliver high-resolution images that allow diagnostic instruments to uncover hard-to-identify tissue abnormalities earlier, and they can guide users of surgical instruments with greater precision than before. For example, the growing field of fluorescence endoscopy can reveal certain tumors or lesions that otherwise cannot be detected using traditional white light endoscopy. When it comes to designing medical and life science instruments that involve lasers, fluorescence and other optical disciplines, the quality of your image will rely on the quality of your lens.

In fluorescence endoscopy and Raman spectroscopy instruments and other critical equipment, distortions due to electromagnetic wavelengths can otherwise adversely affect results. That means lenses must be optimized to eliminate undesirable light and contamination. This article will describe how TAMRON optical filters and coatings can help ensure optimal lens performance with exceptionally low distortion.



Tamron ALL-IN-ONE Technology.

Notch Filters Block Unwanted Light

In order to achieve optimal optical performance required by medical and life science equipment, tight control of the wavelength is key. Notch filters are an effective way to ensure both precise wavelength control and image integrity. These optical filters reject wavelength transmission across a defined range of the electromagnetic spectrum and allow high transmission outside of that range. Notch filter performance is based on its ability to block an unwanted frequency — known as optical density (OD) — and the rate at which it transmits other wavelengths.

Medical and light science devices are typically sensitive to light transmission and demand high-OD notch filters. A high OD indicates a low transmission percentage. For example, OD 1 energy transmission is 10 percent, whereas OD6 — a very desirable OD figure for medical and life science devices that demand high sensitivity — is a very low 0.0001 percent. For many optical component vendors, OD6 is often a design barrier.

Figure 1. *Notch filters reject wavelength transmission within a specific range and have high transmittance outside of that range.*

TAMRON designs and manufactures notch filters that achieve blocking OD of 6 or more within a specific wavelength range from 400 nm, visible to 1,700 nm, near-infrared (NIR). These notch filters feature thin coatings that can help lenses achieve various effects, make certain functions possible and provide greater surface protection, thereby optimizing overall optical performance. In fact, we continually develop coatings to help designers of medical or bioscience devices satisfy their specific requirements and expand optical capabilities in new fields. Our technical expertise allows us to customize an ideal notch filter and coating combination that can best meet your needs.

Along with having high OD and precise transmission capabilities that optimize imaging for medical and bioscience equipment, TAMRON notch filters are manufactured to deliver consistent performance. At our ISO-certified manufacturing facility in Japan, we maintain strict controls and batch inspections throughout production, eliminating imperfections and irregularities from filter surfaces to ensure each unit achieves OD6 every time. And, we back it up with an inspection certificate confirming it meets the customer's specifications. The result: high-precision notch filters with minimal differences between design and manufacturing variables.

TAMRON can propose notch filters as a comprehensive optical system in a wide range of equipment in medical and bioscience disciplines, including:

- **Raman spectroscopy.** Devices used for analyzing lithium-ion batteries, electronic component fabrication, and food and medicine production.
- **Bioscience.** Fluorescence devices that observe cells and proteins.
- **Fluorescence imaging.** Cameras that support fluorescence-guided surgeries.

Solve Filter-Lens Alignment Issues

When it comes to setting up an off-the-shelf external optical filter with a lens unit, it can be difficult to get the components into a precise alignment. If the optical components are not aligned, the filter will not achieve the correct angle of incidence (AOI). Even the best-performing filter cannot reach its full optical potential unless it is used at the proper AOI. And, sometimes device designers do not know how to achieve the right AOI. That's why it pays to work with a partner that specializes in optical design.

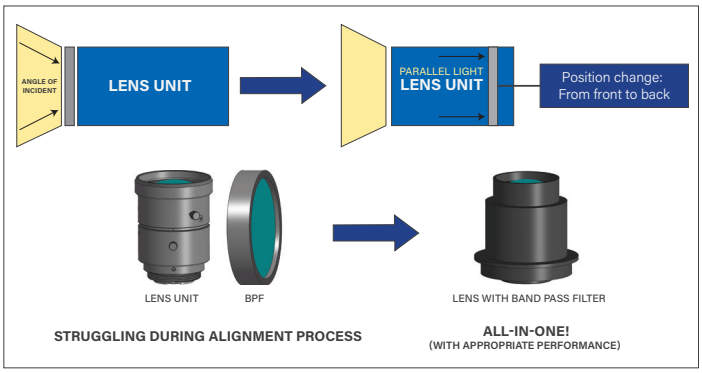


Figure 2a. *TAMRON's all-in-one lens unit and filter solves the problem of getting the components into a precise alignment.*

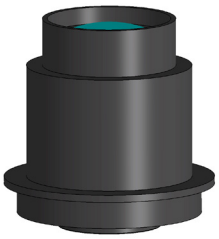


Figure 2b. *A TAMRON all-in-one lens unit and filter.*

For example, TAMRON can custom-design a lens unit and filter combination that eliminates the time and expense associated with aligning the individual components. Thanks to advanced mechanical simulation processes and software, our technical experts can place a band pass filter at the correct AOI without affecting the accuracy of the lens unit and filter. The graphs in Figure 3 illustrate the modular transfer function (MTF) — a reference value used to quantify a system's resolution and contrast performance — of an improperly aligned lens unit and bandpass filter versus a combined lens unit and bandpass filter. As the graphs indicate, the improperly aligned lens unit and bandpass filter exhibits lesser-quality preservation of spatial detail versus that of an all-in-one custom lens unit with internal band pass filter.

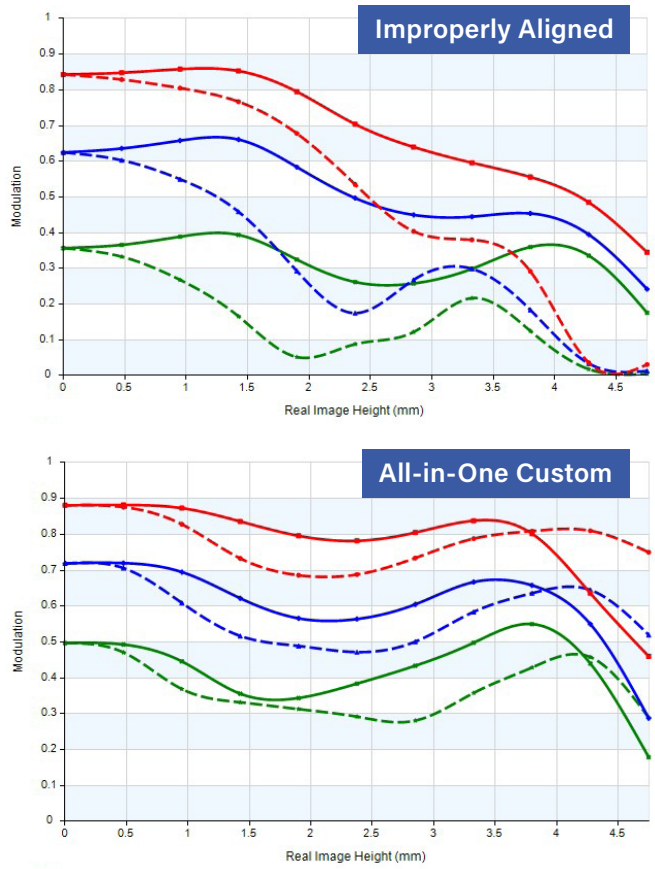


Figure 3. *MTF values of improperly aligned lens unit and bandpass filter versus an all-in-one custom lens unit.*

In addition to designing notch and bandpass filters, TAMRON also designs and produces lens units including cemented prisms with sensor relative error of just 1µm or less that maintain their high performance at temperatures up to approximately 140°C. *(Refer to Figure 4.)*

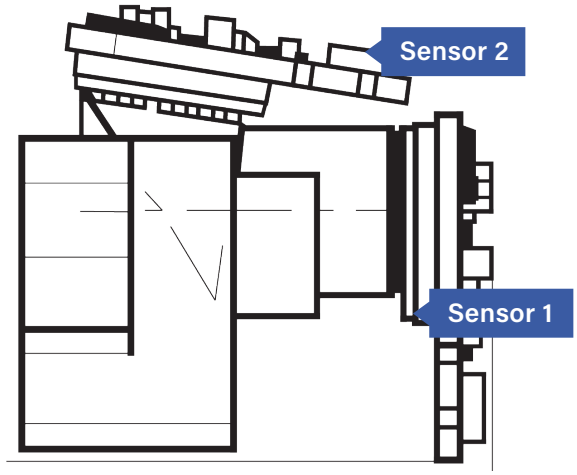
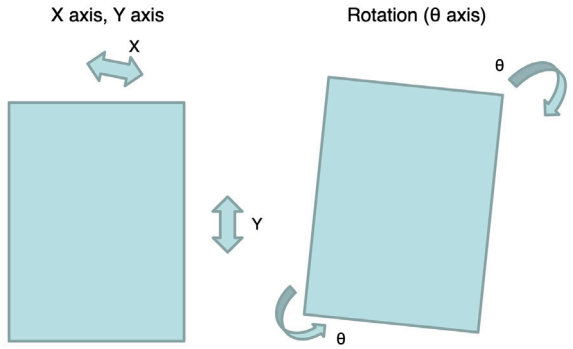


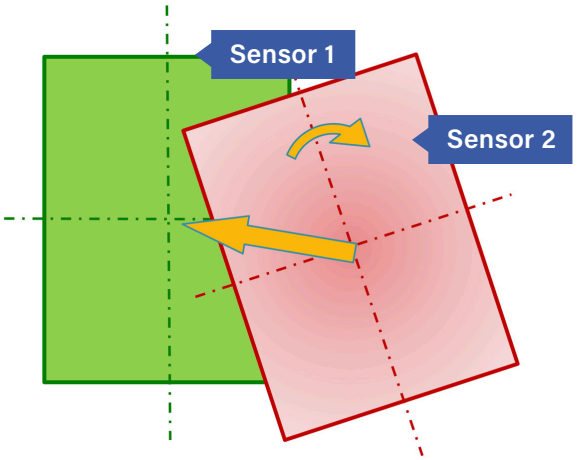
Figure 4*. TAMRON's product lineup includes cemented prism lenses.*

Alignment Between Sensor and Cemented Prisms



Shift (X axis, Y axis): *Within 0.8μm relative to an image sensor*
Rotation (θaxis): *Within 1 pixel relative to an image sensor*

Align Sensor 2 Based on a Sensor 1 Position



Work With Your Optical Components Supplier

When an instrument design calls for high-quality lenses or lens assemblies, keep in mind that not all optical component suppliers are the same. As you select optical lenses or filters for your medical or bioscience device, be sure to communicate your application requirements as well as the lens specifications to the manufacturer.

While many vendors can produce lenses and filters, TAMRON is one of the few suppliers that can optimize products to meet your exact requirements. We will take the information you provide and incorporate your specifications into the lens or filter design. And, if you have an existing design, send us all the optical components. Using our advanced mechanical simulation technology, we'll make the modifications in-house to ensure your lens, filter or lens assembly achieves optimal optical performance. With quality products together with engineering assistance and custom capabilities, TAMRON is your single source for advanced optical components for demanding medical or bioscience instruments.

For more information about TAMRON optical components and capabilities for medical or bioscience applications, visit [www.tamron.com.](http://www.tamron.com)

To learn more, please visit www.tamron-usa.com

Certificated at Tamron Head Office and Aomori Factory
Hirosaki site, Aomori Factory
Namioka site, JAPAN

Detailed scope of certification:
Design and manufacture of lens parts for endoscope.