OPTICS FOR FIGHTING COVID-19

Optical components for your medical diagnostic application

FILTERS | OBJECTIVES | LENSES | OPTICS

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www.edmundoptics.com/advanced-diagnostics
Advanced Diagnostics at Edmund Optics®

Enabling Life-Saving Applications

Optical components from Edmund Optics® (EO) support life-saving advanced medical diagnostics ranging from fighting COVID-19, to ophthalmology, to brain diagnostics. Our engineers specialize in creating cost-effective solutions that meet your application needs, whether you are prototyping or taking a system to volume production.

Edmund Optics® is proud to support technologies as diverse as confocal and multi-photon microscopy, flow cytometry, cell sorting, optical coherence tomography (OCT), and many more.

Why Partner with Edmund Optics®?

• Extensive experience with lot control, change control, serialization, and other critical FDA requirements.
• Single-source stock and custom component provider of EO designed and manufactured optical components, imaging lenses, and advanced coatings.
• Over 200 engineers ready to assist with product selection, application support, and custom component design and manufacturing.
• Key products available from the most trusted brands, including Mitutoyo, Olympus, Nikon, Coherent®, SCHOTT, and Hamamatsu.
• ISO 9001:2015 and compliance programs designed to meet quality control needs, traceability, and serialization of advanced diagnostics manufacturers.

To learn more about our INDUSTRY EXPERTISE, visit www.edmundoptics.com/advanced-diagnostics

Optics for Fighting COVID-19

PCR TESTS FOR DIAGNOSING COVID-19
Detecting both symptomatic and asymptomatic cases

OPTICS FOR ANTIBODY DETECTION
Identifying immune responses to COVID-19

INFRARED FEVER DETECTION
Identify individuals who should proceed with further testing

VISION-GUIDED UV CLEANING ROBOTS
Safely sanitize hospitals and high-traffic locations

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Quick, Reliable, and Accurate COVID-19 Testing

South Korean healthcare diagnostics company, MiCo BioMed, has developed a rapid, highly-sensitive molecular diagnostic device called the VERI-Q PCR 316 which uses bandpass filters, dichroic filters, spherical lenses, and aspherical lenses from Edmund Optics®. The optical design of fluorescence-based PCR screening systems like VERI-Q PCR 316 resembles this setup of a simple fluorescence microscope. These devices follow a similar schematic to fluorescence microscopes. Many PCR screening systems rely on fluorescence. Targeted double-stranded DNA molecules are tagged with fluorescent dyes that emit light when exposed to a shorter wavelength input.

These devices follow a similar schematic to fluorescence microscopes. The optical design of fluorescence-based PCR screening systems like VERI-Q PCR 316 resembles this setup of a simple fluorescence microscope. Microfluidics, where fluids are processed through channels on the order of microns, is the future of this diagnostic technology.

How are Optics Used in COVID-19 Detection?

• Genetic material from nasal or throat swabs is added to a unique test solution.
• Sample DNA is replicated during a polymerase chain reaction (PCR).
• This exponentially replicates DNA samples to allow for accurate analysis.
• Fluorescence-based PCR systems feature higher sensitivity than other techniques.
• PCR systems utilize optical filters, lenses, and mirrors.

To learn more about this CASE STUDY, visit www.edmundoptics.com/covid-pcr

The US Centers for Disease Control (CDC) has approved RT-PCR tests for combatting the spread of COVID-19.

Related Products

Increase Contrast & Signal Throughput

Fluorescence microscope systems can range from very simple, such as an epifluorescence microscope, to extremely complex, such as confocal or multi-photon systems. Whether simple or complex, fluorescence microscopes share the same basic concept: excitation energy is used to illuminate a sample which then produces emission energy, albeit weak, that is quantifiable. The excitation and emission wavelengths do not share the same center wavelength, and this allows specialized optical filters to increase overall contrast and signal.

The most basic concept and schematic can be seen on page 4. A filter arrangement is constructed out of three very specific filters: an excitation filter, a dichroic filter, and an emission filter.

• Excitation Filter: Placed within the illumination path of a fluorescence microscope. It filters out all wavelengths of the light source except for the excitation range of the fluorophore or specimen.

• Emission Filter: Placed within the imaging path of a fluorescence microscope. It filters out the excitation range of the fluorophore and transmits its emission range.
Identifying Immune Responses to COVID-19

• One technique for identifying antibodies is direct enzyme-linked immunosorbent assay (ELISA).
• A patient’s blood is drawn and processed into a serum.
• Any antibodies bond with an immobilized synthetic spike protein with a similar shape to COVID-19 in a well plate.
• A chemical is added which changes color if antibodies have bound to the target antigen.

To learn more about this CASE STUDY, visit www.edmundoptics.com/antibody

Color change indicates the presence of antibodies in the direct ELISA process.

Indirect Fluorescent Antibody (IFA) Tests

• IFA is similar to ELISA, but fluorescent dye-conjugated anti-immunoglobulin are added to reveal the presence of antibodies.
• Fluorescence microscopes are used to identify reactions indicating an immune response.
• An advantage of IFA over ELISA is the ability to use the morphology and location of fluorescence to better differentiate antibodies specifically tailored for COVID-19 from more general immune responses.
• These fluorescence systems use many of the same components used in PCR diagnostics.

Using Tube Lenses with Infinity Corrected Objectives

Selecting the Proper Tube Lens

In order to create an image with an infinity corrected objective, a tube lens must be used to focus the image. One advantage to using an infinity corrected objective with a tube lens is that there can be a space between the objective and tube lens. The space allows additional optical components to be inserted into the system, such as optical filters or beamsplitters. The distance between the objective and the tube lens (L) can be varied, but this will affect the image field diameter (Ø). Equations 1 and 2 are approximation formulas to determine the relation between Ø and L.

\[ Ø_1 = 2fNA (1) \]
\[ L = \left( \frac{Ø_1 - Ø_2}{f_1} \right) f_2^2 (2) \]

\( Ø_1 \) [mm] is the exit pupil diameter of the objective, \( Ø_2 \) [mm] is the entrance pupil of the tube lens, \( f_1 \) [mm] is the focal length of the objective, \( f_2 \) [mm] is the focal length of the tube lens, and NA is the numerical aperture of the objective.

www.edmundoptics.com/tube-length to use our Infinite Conjugate Tube Length Calculator and calculate the optimal tube length distance (L) for your application. Based on the parameters of your objective, tube lens, and imaging sensor.
Elevated Body Temperatures Could Indicate COVID-19

- Infrared optics are utilized to safely measure temperature at a distance.
- Inexpensive handheld devices are accessible and useful for measuring one person at a time.
- Large-area scanners can analyze groups of people at a longer range.
- These systems require optics made from germanium, zinc selenide, and other substrates that can transmit wavelengths around 9µm.

To learn more about this CASE STUDY, visit www.edmundoptics.com/fever-detection

Related Products

Popular Off-The-Shelf Infrared Windows

<table>
<thead>
<tr>
<th>Material</th>
<th>Wavelength Range (µm)</th>
<th>Sizes (mm)</th>
<th>Anti-Reflective Coatings (µm)</th>
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<tbody>
<tr>
<td>Sapphire</td>
<td>0.3 - 5.5</td>
<td>2.5 - 75</td>
<td>1.65 - 3.0; 2.0 - 5.0</td>
</tr>
<tr>
<td>Zinc Sulphide</td>
<td>0.6 - 12</td>
<td>12.5 - 50</td>
<td>3.0 - 12.0</td>
</tr>
<tr>
<td>Zinc Selenide</td>
<td>0.6 - 18</td>
<td>10.0 - 75.0</td>
<td>3.0 - 12.0; 8.0 - 12.0</td>
</tr>
<tr>
<td>KRS-5</td>
<td>3.0 - 4.0</td>
<td>25.4 - 60</td>
<td>Uncoated</td>
</tr>
<tr>
<td>ZnS</td>
<td>0.4 - 12</td>
<td>10.0 - 75.0</td>
<td>3.0 - 12.0</td>
</tr>
<tr>
<td>Gallium Arsenide</td>
<td>0.7 - 1.6</td>
<td>25.4 - 60</td>
<td>Uncoated</td>
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<tr>
<td>Cadmium Telluride</td>
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<td>12.7 - 25.4</td>
<td>Uncoated</td>
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<tr>
<td>Silicon</td>
<td>1.2 - 7</td>
<td>19.0 - 36.2</td>
<td>3.0 - 10, DBC</td>
</tr>
<tr>
<td>Germanium</td>
<td>2.0 - 14</td>
<td>10.0 - 76.2</td>
<td>3.0 - 50; 60; 120; 60; 120; 160</td>
</tr>
</tbody>
</table>

Thermal imaging systems, like non-contact thermometers, can measure infrared radiation to determine a subject’s body temperature.

Safety Sanitizing Hospitals and High-Traffic Locations

- Cleaning robots destroy the DNA or RNA of viruses through UV-C irradiation.
- They use lidar or machine vision to navigate, dodge obstacles, and ensure all surfaces have been cleaned.
- Compact lenses and cameras give robots 3D stereoscopic vision.
- These systems do not require human operators.

To learn more about this CASE STUDY, visit www.edmundoptics.com/uv-cleaning-robots

Related Products

Ultraviolet (UV) Cleaning Robots

- Cleaning robots destroy the DNA or RNA of viruses through UV-C irradiation.
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Research published through the American Chemical Society found that 99.9% of aerosolized coronaviruses similar to COVID-19 were killed when directly exposed to a UV-C lamp.

Mobile vision-guided cleaning robots reportedly disinfect rooms more thoroughly than humans.

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**Monitoring Patients Using Ventilators to Prevent Complications**

- Ventilators are critical for COVID-19 patients experiencing inflammation in their lungs or respiratory failure.
- Optics are used to closely monitor the blood of ventilator users.
- Parameters including blood gas levels and acidity must be measured to avoid complications.
- These systems use a wide variety of optical components.

To learn more about this CASE STUDY, visit www.edmundoptics.com/ventilator-monitoring

---

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**Basics of Silicon Detectors**

Transforming Light into Electrical Current

When light with enough energy to excite an electron from the valence to the conduction band is incident upon the detector, the resulting accumulation of charge leads to a flow of current in an attached circuit. Light is not the only source of energy that can excite an electron, and a variety of these “non-light” contributions make up the total noise within the detector. The ratio of the overall signal output to the noise level is known as the signal to noise ratio (S/N) and can be used to determine whether noise will be a concern for a particular application.

**Different Operating Modes**

- **Photovoltaic (unbiased):** No external bias is applied to the photodiode. Since dark current is a function of base magnitude, dark current is eliminated as a source of noise. In this case, the noise equivalent power will be lower, allowing greater sensitivity at lower wavelengths. However, one disadvantage is the slightly lower responsivity at higher wavelengths.

**Photoconductive (biased):** A reverse bias on the photodiode results in a number of response advantages, such as a faster rise time. This makes this type of operation more suitable for high frequency applications. One inconvenience is that the dark current increases with this applied biased current, so noise is introduced into the system.

---

**Blood Gas Analyzers**

This schematic shows how optics are used to determine the pH level of a patient’s blood. Different setups are used to measure O₂, CO₂, and other parameters.

Carbon dioxide, oxygen, pH, and hemoglobin levels are key parameters in arterial blood gas monitoring.
Other Advanced Diagnostics

FILTERS: From UV to IR, We Cover Your Wavelength

Filter Coatings and Color Glass
Edmund Optics® provides precision filters for even the most demanding applications requiring high optical density, high transmission, and steep slopes. From ultra-durable dielectric coatings deposited on precision substrates to custom color glass, we have a filter solution for your application with extensive experience in the documentation, controls, and processes required for FDA-approved devices.

A vast selection of standard filters is in-stock and ready to ship. Custom filters are available for both large volume production and prototyping volumes. Our custom filter capabilities cover the entire range of filter designs including shortpass, longpass, laser-line bandpass, fluorescence bandpass, dichroic, notch, and color glass filters. Contact us for more information or to arrange a quote at www.edmundoptics.com/contact.

Filter Coating Capabilities

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 - 1000mm</td>
<td>All Glass Types</td>
<td>193nm - 14μm</td>
<td>&lt;0.5%</td>
<td>&lt;1% Deviation, &lt;0.5% Special Cases</td>
<td>&gt;OD 7, Measured</td>
<td>95 - 45%</td>
<td>±1nm</td>
<td>1nm - Broadband</td>
<td>&gt;95%, Typical</td>
<td>0.1 - 99.95%</td>
<td>10,000:1</td>
<td>Up to 20 J/cm² @ 20ns Pulses</td>
<td>MIL-STD-810F, Section 507.4, MIL-C-48497A, Section 3.4.1</td>
<td>1 arcsec</td>
<td>20-10</td>
</tr>
</tbody>
</table>

Filters for Advanced Diagnostics

**Bandpass Filters** — transmits light within a defined bandwidth, which can be as narrow as <5nm or as broad as >50nm. Available in various precision levels from colored glass to advanced hard-coated options.

**Shortpass Edge Filters** — wavelengths longer than the cut-off wavelength are reflected or absorbed, while shorter wavelengths are transmitted.

**Notch Filters** — blocks a pre-selected bandwidth while transmitting all other wavelengths within the design range. Used to remove a single laser wavelength or other narrow band of light.

**Dichroic Filters** — a specific wavelength range is transmitted while a different range is reflected. These designs can be longpass or shortpass and also allow for specific polarization control.

**Neutral Density (ND) Filters** — attenuates, or reduces transmission evenly, across a designed wavelength range. They either reflect or absorb light and are typically characterized by their optical density (OD).
TECHSPEC® Fluorescence Filters

- Excitation, Emission, and Dichroic Filters for Fluorescence Imaging
- Common Wavelengths for Popular Fluorophores
- High Transmission and OD 6 Blocking for Maximum Brightness and Contrast

TECHSPEC® Fluorescence Filters are designed to provide high transmission and sharp cutoffs for excitation and emission applications. They are made with SCHOTT® glass types for superior performance in fluorescence microscopy. These filters feature steep transmission and rejection slopes, making them ideal for high-performance imaging applications.

Microscope Filter Cubes

- Ensure Proper Alignment of Filter Sets
- Easily Adapt to Common Microscopes
- Available in Three Versions

Microscope Filter Cubes

- 40 SCHOTT Optical Filter Glass Types in Stock
- No Minimum Order Quantity for Both Standard and Custom Dimensions
- Build-to-Print Manufacturing and Full Custom Design
- Rapid Turnaround for Prototypes

CUSTOM COLOR GLASS FILTERS

- SCHOTT Optical Filter Glass Types Available for Customization

TECHSPEC® Hard Coated OD 4 Bandpass Filters

- Ideal for Life Sciences or Chemical Analysis
- Deep Blocking and High Transmission
- Steep Transmission and Rejection Slopes

TECHSPEC® Hard Coated OD 4 Bandpass Filters are narrowband filters used extensively in life sciences for applications such as fluorescence, bio-imaging, and chemical analysis. These single substrate filters feature hard coatings that maximize transmission and blocking, while preventing long-term performance degradation. Each filter features steep slopes with deep, extended blocking to achieve high performance in demanding applications. TECHSPEC® Hard Coated OD 4 Bandpass Filters are mounted in a black anodized aluminum ring and are available with 5nm, 10nm, 25nm, or 50nm wide half max and with center wavelengths from the UV to the IR.
Objectives: Top Brands in the Industry

Olympus Objectives

- Ideal For Brightfield, Darkfield, Fluorescence, Water Immersion, or Super Resolution Techniques
- Excellent Price-to-Performance Ratio
- Ideal for Biological and Industrial Applications

Mitutoyo Objectives

- Long Working Distances
- High Quality Plan Apochromat Design
- Excellent Brightness
- Flat Image Surface Over Entire Field of View

Zeiss Objectives

- Ideal For Brightfield, Darkfield, Fluorescence, Water Immersion, or Super Resolution Techniques
- Excellent Price-to-Performance Ratio
- Ideal for Biological and Industrial Applications

Nikon Objectives

- Excellent Color Reproduction
- Long Working Distance and High Numerical Aperture
- Strain Free
- M25 x 0.75 Mounting Thread

Designed to meet the most advanced imaging requirements, the CFI60 objectives represent the culmination of Nikon’s optical technology. Relying on a 60mm parfocal distance and a much larger barrel diameter allows these objectives to offer increased brightness and the highest possible combination of working distance and numerical aperture for light gathering ability. Designed to correct lateral and axial chromatic aberrations over the entire field of view, these objectives produce crisp, flat, and clear images with high contrast and high resolution.

Tube Lenses

- Variety of Options Covering Wavelengths as Low as 266nm and up to 1064nm

In order to create an image with an infinity corrected objective, a tube lens must be used to focus the image. One advantage to using an infinity corrected objective with a tube lens is that there can be a space between the objective and tube lens. The space allows additional optical components to be inserted into the system, such as optical filters or beamsplitters.

Zeiss Objectives

<table>
<thead>
<tr>
<th>Objective Type</th>
<th>Wavelength Range (nm)</th>
<th>Stock No.</th>
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</thead>
<tbody>
<tr>
<td>DC Epiplan</td>
<td>480 - 700</td>
<td>#13-522</td>
</tr>
<tr>
<td>A-Plan</td>
<td>480 - 700</td>
<td>#13-515</td>
</tr>
</tbody>
</table>
TECHSPEC® Spherical Singlet Lenses
• Vast Selection of Materials, Focal Lengths, Sizes, and coatings
• Used for Light Focusing or Collimation
• >50 Years of Manufacturing Experience
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TECHSPEC® Achromatic Doublet Lenses
• Minimize Chromatic and Spherical Aberrations using Multiple Lens Elements
• Wide Selection of Wavelength Ranges
• Standard Mounted Options Available
• Visit www.edmundoptics.com/achromats for Over 800 Achromatic Doublets

Molded Aspheric Lenses
• Small Diameter Lenses for Laser Collimation and Focusing
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• Lightweight Options for Weight-Sensitive Systems
• Visit www.edmundoptics.com/aspheres for Over 1,100 Aspheric Optics

TECHSPEC® Machined Aspheric Lenses
• Ideal for Applications Requiring the Highest Precision Performance
• RMS Asphere Figure Error Down to λ/40
• Laser Line Coated Options Available
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TECHSPEC® Laser Mirrors
• Vast Selection of Laser Line and Broadband Coatings
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• Superpolished Options with s1Å RMS Surface Roughness
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TECHSPEC® Infrared Windows
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• Many Anti-Reflective Coating Options
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• Visit www.edmundoptics.com/ir-windows for Over 700 Infrared Windows

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• Redirect Light at a Designated Angle
• Visit www.edmundoptics.com/prisms for Over 600 Prism Configurations

TECHSPEC® Beamsplitters
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• Coating Capabilities from 350 - 1620nm
• Split Input Light Into Multiple Beam Paths
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• LED, Quartz Halogen, Metal Halide, Tungsten, Deuterium, and Xenon Sources Available
• Variety of Wavelength Ranges

Optomechanics and Stages
• Mounts for Simple Positioning of Optical Components
• Cage and Tube Systems for Convenient Prototyping
• Manual and Motorized Translation Stages

Testing and Detection
• Variety of Detectors, Light Meters, and Laser Measurement Systems
• Spectrometers and Integrating Spheres
• Measurement Tools and Standards for Scratch Dig and Roughness

Lab Kits
• Starter Kits Available for Starting New Labs
• Optics, Optomechanics, Cleaning, Tools, and More
• Lab Essentials Kits Available for Refilling Lab Consumables

Your One Stop Shop for Over 50 Brands.
Edmund Optics® prides itself on understanding how customers implement imaging technology in their applications. This knowledge allows us to quickly deploy the right option from our off-the-shelf products or a custom designed solution to meet your specific requirements. Our global network of engineers evaluates each design with knowledge of manufacturing, tolerancing, and integration. In addition to a team of dedicated imaging solution support engineers, EO offers a select network of Vision Integration Partners who facilitate on-site integration of complete imaging systems. EO’s award-winning imaging lenses have been consistently recognized by leading industry publications such as Vision Systems Design and Inspect.

Explore our library of over 150,000 documents to ease integration into your application.

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- Coating Performance Curves
- 2-D and 3-D Models including STEP, IGES, and eDrawing
- Specsheets, Manuals, Start Up Guides, Software, & Drivers
- Code V Optical Prescription Data
- ISO 10110 Standard Drawing Format

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Advancing All Aspects of Life

The future of optics in Advanced Diagnostics is critical to the wellbeing of all living things. Major advancements in biomedical optics have led to life-saving technologies combatting COVID-19, as well as other critical techniques as wide-ranging as flow cytometry, cell sorting, microscopy, ophthalmology, and laser systems. At Edmund Optics®, we continuously research and investigate new materials, systems, technologies, and processes to improve those aspects with the hope that a new treatment or diagnostic technique can help the population faster, cheaper, and less invasively than ever before.

Learn more about ADVANCED DIAGNOSTICS, visit www.edmundoptics.com/advanced-diagnostics