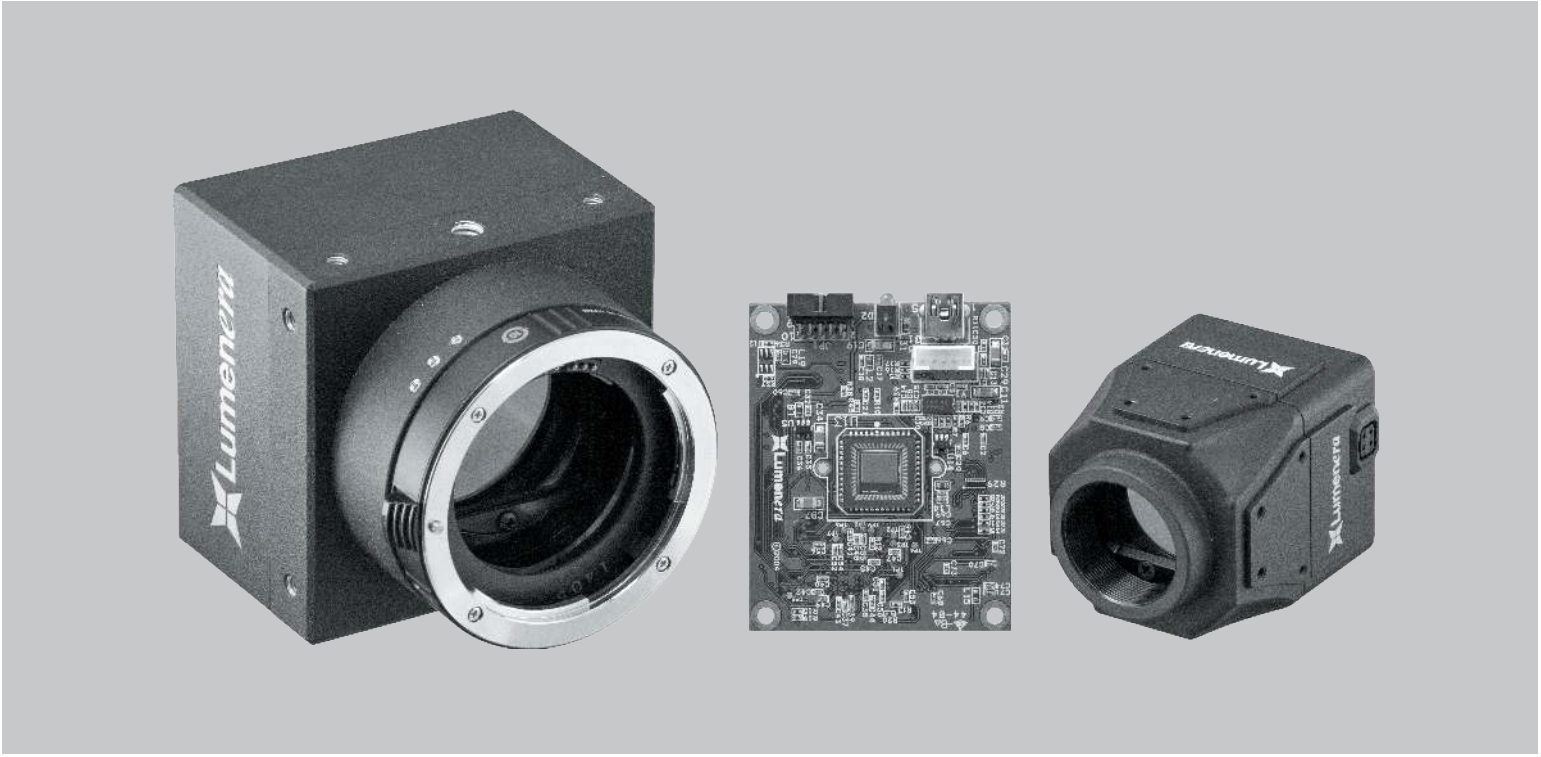
ORDERING OPTIONS: WHAT DOES YOUR CAMERA NEED?

Optimizing different ordering options to improve camera performance



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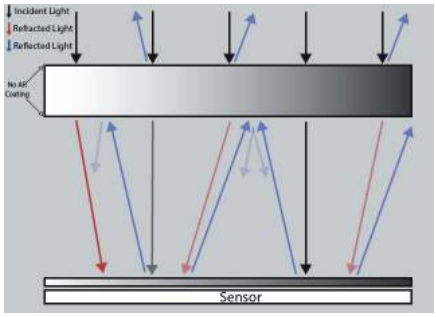

WHAT'S INSIDE

INTRODUCTION

Deciding which camera is best for an application involves looking at many factors. As part of that evaluation process, there are a number of standard camera ordering options that can be selected to improve the performance of the camera depending on the application. This paper will cover the following Teledyne Lumenera camera ordering options: Without Glass (–WOG), Without Cover Glass (–WOCG), Scientific Glass (–SCI), With Infrared Filter (–WIR), Without Infrared Filter (–WOIR), and Confocal Coating (–CC) camera options. In addition, the paper will highlight unique benefits for certain applications and provide examples.

CAMERA ORDERING OPTIONS

–WOG (WITHOUT GLASS)

The glass removed in the –WOG ordering option refers to the protective glass ("optical window") that separates the sensor from any lens (or any direct light in the case of no additional optics). For cameras where the optical window is coated, there will be an IR / AR (infrared / anti-reflective) or an AR / AR variant. The IR filter layer is used to remove the higher wavelengths and better focus on the visible spectrum. The AR coating is used to reduce the reflection loss caused when light makes contact with the glass. Removing the optical window allows for a direct optical path to the sensor protected by a thin cover glass. This can improve high precision applications, such as beam profiling, due to less optical interference from the optical window which can cause multiple reflections and slightly improves the amount of photons converted to photocurrent, referred to as quantum efficiency (QE).

Multiple reflections are caused by light making contact with a material. Once light passes through a surface it will be refracted at an angle specific to the refractive index of the material, as seen in Figure 1.1. In this case, the front / rear surface of the optical window and the cover glass will cause a portion of the incident light to be reflected (approximately 4% at each surface when uncoated), but this is mitigated with an AR coating. Contaminants such as dust on the glass surface will cause additional scattering of the light which deviate from the direction expected of the material. When passing through the rear surface the refracted light will have some additional reflection loss.

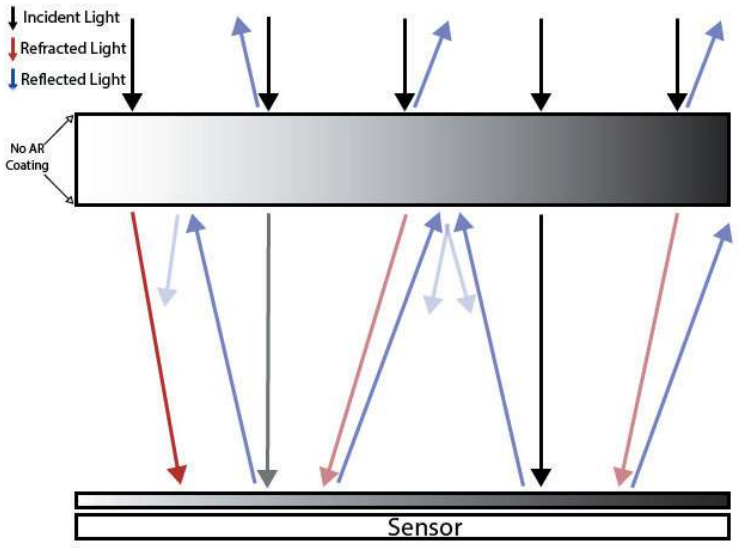

Figure 1.1: Multiple reflections of light as it passes through the optical window

When the optical window is removed, as it is in Figure 1.2, the quantum efficiency will slightly increase when the glass is removed, allowing the sensor to be more sensitive. Another benefit to the –WOG option is that any coatings on the optical window which could have restricted the available spectrum are also removed. It should be noted that due to the removal of the glass the back focal distance will be slightly affected which will affect focusing. There is also the added risk of not having protection over the sensor when the glass is removed, so dust buildup and physical damage to the cover glass needs to be considered.

Figure 1.2: Teledyne Lumenera board level camera without the optical window (– WOG)

–WOCG (WITHOUT COVER GLASS)

When choosing the –WOCG option, cameras will arrive without an optical window (similar to the –WOG option). However, the thin cover glass layer that is normally installed on every sensor will also be removed, slightly improving the QE. This can be significant for laser beam applications where reflections are a problem. When choosing a camera with the –WOCG option, it is crucial to take into consideration the environment that the camera will be operating in. This is because dust and other particles can accumulate and affect the sensor.

Removing the cover glass can be necessary for beam profiling applications. The problem with cover glass or the optical window in this application is that it creates the opportunity for light to reflect multiple times as it approaches the sensor. When light comes into contact with the surface of the cover glass some of the light will be reflected in multiple directions, as seen in Figure 2.1. In the case of the optical window and the cover glass there are multiple reflections happening at both points in the camera. By removing any glass from the camera (Figure 1.1 and 2.1), the sensor has a clear optical path for incoming light.

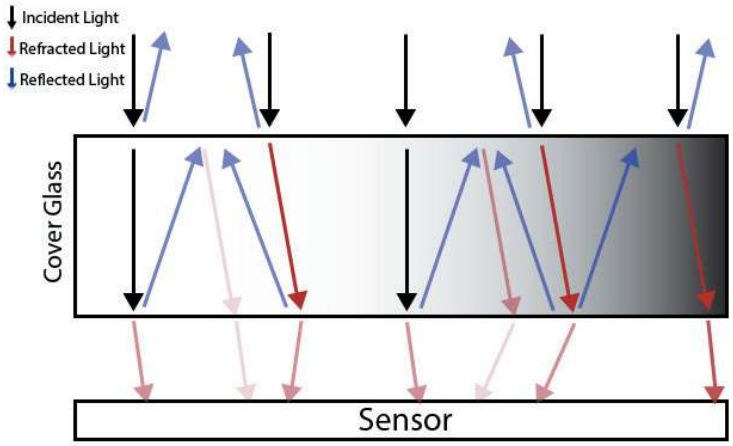

Figure 2.1: Light interacting with front and rear surfaces of the sensor's cover glass

Ultra Violet (UV) applications are significantly impacted by cover glass. This is because for most glass material there will be a higher absorption rate for UV light. Residual impurities such as heavy metals are responsible for the reduced transmission in glass from inorganic elements such as titanium (www.schott.com).

Cover glass generally comes with microlenses that are small lenses that fit over the pixels of a sensor. For most applications these microlenses assist in focusing the image, but the thickness of the glass is proportional to the absorption of light, and this absorption is even higher for UV. When choosing the –WOCG option for a camera, UV light sources will be unaffected by any glass that would normally be inside the enclosure, resulting in a better quality image.

Removing all glass layers protecting the sensor will result in direct contact by light and particles such as dust. Precautions should be taken to better to prevent damaging the sensitive surface of the sensor.

–SCI (Scientific Glass)

The –SCI camera option offers an even higher surface quality than glass found in Teledyne Lumenera's industrial cameras. For applications that use a collimated light source, such as microscopy, having any impurities in the glass can ruin an image. By purchasing a camera with –SCI Teledyne Lumenera guarantees that the glass used within the camera is 100% pristine. This guarantee is covered under warranty which means Teledyne Lumenera will ensure the camera glass is without issues such as internal dust build up, physical problems, or any other.

Applications that use a collimated light source will be more sensitive to surface quality issues on the optical window / cover glass. Typically, applications that use a microscope, such as blood sample imaging, will find that adding –SCI to an order will improve image, quality. This option comes standard for Teledyne Lumenera's INFINITY microscope cameras. However, –SCI is also available for many of the Teledyne Lumenera's cameras such as the Teledyne Lumenera LtX45R camera series.

–WIR (With IR Filter)

Adding an IR filter to the optical window is standard for color cameras, but can be applied to monochrome (mono) cameras as well. Figure 3.1 highlights a Teledyne Lumenera Lt29056H color camera featuring an IR filter with its reflective red surface inside the enclosure. The mono cameras come with a broad band AR coating on both sides that aids in reducing reflection, but if –WIR is selected for a mono camera, the camera will allow the visible spectrum to reach the sensor while blocking near-infrared (NIR) light.

Figure 3.1: –WIR option on the optical window of a Teledyne Lumenera Lt29056H camera

Therefore, the –WIR ordering option can help in applications where increased resolution is required. Since NIR, which focuses at a different point than visible light, is blocked the result is a high fidelity image. When choosing a camera, specifications can vary and should be reviewed to confirm whether a camera comes with any coating on the optical window.

–WOIR (Without IR Filter)

Color cameras are normally produced with an IR coating on the optical window within the mounting fixture. The rear side of the glass is coated with an AR coating to reduce reflections. The IR coating can be removed which results in the glass being AR coated on both sides. This is an option for color cameras because the mono cameras will normally be –WOIR already.

Cameras needed for nighttime surveillance or monitoring are good candidates for the –WOIR ordering option. Without the IR coating, as seen in Figure 4.1, the camera has greater visibility in low light conditions. This is useful in applications such as Intelligent Traffic Systems (e.g. licence plate recognition) so the camera can accept a broader spectrum of light or even recognize subjects illuminated by NIR light sources. For customers that want to control their own filter strategy with motorized / electronic IR filters or with dual / triple bandpass filters, the –WOIR option will also be useful for various specialized applications.

Figure 4.1: –WOIR option on the optical window of a Teledyne Lumenera Lt665R color camera

IR filters are important for outdoor applications, but for indoors the use of artificial lighting means IR does not pose the same issues. Incandescent and fluorescent bulbs have a board spectrum, but LED lighting systems typically have a narrower band and are becoming more common (with the exception of more specialised broadband LEDs). A typical comparison of the spectra for indoor lighting systems can be seen in Figure 4.2. A red LED is used to demonstrate how small the range of wavelengths used by a common LED source would be. The application and environment need to be considered because in outdoor applications all wavelengths are present, but indoor environments can have minimal impact on various photosensitive applications due to the isolated spectrum found in LEDs.

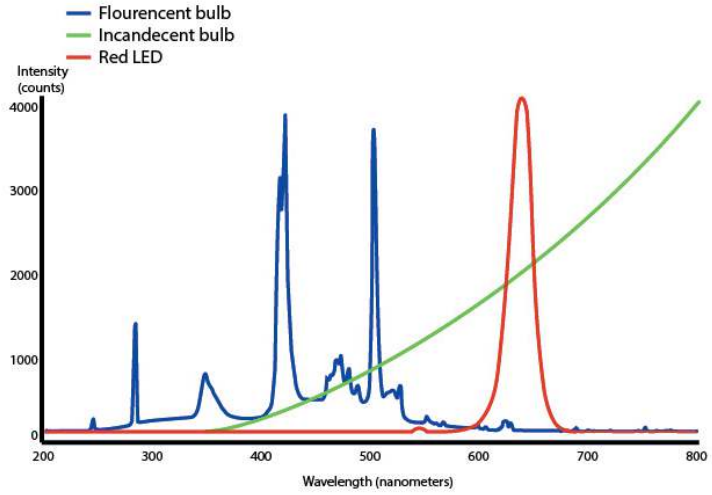

Figure 4.2: Spectra of a fluorescent bulb, incandescent bulb, and red LED.

–CC (CONFORMAL COATING)

A polymer coating can be applied to the electrical circuit board of Teledyne Lumenera cameras. This coating acts as a protective layer which shields the components within the camera from moisture build up due to condensation.

The conformal coating seen in Figure 5 does not ensure a waterproof device as it is not designed to stop water from entering the camera. Instead, it should be considered for applications where water damage can be caused by condensation. For example, if a camera is on an aircraft that changes altitudes, the atmospheric conditions will affect the moisture levels within a camera that is not hermetically sealed.

Adding the conformal coating option ensures a camera is better protected from water that can short circuit the camera. Additionally, there is a reduced chance of corrosion that can cause internal failure.

Figure 5.1: Conformal coating versus no conformal coating

Conclusion

When selecting the right camera for an imaging application, there are many ordering options that can ensure the camera provides the needed image results. Teledyne Lumenera industrial and scientific cameras can also be further adapted to fit very specific application needs – from small-scale modifications to made-to-spec solutions. In addition, Teledyne Lumenera provides a free 30-day camera evaluation program with pre- and post-sales engineering support to ensure a smooth integration with new imaging systems. Teledyne Lumenera's imaging experts are always ready to help better understand what options can provide the most value for an application. And, Teledyne Lumenera cameras are backed by a 4-year warranty.