Deposition Sciences, Inc.
Quality Coating Solutions

Specifying Optical Filters for Sensor Applications

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There are many subtleties that should be addressed in order to properly specify optical filters for a given application. In sensor applications, these subtleties are especially crucial in designing the best possible filter for each sensing task. For purposes of this discussion, we'll begin with bandpass filters. The critical parameters for bandpass filters are in-band transmission, band edge placement, and out-of-band blocking.

In-band transmission

When considering in-band transmission, you first must determine whether you are interested in absolute transmission or average transmission. An absolute transmission specification will define the minimum acceptable transmission at any point in the waveband of interest. An average transmission requirement will allow lower transmission at individual wavelengths as long as the integrated value over the waveband of interest meets the requirement. In both cases, if variation within the waveband is critical, a ripple requirement will also be needed.

When specifying in-band transmission, the band edges must be defined. Full-Width-Half-Maximum is a common definition, indicating that in-band transmission is evaluated from the 50% points of the passband. However, these points must be further defined as either absolute 50% or relative to the peak transmission. 80% points are also a common band edge definition.

Edge filter tolerances and slope

In addition to in-band transmission, there are concerns about the tolerances for the edge band placement. For example, if you stipulate that an edge placement must be specified within five or 10 nanometers, what effect does that have on the in-band transmission?

Slope, or the *steepness* of the edge filter, is another consideration. If you need a very steep filter, then it's important to specify a very small slope. Slope is typically defined either as an absolute value between a low transmission point and a high transmission point (i.e. a 5 nm transition between 5% and 80%) or as a percentage ([$WvLn_{(80\%)}$ –

WvLn$_{(5\%)}$]/WvLn$_{(80\%)}$). Again, any time a transmission value is used, you must clarify if it is absolute or relative to the filter peak transmission. Furthermore, there is the transition between the edge of the filter and the out-of-band blocking to be considered. Typical slope definitions use the 5% point as the lower bound. If you are concerned about the transition from this lower bound to the out of band blocking region, you may need to specify the filter performance in this transition region through a parametric equation. Discuss this with your filter supplier early in the requirements definition discussion.

Out-of-band transmission

Out-of-band transmission (OOB) is the amount of blocking that occurs outside of the pass band. As with in-band transmission requirements, out-of-band transmission can be defined either in terms of an average value over a wavelength range or an absolute maximum over that range. Out-of-band transmission blocking must consider the sensitivity of the detector as well. There's no need to provide extra blocking past the sensitivity of the detector (see Fig. 1, Chart).

If you have very stringent out-of-band transmission requirements, you may need to specify to the vendor how those measurements are made; for instance, at a very high resolution or a very narrow slit width on the spectrophotometer or via single wavelength characterization using lasers. Again, these are aspects that can be addressed by your vendor or the optical designer, prior to quoting the job.

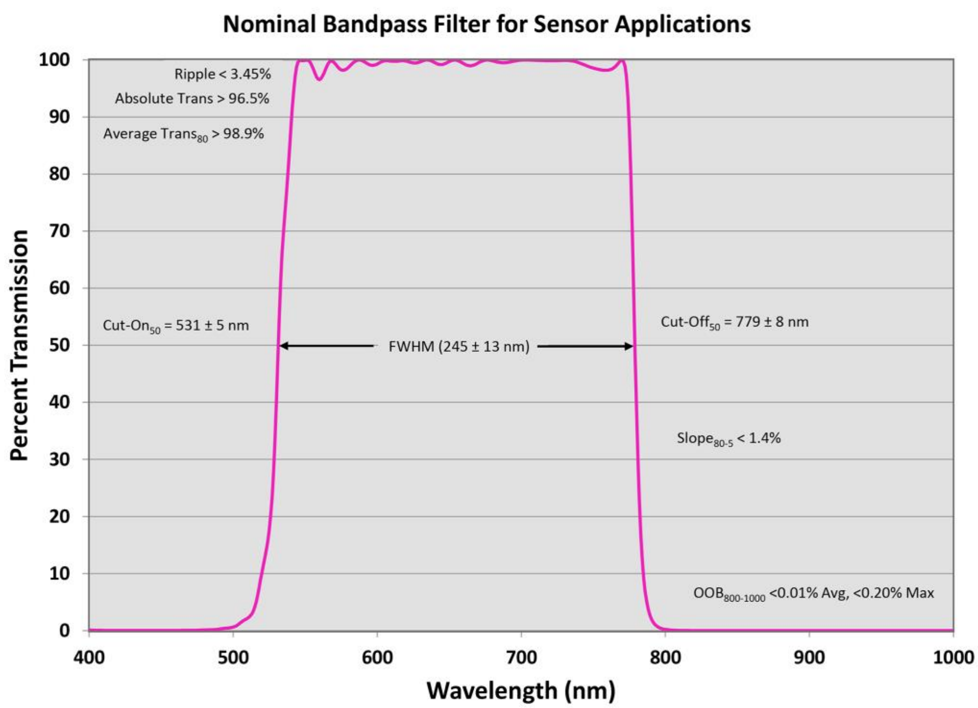

Fig. 1 - Chart showing nominal bandpass filter specifications for sensor applications.

Spectral compensation

Another consideration may be spectral compensation. When designing the filter, it is possible to compensate for the sensor response curve (such as photopic response) or the light source (such as solar-weighting). Simply inform the filter designer of your desire to compensate for these features and it may be done in the filter design as an alternative to compensating for it electronically in the system design later on.

Bandpass filters, and beyond

The guidelines that we've reviewed for bandpass filters apply equally well to antireflective coatings, edge filters, high reflectors, beam splitters, and other optical devices (see Fig. 2). The most important consideration is to involve the filter designer early in your process so that everybody can understand the requirements and trade-offs to design the best possible system, from the filter level through the component, for your system.

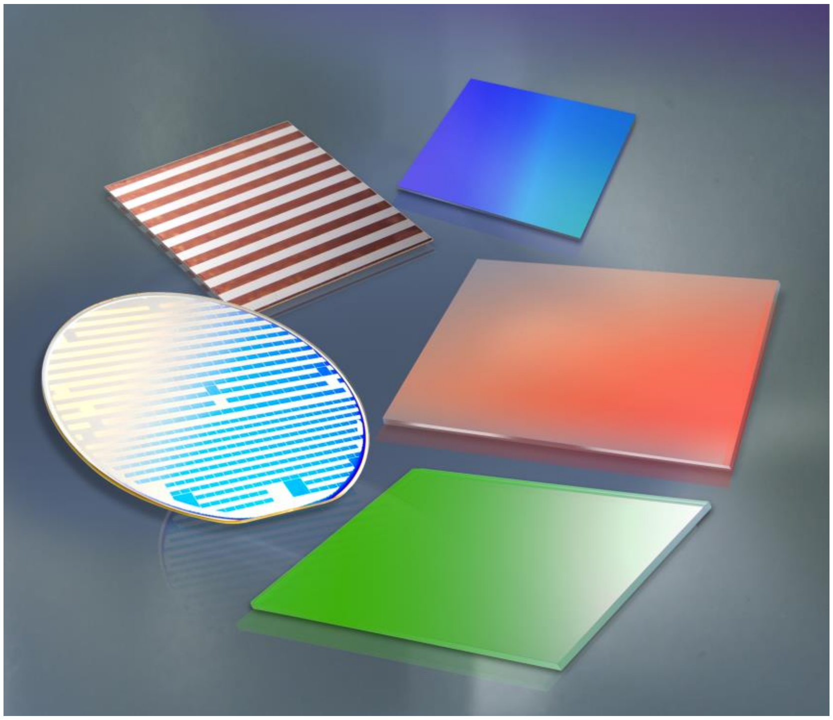

Figure 2 *- Colored and patterned optics from Deposition Sciences, Inc.*