Overview IR Filters NOC

Northumbria Optical Coatings Ltd was established in 1995, specialising in design and manufacture of infrared optical filters and coatings. The filters have many applications including environmental monitoring, analysis and control of gaseous effluent, analysis of vehicle exhaust gases, ozone layer monitoring, night vision systems and space applications.

Northumbria offers the following IR filters:

Neutral Density filters:	~1.0 to 14 µm
Narrow Band Pass filters:	~1.8 to 20 µm
Band Pass filters:	~1.8 to 20 µm
Wide Band Pass filters:	~1.5 to 20 µm
Long Wave Pass filters:	~1.3 to 20 µm
Short Wave Pass filters:	~1.8 to 20 µm
Anti-reflection coatings:	~0.9 to 20 µm

Other products include: Gas Band filters, Order Sorting Filters, Semi-conductor blocking filters, Mirrors, High Efficiency coatings & Substrates.

They can manufacture filters from 2 x 2 mm square, up to 76.2 mm ∅.

The most common sizes are 25.4 mm ∅, 23 mm ∅, 10 mm ∅, 3 x 3 mm and 5 x 5 mm.

04/17 / V03 / IF / noc/ir-filters

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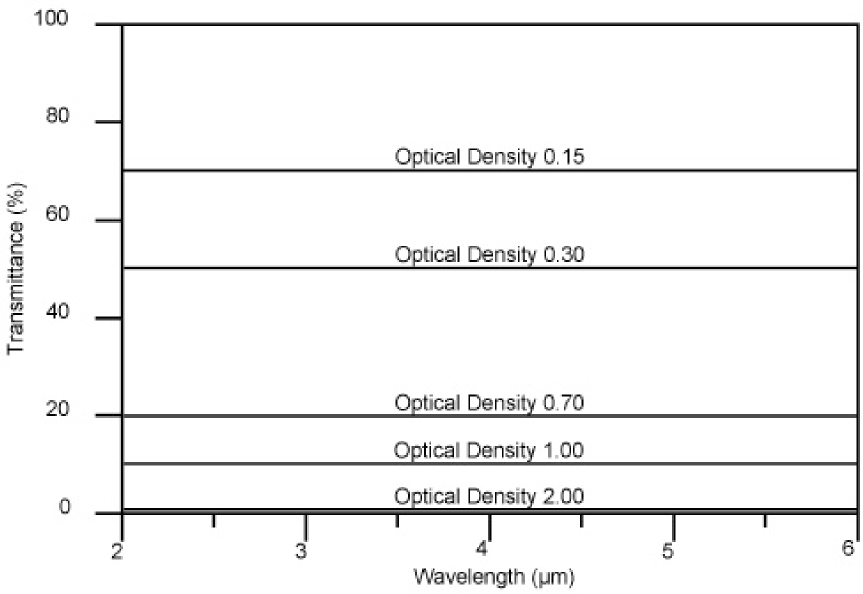
Neutral Density

The majority of neutral density filters offered are manufactured with a metallic coating which attenuates incident light by both reflection and absorption. Depending upon the spectral range of interest, these filters are manufactured on substrates of quartz, sapphire, germanium or silicon. Neutral density filters are categorised by their optical density (D) which is defined as the logarithm to the base 10 of the reciprocal of the transmitted radiant power (T)

$$D = \log_{10} \frac{1}{T} \quad \text{or} \quad T = 10^{-D}$$

Optical densities can be added so several filters can be placed in series to obtain a specific value (e.g. D1 + D2 + D3….). However, care must be taken when aligning the filters to avoid the effects of multiple reflections, from parallel surfaces, which could result in a higher transmitted energy than expected. In general, neutral density filters are manufactured on a custom basis with optical densities from 0.1 to 2.0 (79 to 1%).

Typical Performance



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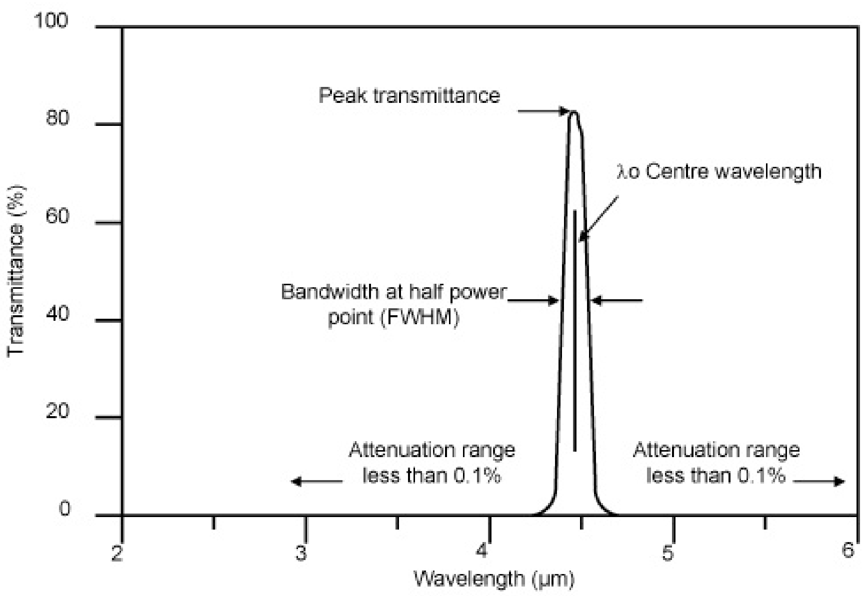
Narrow Bandpass

Narrow bandpass filters are designed to isolate a narrow region of the infra-red spectrum. This is accomplished using a complex process of constructive and destructive interference. Narrow band pass filters have bandwidths (measured at half-peak transmittance levels) less than 6% of the centre of wavelength value.

When ordering, the bandwidth can be expressed as a percentage of the centre wavelength, or can be given in microns. The filters exhibit high peak transmission (typically greater than 60%) combined with high attenuation levels outside the passband (typically less than 0.1%).

Typical Performance



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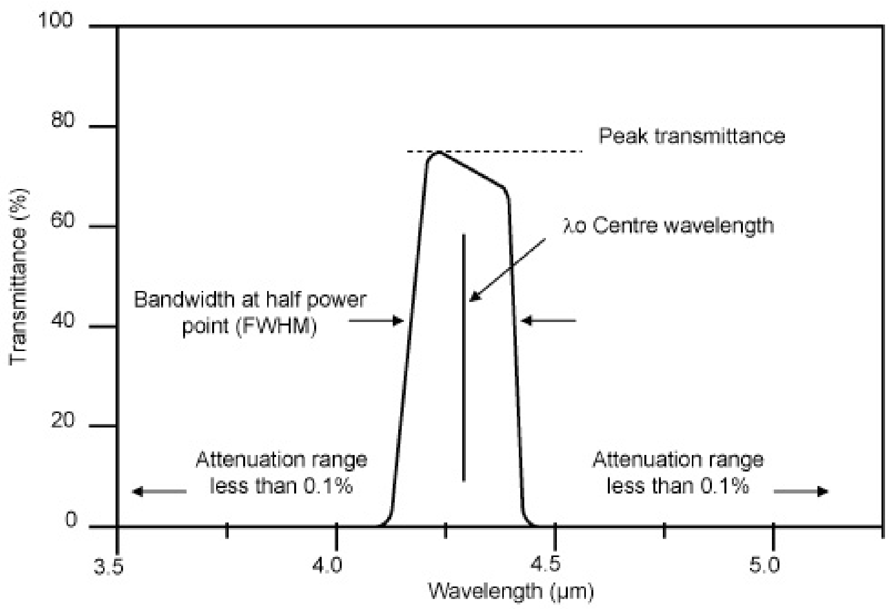
Bandpass

Bandpass filters are designed to isolate a relatively wide spectral band. They are classified by having bandwidths (measured at half-peak transmittance levels) between 6% and 13% of the centre wavelength value. When ordering, the bandwidth can be expressed as a percentage of the centre wavelength or can be given in microns. The filters exhibit high peak transmission in the passband (typically greater than 70%) and very low transmission levels outside the passband (typically less than 0.1%).

Typical Performance



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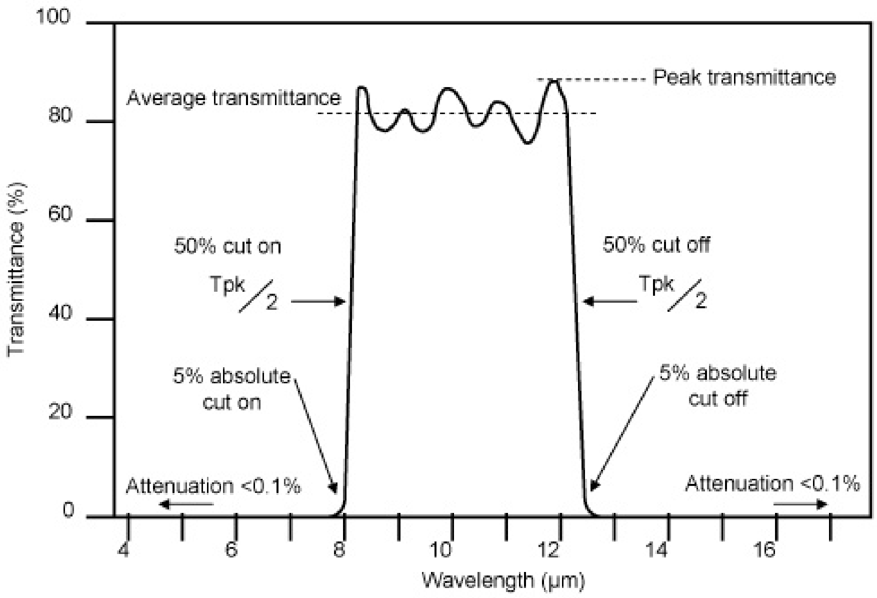
Wide Bandpass

Wide bandpass filters are designed to isolate a very wide spectral band. They are classified by having bandwidths (measured at half peak transmittance levels) greater than 13%. When ordering, it is necessary to specify the 5% cut on/cut off transmission points or the 50% cut on/cut off transmission points (the 5% points are measured as absolute values but the 50% points are measured as 50% of peak transmittance). The filters exhibit high average transmission in the passband (typically greater than 70%) and very low transmission levels outside the passband (typically less than 0.1 %). This type of filter is particularly useful for isolating the 3 – 5 µm or 8 – 12 µm atmospheric windows and finds widespread use in thermal imaging/human body sensor applications.

Typical Performance



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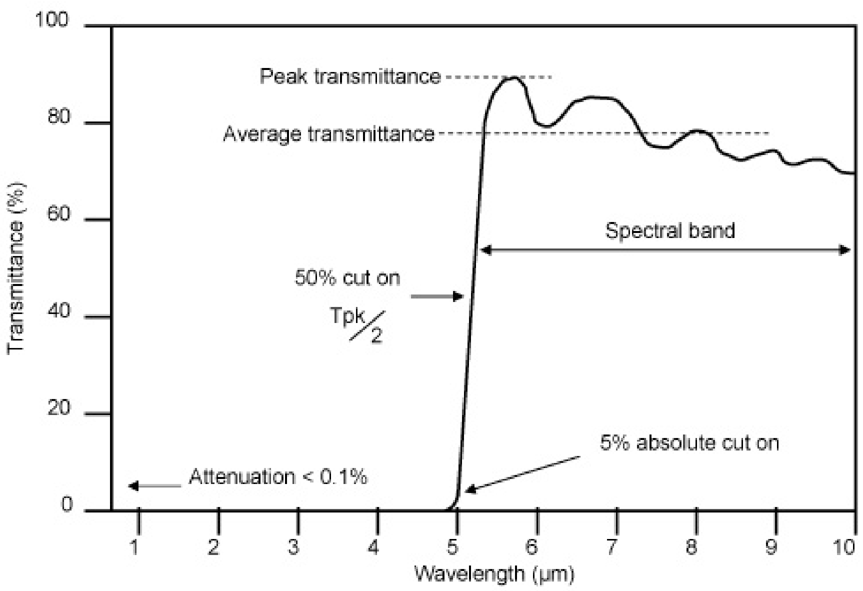
Long Wave Pass

Long Wave Pass filters (also referred to as edge filters) are constructed from stacks of thin layers. They are distinguished by a sharp transition from a zone of rejection to a zone of transmission. The rejection region extends to below 0.3 µm and the transmission region typically extends to greater than twice the wavelength of the edge position. When ordering it is necessary to specify the required 5% or 50% cut on edge position (the 5% point is measured as an absolute value but the 50% point is measured as 50% of peak transmittance).

Typical Performance



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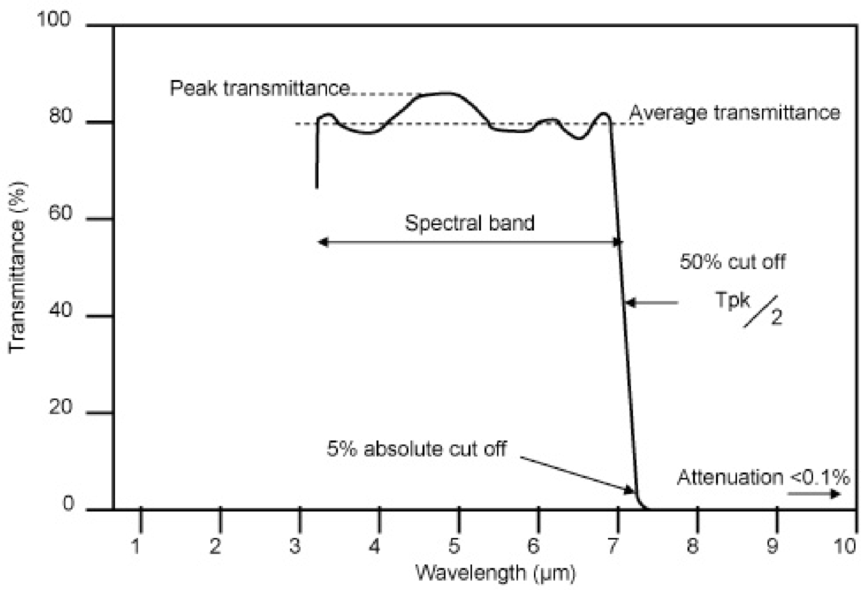
Short Wave Pass

Short wave pass filters are distinguished by a sharp transition from a zone of transmission to a zone of rejection. The rejection region typically extends to the far infrared but can be limited for filters with edge positions below 2 µm. When ordering it is necessary to specify the 5% or 50% cut off edge position (the 5% point is measured as an absolute value but the 50% point is measured as 50% of peak transmittance).

Typical Performance



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Anti-Reflection

Capabilities in anti-reflection coatings range from single layers to advanced high efficiency multi-layer coatings. These coatings can be applied to windows, lenses or customer supplied substrates. For special applications, the coatings can be designed for operation at angles of incidence other than normal, or optimised for particular wavelength regions. High efficiency multi-layer broadband coatings find widespread use in the 3 – 5 micron or 8 – 12 micron regions (the "atmospheric windows").

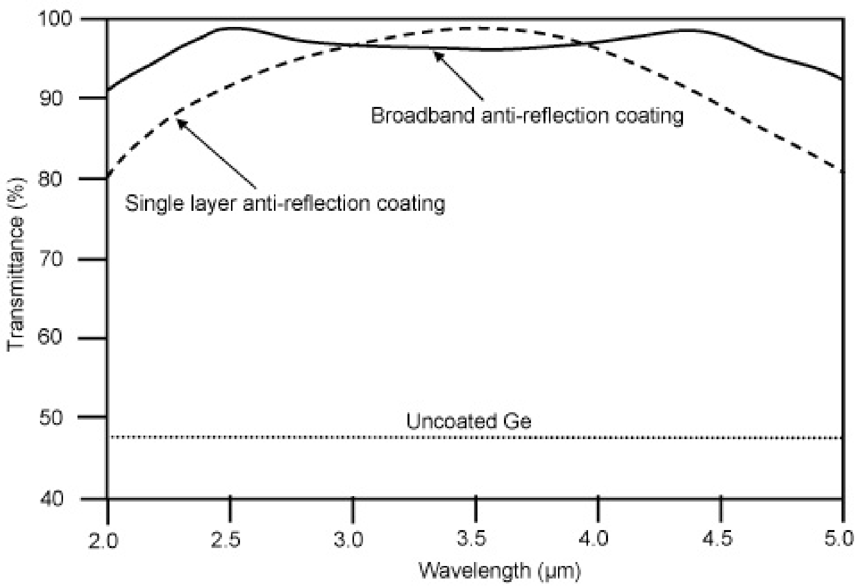
High Efficiency Multi-layer Broadband Coatings

Typical Wavelength ranges	3 – 5, 5 – 8 and 8 – 12 micron
Typical average transmission	> 95%
Substrate material	Germanium

Single Layer Coatings

Wavelengths available	0.9 to 20 micron
Typical peak transmittance	> 95%
Substrate materials	germanium, silicon, sapphire, zinc selenide, gallium arsenide

Typical Performance



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Semiconductor Filters

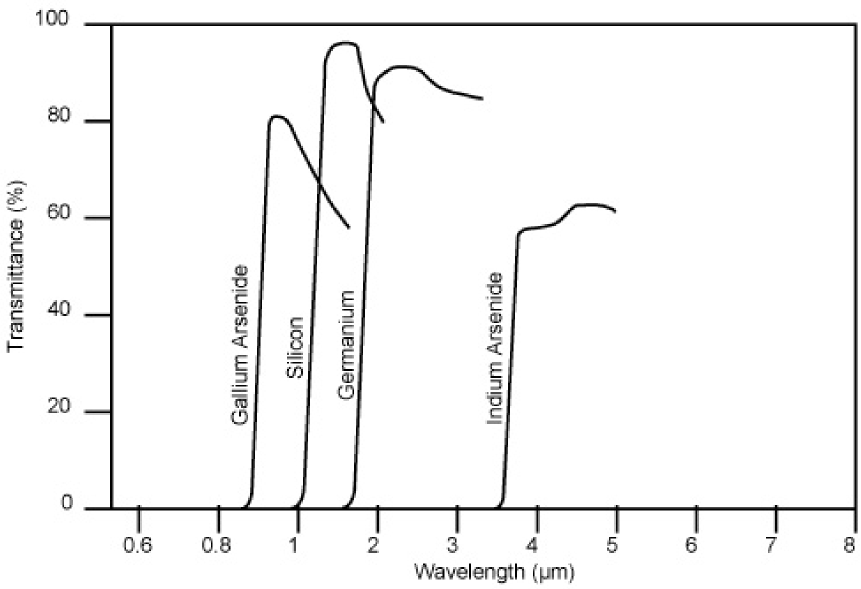
Semiconductor filters are, strictly, not thin film filters, but absorption filters, relying on the electronic band of their structure.

In an intrinsic semiconductor, the conduction band is empty and the valence band is completely full. Only a small gap separates the two bands. If an incident photon has energy greater than this gap it is able to lift an electron out of the valence band into the conduction band and, is in this way absorbed. If it has an energy less than the gap however, because the allowed levels in the valence band are completely filled, the electrons are unable to absorb it and the photon will be transmitted. This abrupt change from absorption to transmission, occurring at the wavelength corresponding to the energy gap, is known as the intrinsic edge.

To use a semiconductor as an optical filter, two problems must be solved. Firstly, there is always some residual free carrier absorption in the pass region, and secondly, the high refractive index of semiconductors makes reflection loss at the surface rather large. The first difficulty is overcome by using a thin slice of very pure material, the second by depositing an anti-reflection coating on the surface.

Semiconductor filters have long wave pass characteristics and consist of coated, optically polished discs of semiconductor, often mounted in holders for protection. Because of their very high absorption in the stop region, they are particularly useful in IR grating monochromators for the elimination of higher order spectra, which are especially troublesome when high temperature sources are used.

Typical Performance



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