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NORTHUMBRIA OPTICAL COATINGS

COMPANY HISTORY

Northumbria Optical Coatings Limited (NOC Ltd) was incorporated in December 1994 through a Management 'Buy-Out' of the Optical Filters Department within Rolls Royce plc, International Research & Development (IRD) in Newcastle upon Tyne.

Rolls Royce decided to withdraw from specific business areas to concentrate on core business. The four employees in the Optical Filters Department were offered the opportunity to purchase plant, equipment, furniture and a healthy order book, and continue independently of Rolls Royce. In July 1995, all equipment, materials, stock and existing orders were transferred to a new 2,000sqft factory in Jarrow, Tyne & Wear, and NOC Ltd began trading on 12th July 1995.

The history of the business dates back to 1962 when the Thin Film Division was established within Sir Howard Grubb Parsons & Company Ltd, part of C.A. Parsons & Co. Ltd in Newcastle upon Tyne. The Division continued through changes of ownership to IRD (part of Northern Engineering Industries group (NEI)) and finally Rolls Royce, before NOC Ltd was formed in 1995.

In March 2003, NOC Ltd relocated to new premises on the modern, hi-tech Boldon Business Park, Boldon, Tyne and Wear. The 5,000sqft unit was fitted with bespoke offices, inspection areas and production hall.

In November 2011, NOC successfully completed the acquisition of Trade & Assets of FK Optical Ltd, a competitor which offered a similar product range to NOC.

Growth has continued: prior to the acquisition of FK Optical in November 2011, NOC had seen a 25% growth in sales based on its previous 12 months. This growth has allowed NOC to expand, and it now employs 18 personnel.

As part of our continuous improvement plan and vision for the future, NOC was accredited with ISO 9001 quality management system in 2006 and is regularly audited to retain the accreditation.

The company launched a new website in 2006, and this was further upgraded to an e-commerce website in 2011. The e-commerce website is a valuable addition to the NOC portfolio which has further boosted sales and our customers have given generous feedback.

The company still has ambitious plans. In 2008, NOC made a considerable investment for new Production and Inspection equipment to improve manufacturing and testing capabilities. Following the acquisition of FK Optical, we are continuing to invest in R&D and enhanced equipment to drive further growth.

CURRENT OPTICAL FILTER RANGE

Infrared Narrow Band Pass filters

- Narrow Band Pass (NB) filters generally have a bandwidth of less than 6% of CWL
- Main wavelength range: 2.50µm to 15.00µm
- Standard substrates used for this range: Quartz, Sapphire and Germanium
- Standard filter bandwidths are 1.1%, 2%, 3% and 4.3% of CWL
- With standard tolerances applied, our standard filter designs give respective bandwidth ranges of 0.9 –1.3%, 1.6 – 2.4%, 2.5 – 3.5% and 3.8 – 4.8%
- We can achieve other bandwidths between ~0.5% and 6% of CWL.

A basic specification for a narrow band filter would be:-
CWL: 5.000µm ±0.75%
BW: 0.215µm ±0.025µm (~3.80 – 4.80%)
T (pk): ≥70%
Blocking: Fully blocked out of band with T(av) <0.1% and T(pk) ≤0.3%
Substrate: Sapphire

Infrared Band Pass filters

- Band Pass (BP) filters generally have a bandwidth between 6% and 14% of CWL
- Main wavelength range: 2.50µm to 15.00µm
- Standard substrates used for this range: Quartz, Sapphire and Germanium
- Standard filter bandwidths are 8%, 9%, and 11%
- With standard tolerances applied, our standard filter designs give respective bandwidth ranges of 7-9%, 8-10% and 10-12%
- We can achieve other bandwidths between ~6% and 14% of CWL.

A basic specification for this type of filter would be:-
CWL: 9.000µm ±1.50%
BW: 0.990µm ±0.120µm (~9.67 – 12.33%)
T(pk): ≥75%
Blocking: Fully blocked out of band to ≥14.0µm with T(av) <0.1% and T(pk) ≤0.3%
Substrate: Germanium

Infrared Wide Band Pass filters

- Wide Band Pass (WBP) filters have a bandwidth between 14% and 70% of CWL
- Main wavelength range: 1.50µm to 16.00µm
- Standard substrates used for this range: Quartz, Sapphire and Germanium
- There are no standard designs for this filter type. The widest bandwidth that can be achieved is ~70% of CWL, though this does depend on the set of materials to be used.
- These filters are normally constructed using a combination of Long Wave Pass (LWP) and Short Wave Pass (SWP) edge filters
- The filters are generally described using cut on and cut off edges rather than CWL
    - T 50% cut on and cut off points are most commonly specified
    - T 5% (absolute) points can also be specified
    - Standard edge tolerances are ±4% and ±3%; lower tolerances are achievable.

A basic specification for this type of filter would be:-
CWL: 2.100µm
BW: 0.600 (~28.57%)
T 50% Cut On 1.800µm ±4%
T 50% Cut Off 2.400µm ±4%
T(av): ≥65%
Blocking: Fully blocked out of band to ≥3.50µm with T(av) <0.1% and T(pk) ≤0.3%
Substrate: Fused Quartz

Infrared Long Wave Pass filters

- Long Wave Pass (LWP) filters have a sharp transition from a zone of rejection to a zone of transmission
- Main wavelength range: 1.30μm to 18μm
- Germanium is the standard substrate for wavelengths ≥1.9μm as it transmits to >16μm
    - Quartz and Sapphire can be used if transmission is not needed > ~4μm and ~6μm
- LWP filters are generally described using cut on edge wavelength:
    - T 5%(absolute) cut on point is most commonly specified
    - T 50% cut on point can also be specified
    - Standard edge tolerances are ±4% and ±3%; lower tolerances are achievable.

A basic specification for this type of filter would be:-
T 5% Cut On: 7.000μm ±4%
Cut On Slope: <5%
T(pk): ≥75%
T(av): ≥65% between 8.0μm and 14.0μm
Blocking: Fully blocked lowers with T(av) <0.1% and T(pk) ≤0.3%
Substrate: Germanium

Infrared Short Wave Pass filters

- Short Wave Pass (SWP) filters have a sharp transition from a zone of transmission to a zone of rejection
- Main wavelength range: 1.80μm to 20μm
- Standard substrates used for this range: Quartz, Sapphire and Germanium
- SWP filters are generally described using cut off edges
    - The T 5%(absolute) cut off point is most commonly used
    - T 50% cut off points can also be specified
    - Standard edge tolerances are ±4% and ±3%; lower tolerances are achievable.

A basic specification for this type of filter would be:-
T 5% Cut Off: 3.500μm ±4%
Cut Off Slope: <5%
T(pk): ≥75%
T(av): ≥65% down to <2.0μm
Blocking: Fully blocked uppers with T(av) <0.1% and T(pk) ≤0.3%
Substrate: Fused Quartz

Anti-reflection coatings

- Anti-reflection coatings range from single layers to high efficiency multi-layer coatings
- These can be applied to filters, lenses or customer supplied substrates
- Coatings can be optimised for a particular wavelength region or angle of incidence

High Efficiency Multi-layer Broadband Coatings

- These find widespread use in the windows at 3 – 5μm, 5 – 8μm and 8 – 12μm
- Typical average transmission: >95%
- Standard substrates: Germanium

Single Layer Coatings

- Wavelength range: 0.9 to 20μm
- Typical average transmission: >95%
- Standard substrates: Germanium, Silicon, Sapphire, Zinc selenide, Gallium arsenide

Neutral Density Filters

- These filters are manufactured with a metallic coating which attenuates incident light by both reflection and absorption
- ND filters are categorised by optical density (D), the logarithm (Base 10) of the reciprocal of transmitted radiant power (T).

$$D = \log_{10}(1/T)$$

- Optical densities can be added by placing filters in series - a specific D value (D1 + D2 + D3 +…) can be obtained.
- Manufacturing range: Optical densities from 0.1 to 2.0 (equivalent to T 79% to 1%)
- Substrates: Germanium, Silicon, Sapphire, Quartz (depending on spectral range needed)

FILTER TYPES NOT IN OUR CURRENT RANGE

- Notch Filters
- Dual Narrow Band Filters

FILTER SIZES

- Standard substrate sizes for Quartz, Sapphire, Germanium and Silicon are:
    - 25.4mm diameter, both 1mm and 0.5mm thickness
    - 25mm diameter, 1mm thickness
    - 23mm diameter, 1mm thickness
    - 10mm diameter, 1mm thickness
- Non-standard substrate sizes are also used, for example:
    - 76.2mm diameter, 1mm thickness
    - 50.8mm diameter, 1mm thickness
    - 12.7mm diameter, 1mm thickness
- We have tooling available to coat a wide variety of additional substrate sizes
- Standard substrates are readily available, but sourcing leadtimes may be longer for non-standard substrates.
- Larger circular substrates, such as 25.4, 50.8 & 76.2mmØ can be cut into smaller sizes, usually squares.
- Common cut sizes are:
    - 3mm x 3mm
    - 4.2mm x 4.2mm
    - 5mm x 5mm
- We can have filters cut to a range of additional sizes.
- Cutting is not without risk, which is in part a function of filter structure and substrate.

TOLERANCES

- Our standard filter constructs are associated with tolerance ranges around nominal bandwidths, as shown in the table below.
- The table also shows how each bandwidth is linked with a typical tolerance on centre wavelength.
- Tolerances can be tightened on centre wavelength or to smaller bandwidth ranges, but this raises manufacturing costs.

			Typical Tolerances on Centre Wavelength or Cut On/Off Edges										
Filter	**Nominal bandwidth**	**Bandwidth with tolerances**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**0.6%**	**0.75%**	**1.5%**	**2.0%**	**3.0%**	**4.0%**
NBP	1.1%	0.9 - 1.3%			X								
NBP	2%	1.6 - 2.4%					X						
NBP	3%	2.5 - 3.5%						X					
NBP	4.3%	3.8 - 4.8%							X				
BP	11%	10 - 12%								X	X		
WBP		Edge tolerances									X	X	X
LWP		Edge tolerances									X	X	X
SWP		Edge tolerances									X	X	X

WEBSITE AND WEBSTOCK FILTERS

- We have a large number of filters in stock:
    - Some of these can be viewed on our website (www.noc-ltd.com)
    - Webstock filters are limited in number and arise from manufacturing over-runs
    - They are available on a first-come basis
    - As they are bespoke items, stocks of individual filters are not usually replenished

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