



# Waveplates





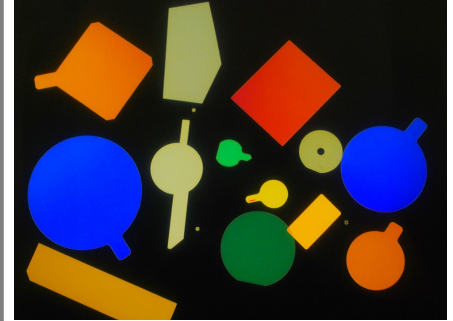
## Polymer Film Retarders

Meadowlark Optics is pleased to present our Bare Polymer Film Retarder. Our proprietary polymer film provides high retardance accuracy in a cost effective product which can be provided in almost any configuration and quantity. The temperature dependence of the nominal retardance is approximately 0.01%/°C, which provides a very stable and versatile polarization solution.

Manufactured in-house for wavelengths between 400 and 1800 nm, this retarder is ideal for applications requiring a high precision, thin and cost effective solution. We are also able to tune the retardance to your Angle of Incidence to optimize performance. AR coatings are available on a special order basis.

Standard shapes and retardance values are available when quick turn-around is needed. We can also accommodate requests for custom shapes sizes (up to 4 inches) and retardance values.

Please contact a Meadowlark Optics Sales Engineer for assistance with your custom requirements.



### Key Features

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Very thin profile

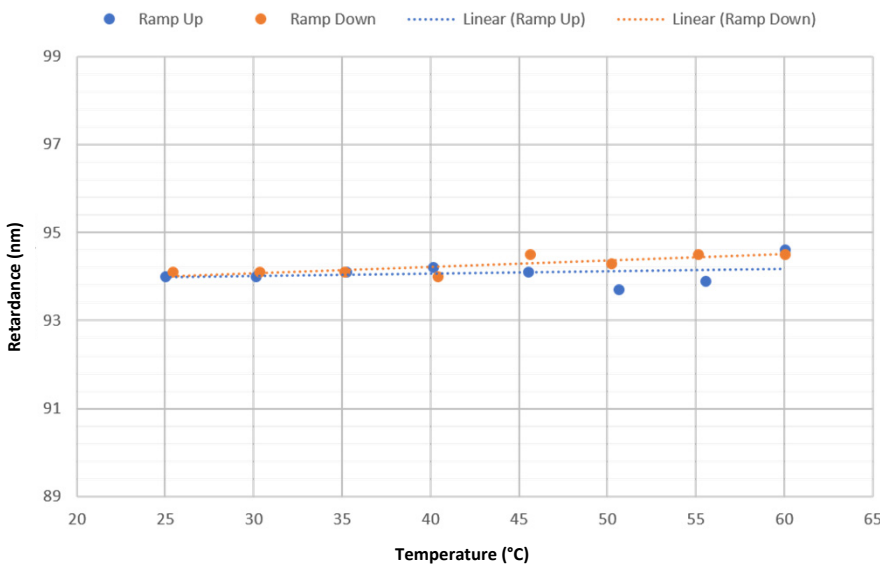
Thermally stable

High volume scalable

AR coatings available

Custom retardance available

Thermal Stability of Polymer Retarder



### Waveplate Suite

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Precision Retarder

Precision Achromatic Retarder

Precision Superachromatic Retarder

Dual-Wavelength Retarder

Wide Field Retarder

Liquid Crystal Variable Retarder

Polymer Film Retarder

Raptor Applied Polymer Retarder

Large Aperture Retarder

Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
Substrate Material	Polymer Film
Thickness	0.005 inch (127 mm), nominal
Wavelength Range	400 – 1800 nm
Retardance Ranges Single Layer Double Layer	20 – 1600 nm 1600 – 3000 nm
Reflectance	~4% per surface
Retardance Variation	≤ 2%/inch
Retardance Accuracy	± λ/300
Acceptance Angle	± 6°
Transmitted Wavefront Distortion (per inch)	≤ 2λ (P-V @ 633) ≤ λ/2 (RMS @ 633)
Surface Quality	80 – 50 scratch-dig
Beam Deviation	≤ 30 arc sec
Operating Temperature	-40°C to +60°C

ORDERING INFORMATION		
Round		
Dimensions in. (mm)	Clear Aperture in. (mm)	Part Number
Ø0.50 (12.7 mm)	0.45 (11.43 mm)	λ/4 Wave: BQ – 050 – λ λ/2 Wave: BH – 050 – λ
Ø1.00 (25.4 mm)	0.90 (22.86 mm)	λ/4 Wave: BQ – 100 – λ λ/2 Wave: BH – 100 – λ
Ø1.50 (38.1 mm)	1.35 (34.29 mm)	λ/4 Wave: BQ – 150 – λ λ/2 Wave: BH – 150 – λ
Ø2.00 (50.8 mm)	1.80 (45.72 mm)	λ/4 Wave: BQ – 200 – λ λ/2 Wave: BH – 200 – λ
Square		
Dimensions in. (mm)	Clear Aperture in. (mm)	Part Number
0.50 x 0.50 (12.7 x 12.7)	0.50 x 0.50 (12.7 x 12.7)	λ/4 Wave: BQ – 050x050 – λ λ/2 Wave: BH – 050x050 – λ
1.00 x 1.00 (25.4 x 25.4)	0.90 x 0.90 (22.86 x 22.86)	λ/4 Wave: BQ – 100x100 – λ λ/2 Wave: BH – 100x100 – λ
1.50 x 1.50 (38.1 x 38.1)	1.35 x 1.35 (34.29 x 34.29)	λ/4 Wave: BQ – 150x150 – λ λ/2 Wave: BH – 150x150 – λ
2.00 x 2.00 (50.8 x 50.8)	1.80 x 1.80 (45.72 x 45.72)	λ/4 Wave: BQ – 200x200 – λ λ/2 Wave: BH – 200x200 – λ

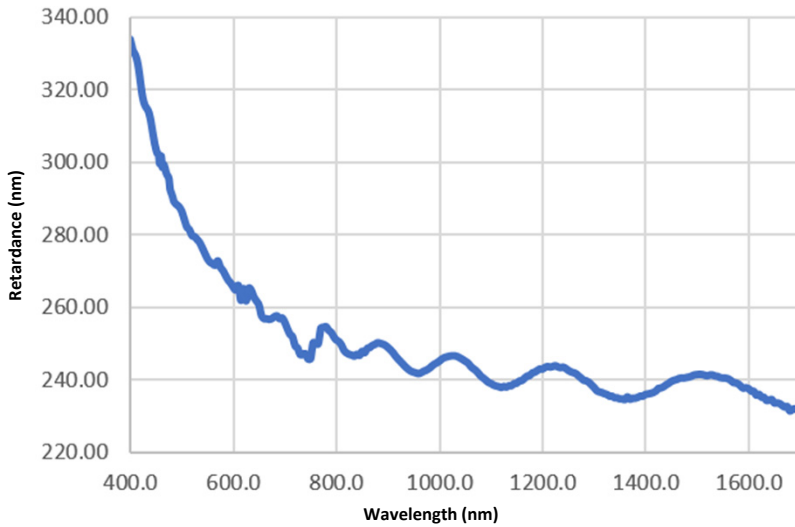
Note: Dimensions are ±0.02

## RAPtor Applied Polymer Retarders

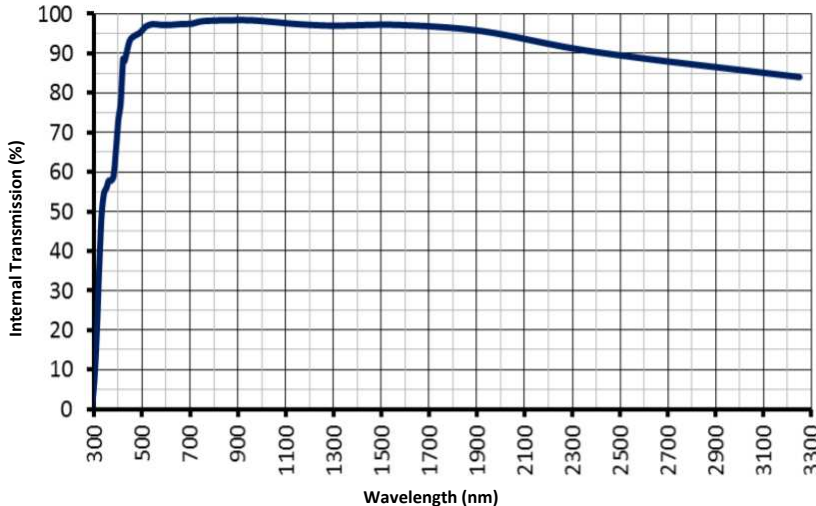
Retarder-Applied-Polymer parts are manufactured using a proprietary high birefringent polymer and are true zero order retarders with a typical film thickness less than 10 microns. These parts can be added to customer provided windows and other plano or slightly curved substrates to produce truly custom solutions.

These retarders were originally designed for use in astronomy but have applications wherever a true zero order waveplate would be used. Meadowlark Optics can apply these retarders to substrates from 10 mm to 100 mm diameter (and even larger on a custom basis.)

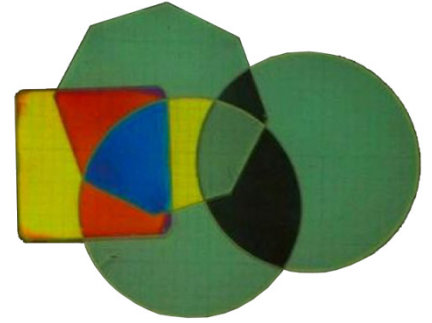
Actual Retardance Data for a Sample RAPtor Applied Polymer Retarder



Transmission vs. Wavelength



Raptor Retarder films can be applied to your substrates and surfaces. They can be tuned to custom retardance values and are transmissive over a large wavelength range.



### Key Features

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- Extremely thin and large diameter
- Curved surfaces
- High temperature resistance
- Custom sizes, shapes, wavelengths and retardances available

### Waveplate Suite

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- Precision Retarder
- Precision Achromatic Retarder
- Precision Superachromatic Retarder
- Dual-Wavelength Retarder
- Wide Field Retarder
- Liquid Crystal Variable Retarder
- Polymer Film Retarder
- Raptor Applied Polymer Retarder
- Large Aperture Retarder
- Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
Retarder Material	High Birefringence Polymer
Retarder Thickness	< 10 $\mu\text{m}^{**}$
Substrate Thickness	1.1 mm fused silica
Wavelength Range and Retardance	400 – 1064 nm ( $\lambda/2$ ) 400 – 1550 nm ( $\lambda/4$ )
Retardance Accuracy	< $\pm \lambda/100$
Retardance Uniformity	< $\lambda/100$ [ $<5$ nm]
Clear Aperture	80%
Reflectivity (back surface)	$\leq 0.5\%$
Transmitted Wavefront Distortion	$\leq \lambda/2$ (P-V @ 633 nm) $\leq \lambda/8$ (RMS @ 633 nm)
Beam Deviation	$\leq 5$ arc sec
Surface Quality	80-50 scratch-dig
Operating Temperature	-20 °C to 80 °C
Storage Temperature	-40 °C to 80 °C

*\*\*exact thickness design dependent*

STOCK ORDERING INFORMATION (Quarter-Wave and Half-Wave parts)		
Diameter in. (mm)	Clear Aperture in. (mm)	Part Number
$\varnothing 1.00$ in. (25.4 mm)	$\varnothing 0.9$ in. (22.9 mm)	PQ – 100 – $\lambda$ PH – 100 – $\lambda$
$\varnothing 2.00$ in. (50.8 mm)	$\varnothing 1.8$ in. (45.7 mm)	-200 – $\lambda$ PH – 200 – $\lambda$

CUSTOM DESIGN	
Wavelength Range	350 – 3300 nm
Retardance Accuracy	< $\pm \lambda/200$
Dimensions	Up to 150 mm diameter
Fast Axis Datum / Orientation	Customer specified
Substrate material/geometry/thickness	Customer specified

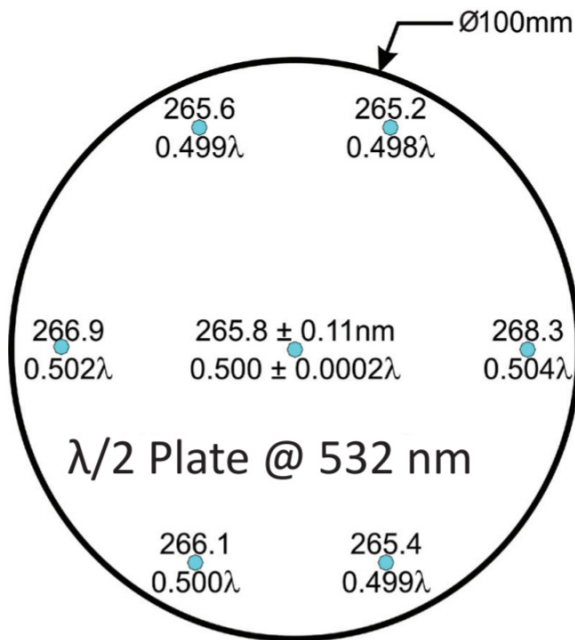
## Large Aperture Retarder

For many astronomical, aerospace, and defense projects, large aperture retarders are required. Meadowlark Optics has over thirty-five years of retarder manufacturing expertise and is able to manufacture from a wide variety of materials to facilitate high or low power applications.

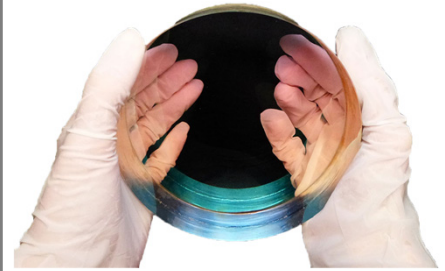
Waveplates up to 150 mm diameter are available. Some materials allow retarders to be used over different wavelengths from the ultraviolet, through the visible and into the near infrared.

Meadowlark Optics uses proprietary methods to ensure the best spatial uniformity of its polymer and crystalline retarders. These retarders have a spatial uniformity of better than two percent across the clear aperture and with the correct substrates, can have a wavefront distortion that is on par with Meadowlark Optics' Precision Retarders.

Meadowlark Optic's liquid crystal variable retarders can also be built with large clear apertures. Please contact your Meadowlark Optics Sales Engineer for assistance and a custom quote.



Actual spatial retardance data from a 100mm Large Aperture Retarder



## Key Features

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Outer diameter up to 6 inches

Clear aperture > 90%

Custom size retardance and wavelength range available

Spatial uniformity less than 2% across clear aperture

Various materials available: (polymer, quartz, sapphire, magnesium fluoride, liquid crystal)

Less than 15mm Thickness

True Zero-Order

Broad Wavelength ranges

## Waveplate Suite

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Precision Retarder

Precision Achromatic Retarder

Precision Superachromatic Retarder

Dual-Wavelength Retarder

Wide Field Retarder

Liquid Crystal Variable Retarder

Polymer Film Retarder

Raptor Applied Polymer Retarder

Large Aperture Retarder

Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
<b>Retarder (Birefringent) Material Options</b>	Polymer Crystalline Quartz Magnesium Fluoride Sapphire Liquid Crystal†
<b>Wavelength</b>	300-2500 nm (please specify)
<b>Retardances</b>	0 to 100s of $\lambda$
<b>Retardance Accuracy</b>	
<b>Center Spatial Uniformity</b>	$\leq \lambda/100$ to $\leq \lambda/350$ $\leq \lambda/10$ to $\leq \lambda/100$
<b>Transmitted Wavefront Distortion</b>	$\leq \lambda$ to $\leq \lambda/5$ (P-V @ 633) $\lambda/4$ to $\lambda/20$ (RMS @ 633)]
<b>Surface Quality</b>	40 – 20 scratch-dig to 80 – 50 scratch-dig
<b>Outside Dimensions</b>	Up to 150 mm

*Large Aperture retarders are available in a variety of different sizes and shapes with custom retardances at specific wavelengths. Combinations of different materials allow custom achromatic, athermal or wide angle designs. Please contact your Meadowlark Optics Sales Engineer for a custom quote.*

## Precision Superachromatic Retarder

Meadowlark Optics is proud to offer our Precision Superachromatic Retarder—with the broadest wavelength coverage of our entire retarder product line. These are available standard for two wavelength ranges; 420 to 1100 nm, and 800 to 1700 nm. Both quarter and half wave retardances available as standard options. Custom devices are available for other wavelength ranges and retardances. Stock items are not anti-reflection coated due to the broad wavelength coverage but custom coatings can be provided.

The Superachromatic Retarders contain carefully aligned birefringent polymer sheets laminated between precision polished optically flat N-BK7 windows. While assembly is quite similar to that of our Precision Retarders, optical transmission is slightly reduced because there are more polymer layers and there is no anti-reflection coating.

These retarders are accurate to  $\pm\lambda/50$  over the entire wavelength range; we ship retardance measurements at more than 25 wavelengths accurate to  $\pm 0.001$  waves with every Precision Superachromatic Retarder.



### Key Features

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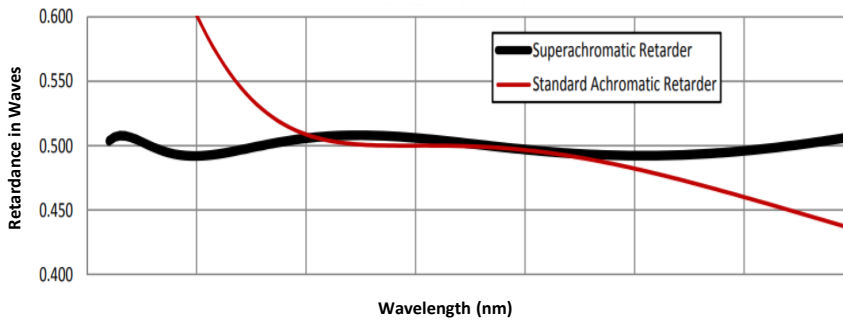
- Ultra-broadband wavelength range  
420 to 1100 nm and 800 to 1700 nm
- Custom wavelength ranges available
- Custom retardances available
- Superior field of view

### Waveplate Suite

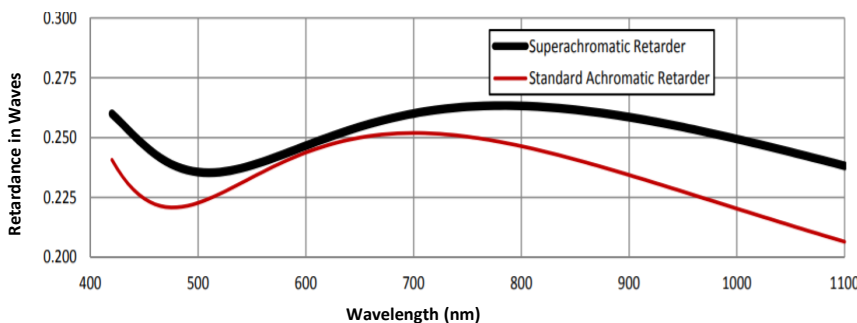
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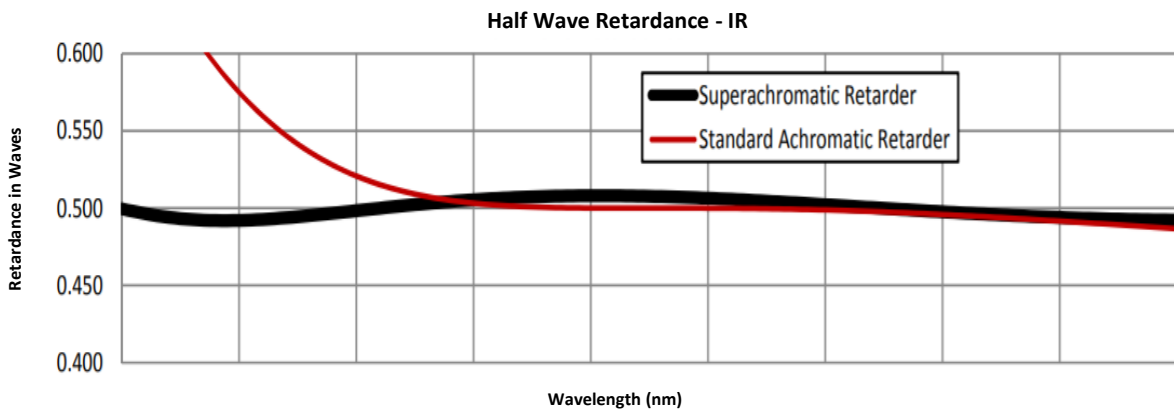
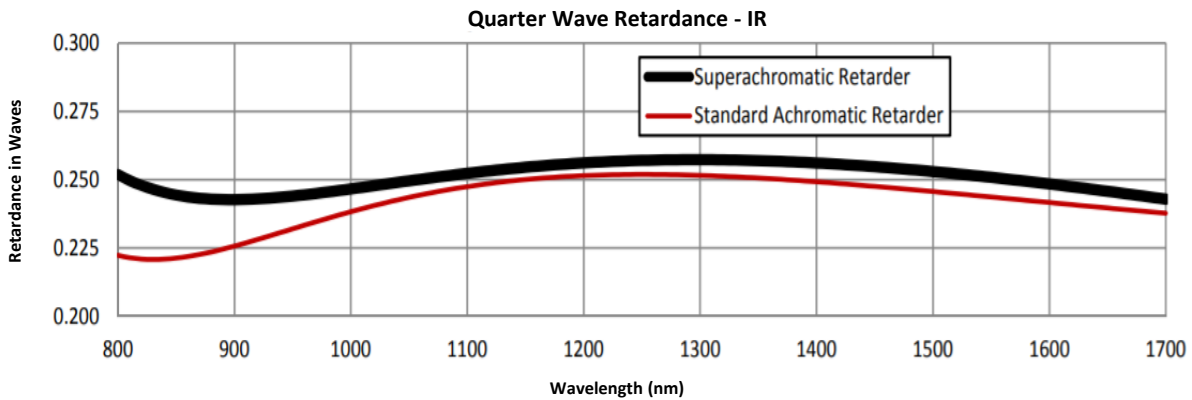
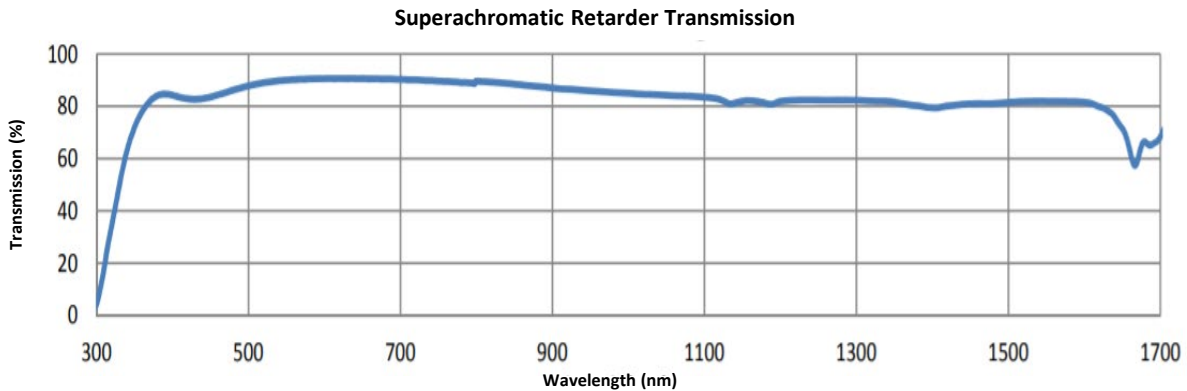
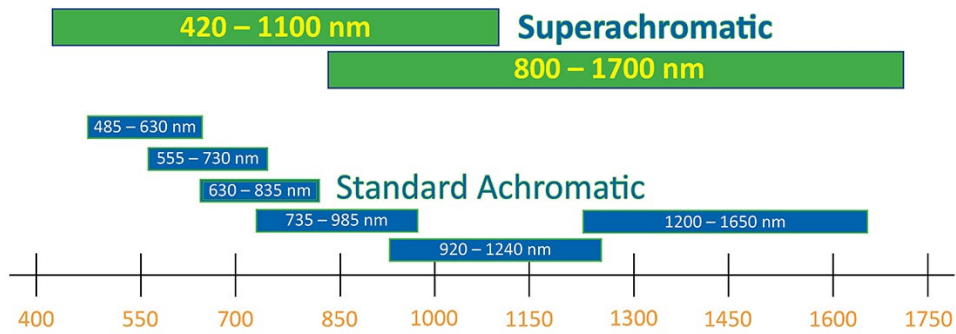
- Precision Retarder
- Precision Achromatic Retarder
- Precision Superachromatic Retarder
- Dual-Wavelength Retarder
- Wide Field Retarder
- Liquid Crystal Variable Retarder
- Polymer Film Retarder
- Raptor Applied Polymer Retarder
- Large Aperture Retarder
- Bi-Crystalline Achromatic Retarder

Half Wave Retardance – VIS to NIR



Quarter Wave Retardance – VIS to NIR







ORDERING INFORMATION					
Mounted					
Diameter ±0.005 in. (±0.13 mm)	Clear Aperture in. (mm)	Thickness ±0.020 in. (±0.51 mm)	Wavelength Range (nm)	λ/4 Part #	λ/2 Part #
1.00 (25.40)	0.70 (17.80)	0.36 (9.10)	420 – 1100 nm	AQM – 100S	AHM – 100S
1.00 (25.40)	0.70 (17.80)	0.36 (9.10)	800 – 1700 nm	AQM – 100L	AHM – 100L
2.00 (50.80)	1.20 (30.50)	0.50 (12.70)	420 – 1100 nm	AQM – 200S	AHM – 200S
2.00 (50.80)	1.20 (30.50)	0.50 (12.70)	800 – 1700 nm	AQM – 200L	AHM – 200L
Unmounted					
Diameter ±0.010 in. (±0.25 mm)	Clear Aperture in. (mm)	Thickness ±0.020 in. (±0.51 mm)	Wavelength Range (nm)	λ/4 Part #	λ/2 Part #
1.00 (25.40)	0.80 (20.30)	0.27 (6.90)	420 – 1100 nm	AQ – 100S	AH – 100S
1.00 (25.40)	0.80 (20.30)	0.27 (6.90)	800 – 1700 nm	AQ – 100L	AH – 100L
2.00 (50.80)	1.60 (40.60)	0.51 (13.00)	420 – 1100 nm	AQ – 200S	AH – 200S
2.00 (50.80)	1.60 (40.60)	0.51 (13.00)	800 – 1700 nm	AQ – 200L	AH – 200L

Custom sizes and retardances are available. Please contact your sales engineer for assistance.

SPECIFICATIONS	
Retarder Material	Birefringent Polymer
Substrate Material	N-BK7
Wavelength Ranges	420 – 1100 nm 800 – 1700 nm
TWD (1.00 in.)	λ/2 (P-V@633 nm)
Retardance Accuracy	≤λ/50
Acceptance Angle	±10°
Surface Quality	40 – 20 scratch-dig
Beam Deviation	≤ 2 arc-min
Temperature Range	-20°C to +50°C (Operating)
Laser Damage Threshold	500 W/cm <sup>2</sup> , CW 300 mJ/cm <sup>2</sup> , 10 ns, visible 500 mJ/cm <sup>2</sup> , 10 ns, 1064 nm



## Precision Retarder

Meadowlark Optics specializes in precision polymer retarders for the visible to near infrared region. Our Precision Retarders have the highest optical quality and tightest retardance tolerance of all polymer retarders. These true zero-order Precision Retarders consist of a birefringent polymer cemented between two precision polished, optically flat BK 7 windows. The retarder fast axis is conveniently marked for quick and easy reference.

Precision Retarders are supplied with a broadband antireflection coating. Optical transmittance of a Precision Retarder is typically greater than 97%. The retardance  $\delta$  at a wavelength  $\lambda$  that is different from the center wavelength  $\lambda_c$  is given by:

$$\delta \approx \delta_c(\lambda_c / \lambda)$$

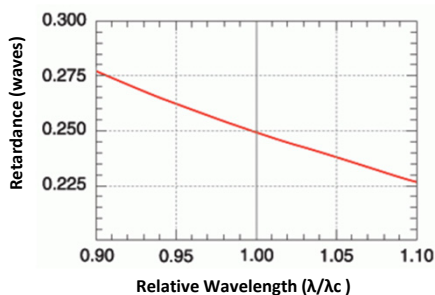
where  $\delta_c$  is the retardance at  $\lambda_c$ .

This relationship is very important when using sources which vary in wavelength from their nominal value. The 2 graphs show the retardance behavior as a function of relative wavelength for a quarter- and half-wave retarder, respectively. The Mueller calculus can be used to calculate the transmitted polarization state based upon the retardance differences from the ideal case.

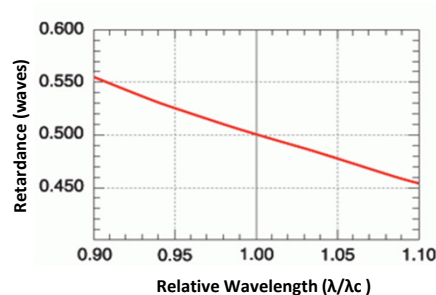
Since polymer retarders are true zero-order devices, they offer the significant advantage of improved angular performance. You can expect less than 1% retardance change over  $\pm 10^\circ$  incidence angle.

Meadowlark Optics has developed precision ellipsometric techniques that can measure retardance to  $\lambda/1000$ . Our metrology for these measurements is the best in the industry. You can have absolute confidence that the calibration measurements supplied with your retarder are of the highest accuracy obtainable.

Quarter-Wave Precision Retarder Performance



Half-Wave Precision Retarder Performance



## Key Features

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- True zero-order retarders
- Excellent off-axis performance
- Unequaled measured accuracy
- Less temperature dependence than quartz waveplates
- Lower cost than compound zero-order waveplates
- Better angular acceptance than compound zero-order quartz waveplates

## Waveplate Suite

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- Precision Retarder
- Precision Achromatic Retarder
- Precision Superachromatic Retarder
- Dual-Wavelength Retarder
- Wide Field Retarder
- Liquid Crystal Variable Retarder
- Polymer Film Retarder
- Raptor Applied Polymer Retarder
- Large Aperture Retarder
- Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
Retarder Material	Birefringent Polymer
Substrate Material	N-BK7
Standard Wavelengths	532, 632.8, 670, 780, 850, 1064, and 1550 nm
Custom Wavelengths	400 – 1800 nm (please specify)
Standard Retardances	$\lambda/2$ and $\lambda/4$
Retardance Accuracy	$\leq \lambda/350$
Retardance Change (at 30° tilt)	$\leq \lambda/32$ (Half-Wave) and $\leq \lambda/59$ (Quarter-Wave)
Transmitted Wavefront Distortion	$\leq \lambda/5$
Surface Quality (scratch-dig)	40 – 20
Beam Deviation	$\leq 1$ arc-min
Reflectance (per surface)	$\leq 0.5\%$ at normal incidence
Threshold	500 W/cm <sup>2</sup> , CW 600 mJ/cm <sup>2</sup> , 20 ns, visible 4 J/cm <sup>2</sup> , 20 ns, 1064 nm
Operating Temperature Range	20°C to 50°C

Custom retardance values and sizes are available.  
Please call for a quote.

ORDERING INFORMATION				
Mounted				
Clear Aperture in. (mm)	Dimensions $\pm 0.005$ in. ( $\pm 0.13$ mm)	Thickness $\pm 0.020$ in. ( $\pm 0.51$ mm)	Part Number	
Half-Wave				
0.40 (10.2)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.25 (6.35)	NHM – 050 – $\lambda$	
0.70 (17.8)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.35 (8.9)	NHM – 100 – $\lambda$	
1.20 (30.5)	$\varnothing 2.00$ ( $\varnothing 50.8$ )	0.50 (12.7)	NHM – 200 – $\lambda$	
Quarter-Wave				
0.40 (10.2)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.25 (6.35)	NQM – 050 – $\lambda$	
0.70 (17.8)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.35 (8.9)	NQM – 100 – $\lambda$	
1.20 (30.5)	$\varnothing 2.00$ ( $\varnothing 50.8$ )	0.50 (12.7)	NQM – 200 – $\lambda$	
Unmounted				
Clear Aperture in. (mm)	Dimensions $+0/-0.010$ in. ( $+0/-0.25$ mm)	Thickness $\pm 0.020$ in. ( $\pm 0.51$ mm)	Part Number	
Half-Wave				
0.40 (10.2)	$\varnothing 0.50$ ( $\varnothing 12.70$ )	0.13 (3.3)	NH – 050 – $\lambda$	
0.80 (20.3)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.26 (6.3)	NH – 100 – $\lambda$	
1.60 (40.6)	$\varnothing 2.00$ ( $\varnothing 50.8$ )	0.51 (13.0)	NH – 200 – $\lambda$	
Quarter-Wave				
0.40 (10.2)	$\varnothing 0.50$ ( $\varnothing 12.70$ )	0.13 (3.3)	NQ – 050 – $\lambda$	
0.80 (20.3)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.26 (6.3)	NQ – 100 – $\lambda$	
1.60 (40.6)	$\varnothing 2.00$ ( $\varnothing 50.8$ )	0.51 (13.0)	NQ – 200 – $\lambda$	

Please specify your center wavelength  $\lambda$  in nanometers when ordering. Custom sizes and shapes with improved transmitted wavefront distortion and/or beam deviation are available. Please call for a quote.

## Wide Field Retarder

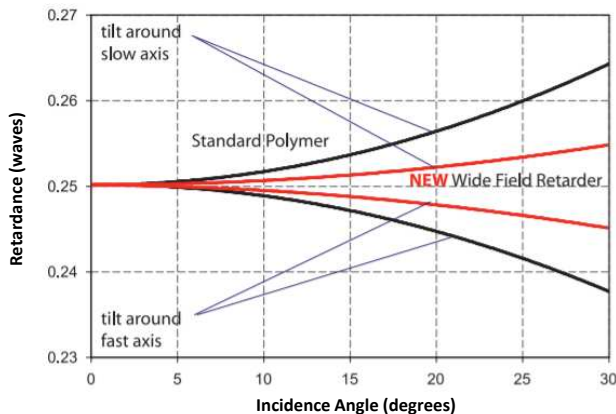
Meadowlark Optics now offers Wide Field Retarders, the latest innovation in near zero-order polymer retarder technology. At their design wavelength, Wide Field Retarders provide a consistent retardance value over a wide acceptance angle, out to 30° or more.

Standard quarter- and half-wave designs are available for common wavelengths in the visible to near infrared region. The graphs show the Wide Field Retarder performance as a function of incidence angle for the both half-wave and quarter-wave designs.

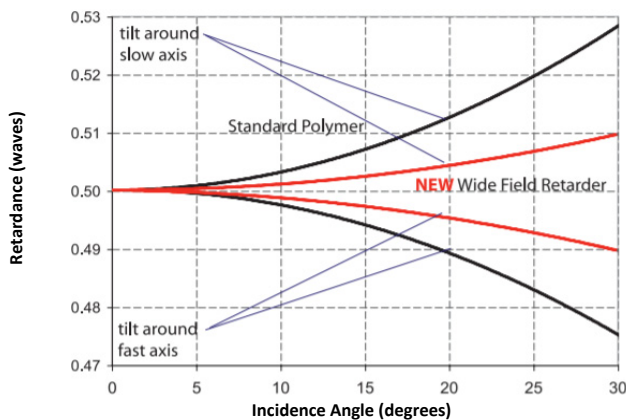
Multilayer broadband antireflection (BBAR) coatings are included as standard. Note that BBAR coating performance varies with incidence angle; these coatings perform best at (or near) normal incidence.

As with all Meadowlark Optics retarders, the fast axis is conveniently marked. Custom retardance values are available for wavelengths from 400-1800 nm. Please call for application assistance or to request a custom quotation.

**Quarter-Wave Wide Field Retarder Performance vs. Incidence Angle**



**Half-Wave Wide Field Retarder Performance vs. Incidence Angle**



### Key Features

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- Unmatched off-axis performance
- Standard and custom wavelength retarders
- Mounted and unmounted versions available
- Off-axis performance ideal for uncollimated light applications

### Waveplate Suite

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- Precision Retarder
- Precision Achromatic Retarder
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- Dual-Wavelength Retarder
- Wide Field Retarder
- Liquid Crystal Variable Retarder
- Polymer Film Retarder
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- Large Aperture Retarder
- Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
Retarder Material	Birefringent Polymer
Substrate Material	N-BK7
Standard Wavelengths	532, 632.8, 670, 780, 850, 1064, and 1550 nm
Custom Wavelengths	400 – 1800nm (please specify)
Retardance	$\lambda/2$ and $\lambda/4$
Retardance Accuracy	$\leq \lambda/250$ at normal incidence at the center of the part
<b>Retardance Change (at 30° tilt)</b>	
Half-wave	$\leq \lambda/100$
Quarter-wave	$\leq \lambda/200$
Transmitted Wavefront Distortion	$\leq \lambda/2$
Surface Quality	60 – 40 scratch-dig
Beam Deviation	$\leq 1$ arc-min
<b>Reflectance (per surface)</b>	
At normal incidence	$\leq 0.5\%$
At 30° incidence	$\leq 1.0\%$
Operating Temperature	0°C to 40°C

ORDERING INFORMATION			
<b>Mounted</b>			
Clear Aperture in. (mm)	Dimensions $\pm 0.005$ in. ( $\pm 0.13$ mm)	Thickness in. (mm)	Part Number
<b>Quarter Wave</b>			
0.40 (10.2 mm)	$\varnothing 1.00$ ( $\varnothing 25.4$ mm)	0.25 (6.35 mm)	WQM – 050 – $\lambda$
0.70 (17.8 mm)	$\varnothing 1.00$ ( $\varnothing 25.4$ mm)	0.35 (8.9 mm)	WQM – 100 – $\lambda$
<b>Half Wave</b>			
0.40 (10.2 mm)	$\varnothing 1.00$ ( $\varnothing 25.4$ mm)	0.25 (6.35 mm)	WHM – 050 – $\lambda$
0.70 (17.8 mm)	$\varnothing 1.00$ ( $\varnothing 25.4$ mm)	0.35 (8.9 mm)	WHM – 100 – $\lambda$
<b>Unmounted</b>			
Clear Aperture in. (mm)	Dimensions $+ 0/-0.010$ ( $+0/-0.25$ mm)	Thickness in. (mm)	Part Number
<b>Quarter Wave</b>			
0.40 (10.2 mm)	$\varnothing 0.50$ ( $\varnothing 12.7$ mm)	0.14 (3.6 mm)	WFQ – 050 – $\lambda$
0.80 (20.3 mm)	$\varnothing 1.00$ ( $\varnothing 25.4$ mm)	0.28 (7.1 mm)	WFQ – 100 – $\lambda$
<b>Half Wave</b>			
0.40 (10.2 mm)	$\varnothing 0.50$ ( $\varnothing 12.7$ mm)	0.14 (3.6 mm)	WFH – 050 – $\lambda$
0.80 (20.3 mm)	$\varnothing 1.00$ ( $\varnothing 25.4$ mm)	0.28 (7.1 mm)	WFH – 100 – $\lambda$

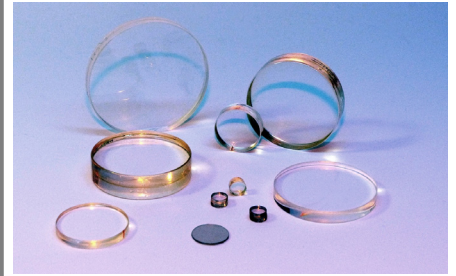
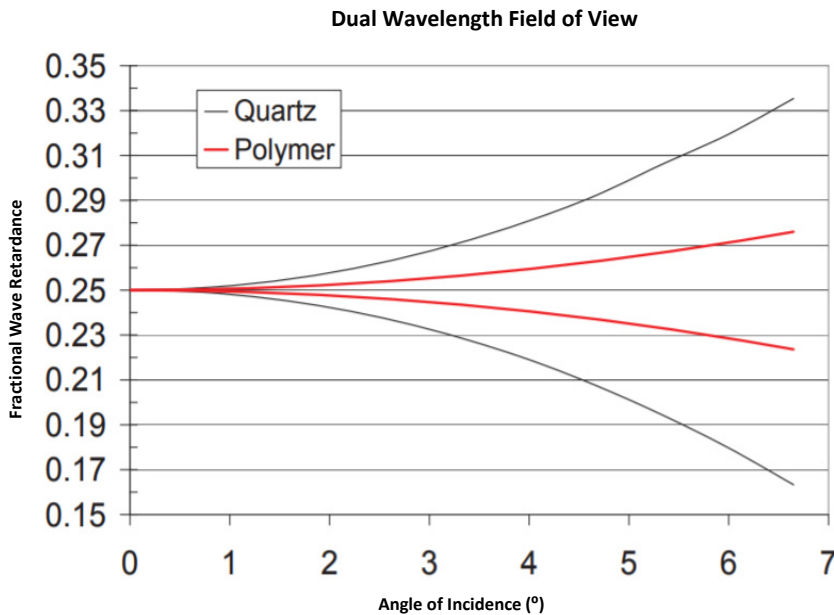
Custom sizes and retardance values are available.  
Please contact your Meadowlark Optics sales engineer for a custom quote.

## Dual-Wavelength Retarder

Dual wavelength retarders can provide the same retardance at two wavelengths that are separated in wavelength by more than the span covered by an achromatic retarder. They can also provide different specified retardances at two different wavelengths.

Traditionally these retarders have been made using crystal quartz and are multiorder retarders at both wavelengths. Our dual wavelength retarders use polymers instead. They are usually much lower order and consequently have a slower change in retardance with angle of incidence as shown in the graph. On average the order is about 20% of that for a comparable quartz dual wavelength retarder.

Call for a quote on a custom coating on these normally uncoated retarders. The retardance tolerance is  $\pm 0.01$  waves at both wavelengths. Many custom combinations not listed in the catalog are available. Please call for a quote on your custom requirement. Standard unmounted sizes are 0.50 inches and 1.00 inches.



### Key Features

• • •

Low order

Wide angular field

Broad wavelength coverage

Coated or Uncoated Available

Mounted or Unmounted Available

### Waveplate Suite

• • •

Precision Retarder

Precision Achromatic Retarder

Precision Superachromatic Retarder

Dual-Wavelength Retarder

Wide Field Retarder

Liquid Crystal Variable Retarder

Polymer Film Retarder

Raptor Applied Polymer Retarder

Large Aperture Retarder

Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
Retarder Material	Birefringent Polymer
Substrate Material	N-BK7
Retardance Accuracy	$\leq \lambda/100$ at both wavelengths
Transmitted Wavefront Distortion	$\leq \lambda/4$
Beam Deviation	$\leq 1$ arc-min
Reflectance (per surface)	$\sim 4\%$ at normal incidence
Storage Temperature	design dependent
Operating Temperature	design dependent

Custom anti-reflection coatings to provide less than 0.5% reflection at both wavelengths are available. Please call your Meadowlark Optics sales engineer for a quote.

ORDERING INFORMATION		
Thickness in. (mm)	Dimensions in. (mm)	Part Number
0.14 (3.6 mm)	0.50 (Ø12.7 mm)	D R1 R2 – d – $\lambda_1/\lambda_2$
0.27 (6.9 mm)	1.00 (Ø25.4 mm)	D R1 R2 – d – $\lambda_1/\lambda_2$

R1,R2 = Q for quarter wave, H for half wave  
d = Diameter (e.g. -100 is 1" OD)  
 $\lambda_1,\lambda_2$  = Design wavelengths. (e.g. -0488 is 488 nm)  
DQH-200- $\lambda_1,\lambda_2$  => 2" Quarter Waveplate @  $\lambda_1$ , Half @  $\lambda_2$ .

## Precision Achromatic Retarder

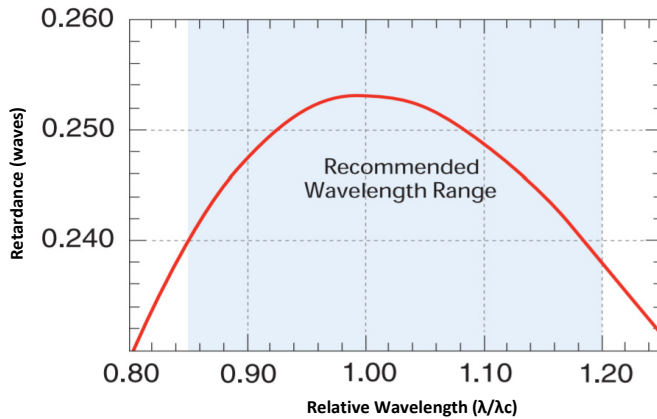
Meadowlark Optics Precision Achromatic Retarders are designed to provide a nearly constant retardance over a broad wavelength region. Standard quarter- and half-wave devices are available for common wavelength regions in the visible and near infrared.

Our Precision Achromatic Retarders consist of carefully aligned birefringent polymer sheets laminated between precision polished, optically flat BK 7 windows. Assembly is quite similar to the assembly of our Precision Retarders.

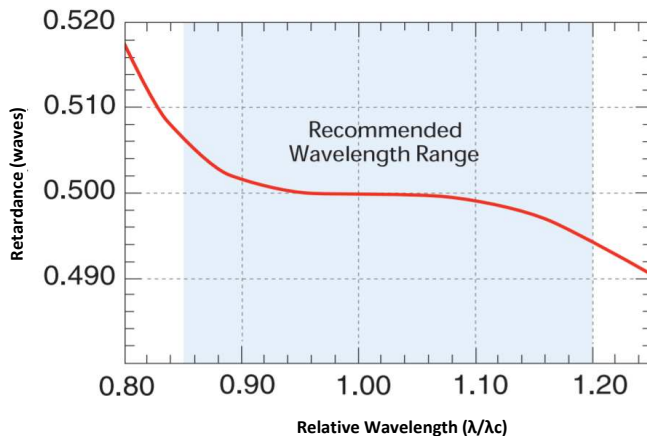
Optical transmittance varies slightly from the Precision Retarder because several polymer layers are used in each Achromatic Retarder.

We provide retardance accurate to  $\lambda/100$  for all wavelengths in the operating range. Achromatic retarders are an excellent choice for applications requiring broad wavelength use.

**Quarter-Wave Achromatic Retarder Performance**



**Half-wave Achromatic Retarder Performance**



### Key Features

• • •

Broad spectral range

Superior field of view

Thermally Stable

Custom Wavelengths Available

### Waveplate Suite

• • •

Precision Retarder

Precision Achromatic Retarder

Precision Superachromatic Retarder

Dual-Wavelength Retarder

Wide Field Retarder

Liquid Crystal Variable Retarder

Polymer Film Retarder

Raptor Applied Polymer Retarder

Large Aperture Retarder

Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
Retarder Material	Birefringent Polymer
Substrate Material	N-BK7
<b>Standard Wavelengths</b>	
545	(485 – 630 operating range)
630	(555 – 730 operating range)
720	(630 – 835 operating range)
840	(735 – 985 operating range)
1060	(920 – 1240 operating range)
1400	(1200 – 1650 operating range)
Custom Wavelengths	400 – 1800 nm (please specify)
Retardance	$\lambda/4$ and $\lambda/2$
Retardance Accuracy	$\leq \lambda/100$
Transmitted Wavefront Distortion	$\leq \lambda/4$
Surface Quality (scratch-dig)	40-20
Beam Deviation	$\leq 1$ arc – min
Reflectance (per surface)	$\leq 0.5\%$ at normal incidence
Threshold	500 W/cm <sup>2</sup> , CW 600 mJ/cm <sup>2</sup> , 20 ns, visible 4 J/cm <sup>2</sup> , 20 ns, 1064 nm
Operating Temperature	-20°C to +50°C

ORDERING INFORMATION				
Mounted				
Clear Aperture in. (mm)	Dimensions $\pm 0.005$ in. ( $\pm 0.13$ mm)	Thickness $\pm 0.020$ in. ( $\pm 0.51$ mm)	Part Number	
<b>Quarter Wave</b>				
0.40 (10.2)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.25 (6.35)	AQM – 050 – $\lambda$	
0.70 (17.8)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.35 (8.9)	AQM – 100 – $\lambda$	
1.20 (30.5)	$\varnothing 2.00$ ( $\varnothing 50.8$ )	0.50 (12.7)	AQM – 200 – $\lambda$	
<b>Half Wave</b>				
0.40 (10.2)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.25 (6.4)	AHM – 050 – $\lambda$	
0.70 (17.8)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.35 (8.9)	AHM – 100 – $\lambda$	
1.20 (30.5)	$\varnothing 2.00$ ( $\varnothing 50.8$ )	0.50 (12.7)	AHM – 200 – $\lambda$	
<b>Unmounted</b>				
Clear Aperture in. (mm)	Dimensions $+0/-0.010$ ( $+0/-0.25$ mm)	Thickness $\pm 0.020$ in. ( $\pm 0.51$ mm)	Part Number	
<b>Quarter Wave</b>				
0.40 (10.2)	$\varnothing 0.50$ ( $\varnothing 12.7$ )	0.14 (3.6)	AQ – 050 – $\lambda$	
0.80 (20.3)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.28 (7.1)	AQ – 100 – $\lambda$	
1.60 (40.6)	$\varnothing 2.00$ ( $\varnothing 50.5$ )	0.50 (12.7)	AQ – 200 – $\lambda$	
<b>Half Wave</b>				
0.40 (10.2)	$\varnothing 0.50$ ( $\varnothing 12.7$ )	0.14 (3.6)	AH – 050 – $\lambda$	
0.80 (20.3)	$\varnothing 1.00$ ( $\varnothing 25.4$ )	0.28 (7.1)	AH – 100 – $\lambda$	
1.60 (40.6)	$\varnothing 2.00$ ( $\varnothing 50.5$ )	0.50 (12.7)	AH – 200 – $\lambda$	

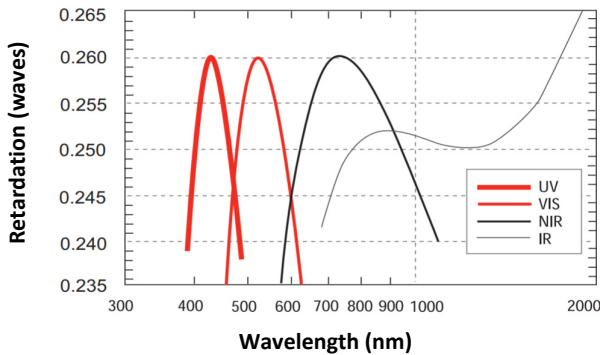
Custom size retarders with improved transmitted wavefront distortion and/or beam deviation are available. Meadowlark Optics one and two-inch diameter retarders conveniently fit our Rotary Mounts.

## Bi-Crystalline Achromatic Retarder

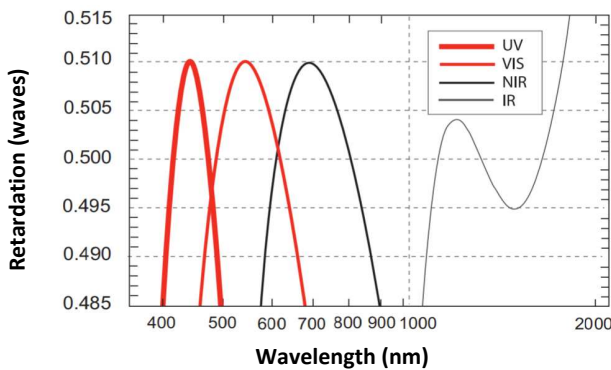
Meadowlark Optics is pleased to offer a selection of quarter and half-wave achromatic retarders that span the UV, visible, near IR and IR portions of the spectrum. Two multi-order crystalline retarders, one made of crystalline quartz and the other magnesium fluoride, are combined in a subtractive mode to give an effective zero-order waveplate. By a careful choice of waveplate thicknesses, retardance dispersion is balanced to give a nearly constant retardance (in waves) over a broad range of wavelengths. The useable wavelength range is defined to give a retardance value within  $\lambda/100$  of the nominal value. Custom designs with larger achromatic ranges or deeper UV wavelengths are available on request.

Bi-Crystalline Achromats are similar in achromatic performance to our polymer achromats in the visible, but they excel in the IR. They have higher power handling capability than our polymer achromats and can withstand higher storage temperatures. Their field of view is narrow compared to polymer achromats. Typically, they cannot be expected to meet their retardance accuracy for rays whose incidence angles exceed  $1.5^\circ$ . If you must have the performance of a Bi-Crystalline Achromat and a large field of view, call us. We have a proprietary design that can be your polarization solution.

**Quarter-Wave Bi-Crystalline Achromatic Retarder Performance**



**Half-Wave Bi-Crystalline Achromatic Retarder Performance**



### Key Features

• • •

- High Damage Threshold
- Volume Pricing
- Superior IR performance
- Broad Spectral Performance
- UV Models Available

### Waveplate Suite

• • •

- Precision Retarder
- Precision Achromatic Retarder
- Precision Superachromatic Retarder
- Dual-Wavelength Retarder
- Wide Field Retarder
- Liquid Crystal Variable Retarder
- Polymer Film Retarder
- Raptor Applied Polymer Retarder
- Large Aperture Retarder
- Bi-Crystalline Achromatic Retarder



SPECIFICATIONS	
<b>Retarder Material</b>	Quartz & Magnesium Fluoride
<b>Retardance Accuracy</b>	$\lambda/4$ or $\lambda/2$
<b>Temp. Coefficient of Retardance</b>	$\lambda/500$ per °C
<b>Standard Wavelengths - Quarter Wave</b>	
<b>Ultraviolet</b>	395 – 465 nm
<b>Visible</b>	475 – 590 nm
<b>Near Infrared</b>	600 – 900 nm
<b>Infrared</b>	690 – 2050 nm
<b>Standard Wavelengths - Half Wave</b>	
<b>Ultraviolet</b>	412 – 475 nm
<b>Visible</b>	500 – 650 nm
<b>Near Infrared</b>	600 – 840 nm
<b>Infrared</b>	1190 – 1660 nm
<b>Transmitted Wavefront Distortion</b>	$\leq \lambda/4$
<b>Surface Quality</b> (scratch-dig)	40 – 20
<b>Beam Deviation</b>	$\leq 1$ arc-min
<b>Reflectance</b> (per surface)	$\leq 0.5\%$ at normal incidence
<b>Storage Temperature</b>	-40°C to + 75°C
<b>Threshold</b>	2 J/cm <sup>2</sup> , 10 ns, 1064 nm

ORDERING INFORMATION		
<b>Mounted</b>		
<b>Clear Aperture</b> <i>in. (mm)</i>	<b>Diameter</b> <i>in. (mm)</i>	<b>Part</b> <b>Number</b>
<b>Half Wave</b>		
0.40 (10.2 mm)	Ø1.00 (Ø25.4 mm)	CHM – 050
<b>Quarter Wave</b>		
0.40 (10.2 mm)	Ø1.00 (Ø25.4 mm)	CQM – 050
<b>Unmounted</b>		
<b>Clear Aperture</b> <i>in. (mm)</i>	<b>Diameter</b> <i>in. (mm)</i>	<b>Part</b> <b>Number</b>
<b>Half Wave</b>		
0.40 (10.2 mm)	Ø0.50 (Ø12.7 mm)	CH – 050
<b>Quarter Wave</b>		
0.40 (10.2 mm)	Ø0.50 (Ø12.7 mm)	CQ – 050

We offer standard Bi-Crystalline Achromatic Retarders to cover 4 regions of the spectrum: UV, VIS, NIR, IR  
Please specify wavelength region when placing order.

