

# Antireflection Coatings

## Broadband Multilayer Antireflection Coatings

Broadband antireflection coatings provide a very low reflectance over a broad spectral bandwidth. These advanced multilayer films, are optimized to reduce overall reflectance to an extremely low level over a broad spectral range.

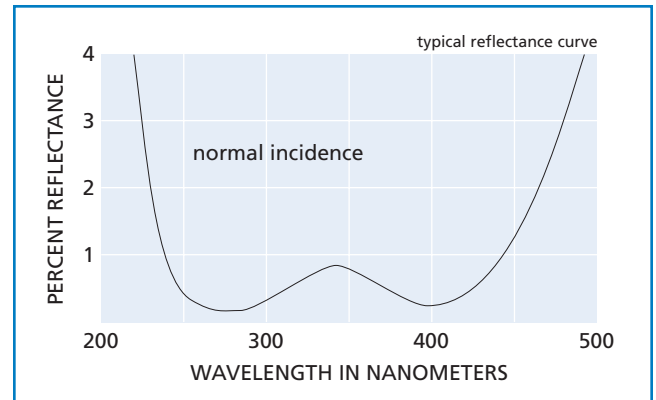
There are two families of broadband antireflection coatings from CVI Melles Griot. HEBBAR™ and BBAR.

### HEBBAR™ Coatings

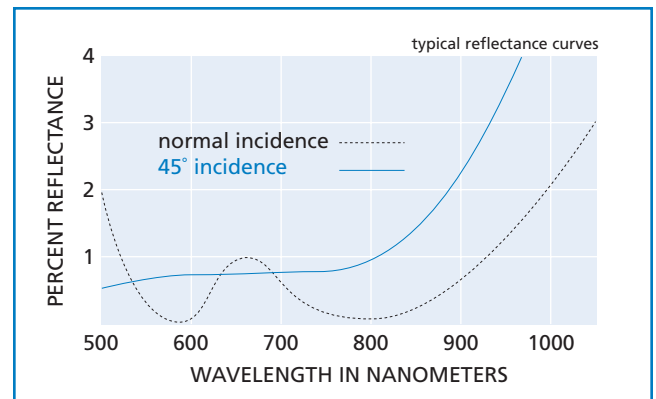
HEBBAR coatings exhibit a characteristic double-minimum reflectance curve covering a spectral range of some 250 nm or more. The reflectance does not exceed 1.0 percent, and is typically below 0.6 percent, over this entire range. Within a more limited spectral range on either side of the central peak, reflectance can be held to well below 0.4 percent. HEBBAR coatings are relatively insensitive to angle of incidence. The effect of increasing the angle of incidence (with respect to the normal to the surface) is to shift the curve to slightly shorter wavelengths and to increase the long wavelength reflectance slightly. These coatings are extremely useful for high numerical-aperture (low f-number) lenses and steeply curved surfaces. In these cases, incidence angles vary significantly over the aperture.

The typical reflectance curves shown below are for BK7 substrates, except for the ultraviolet 245-440 nm and 300-500 nm coatings which are applied to fused silica substrates or components. The reflectance values given below apply only to substrates with refractive indices ranging from 1.47 to 1.55. Other indices, while having their own optimized designs, will exhibit reflectance values approximately 20 percent higher for incidence angles from 0 to 15 degrees and 25 percent higher for incidence angles of 30+ degrees.

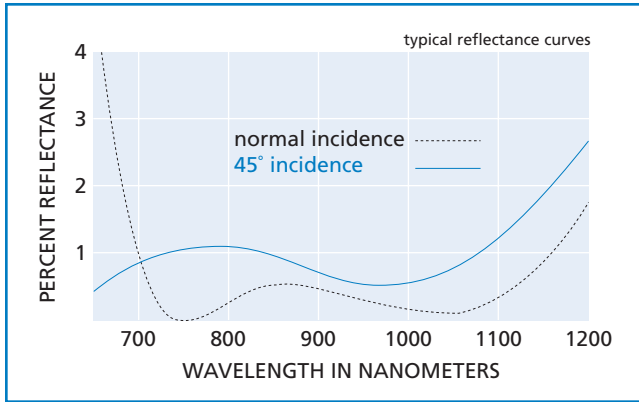
To order a HEBBAR coating, append the coating suffix given in the table below to the product number. In some instances it will be necessary to specify which surfaces are to be coated.



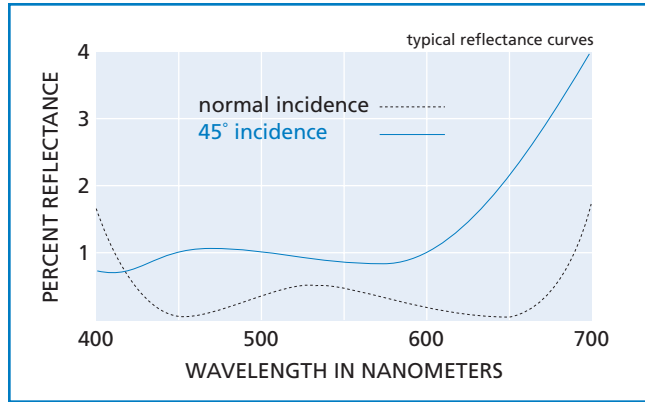
- HEBBAR™ coating for 245 to 440 nm
- $R_{avg} < 0.5\%$ ,  $R_{abs} < 1.0\%$
- Damage threshold: 3.5 J/cm<sup>2</sup>, 10-nsec pulse at 355 nm typical



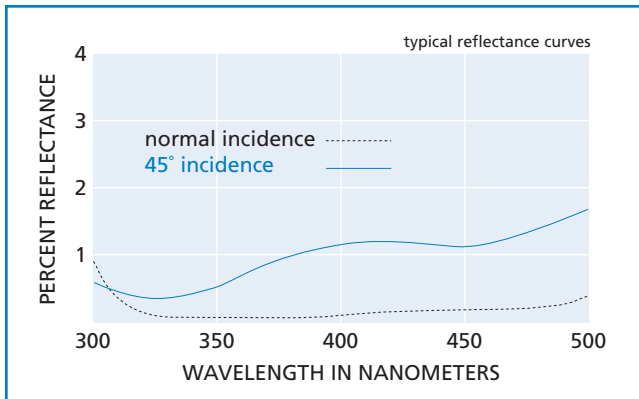
- HEBBAR™ coating for 780 to 850 nm diode lasers
- $R_{avg} < 0.25\%$ ,  $R_{abs} < 0.4\%$
- Damage threshold: 6.5 J/cm<sup>2</sup>, 20-nsec pulse at 1064 nm typical



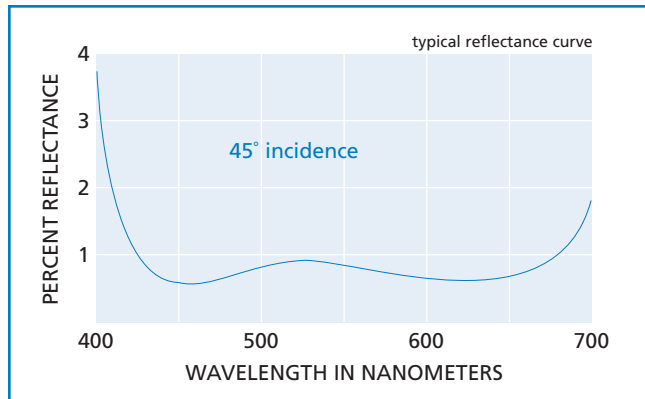
- HEBBAR™ coating for 750 to 1100 nm
- $R_{avg} < 0.4\%$ ,  $R_{abs} < 0.6\%$
- Damage threshold: 6.5 J/cm<sup>2</sup>, 20-nsec pulse at 1064 nm typical



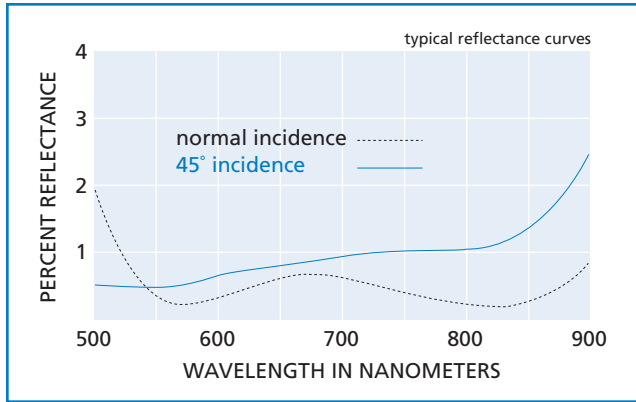
- Specialty HEBBAR™ coating for 415 to 700 nm
- $R_{avg} < 0.4\%$ ,  $R_{abs} < 1.0\%$
- Damage threshold: 3.8 J/cm<sup>2</sup>, 10-nsec pulse at 532 nm typical



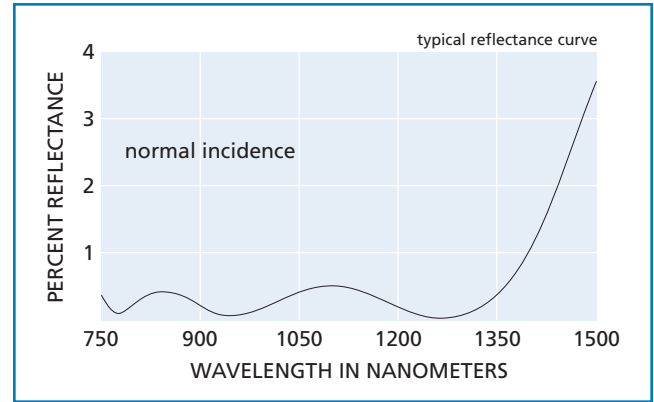
- Specialty HEBBAR™ coating for 300 to 500 nm
- $R_{abs} < 1.0\%$
- Damage threshold: 3.2 J/cm<sup>2</sup>, 10-nsec pulse at 355 nm typical



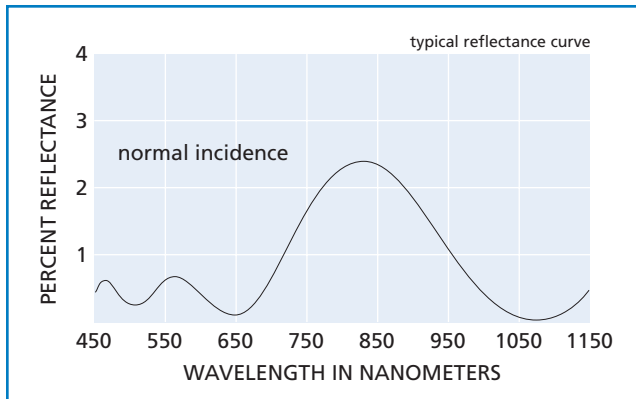
- Specialty HEBBAR™ coating for 425 to 670 nm optimized for 45°
- $R_{avg} < 0.6\%$ ,  $R_{abs} < 1.0\%$
- Damage threshold: 3.8 J/cm<sup>2</sup>, 10-nsec pulse at 532 nm typical



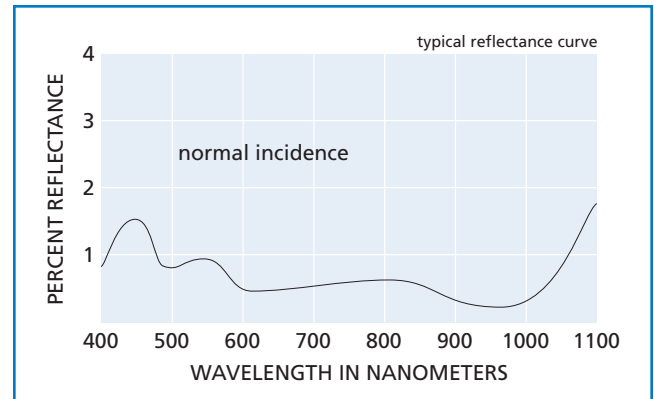
- Specialty HEBBAR™ coating for 660 to 835 nm diode lasers
- $R_{avg} < 0.5\%$ ,  $R_{abs} < 1.0\%$
- Damage threshold: 3.8 J/cm<sup>2</sup>, 10-nsec pulse at 532 nm typical



- Dual Band HEBBAR™ coating for 780 to 830 nm and 1300 nm
- $R_{abs} < 0.5\%$  @ 780 – 830 nm and 1300 nm
- Damage threshold: 5.4 J/cm<sup>2</sup>, 20-nsec pulse at 1064 nm typical



- Dual Band HEBBAR™ coating for 450 to 700 nm and 1064 nm
- $R_{abs} < 1.25\%$  @ 450 – 700 nm,  $R_{abs} < 0.25\%$  @ 1064 nm
- Damage threshold: 1.3 J/cm<sup>2</sup>, 10-nsec pulse at 532 nm typical; 5.4 J/cm<sup>2</sup>, 20-nsec pulse at 1064 nm typical



- Extended HEBBAR™ coating for 420 to 1100 nm
- $R_{avg} < 1.0\%$ ,  $R_{abs} < 1.75\%$
- Damage threshold: 4.5 J/cm<sup>2</sup>, 10-nsec pulse at 532 nm typical; 6.5 J/cm<sup>2</sup>, 20-nsec pulse at 1064 nm typical

**Standard HEBBAR™ Coatings**

Description	Wavelength Range (nm)	Reflectance (%)	Optimized for Angle of Incidence (degrees)	COATING SUFFIX	
				FORMER‡	REPLACED BY
HEBBAR™ 245-440nm	245-440	$R_{avg} < 0.50$	0	/072	HE-245-440
HEBBAR™ 780-850nm	780-850	$R_{avg} < 0.25$	0	/076	HE-780-850
HEBBAR™ 750-1100nm	750-1100	$R_{avg} < 0.40$	0	/077	HE-750-1100

‡ Former Melles Griot part number is replaced by new CVI Melles Griot part number

**Specialty HEBBAR™ Coatings, optional designs for OEM and Prototype applications**

Description	Wavelength Range (nm)	Reflectance (%)	Optimized for Angle of Incidence (degrees)	COATING SUFFIX	
				FORMER‡	REPLACED BY
HEBBAR™ 300-500nm	300-500	$R_{abs} < 1.0$	0	/074	HE-300-500
HEBBAR™ 415-700nm	415-700	$R_{avg} < 0.40$	0	/078	HE-415-700
HEBBAR™ 425-670nm	425-670	$R_{avg} < 0.60$	45 UNP	/079	HE-425-675-45UNP
HEBBAR™ 660-835nm	660-835	$R_{avg} < 0.50$	0	/075	HE-660-835

‡ Former Melles Griot part number is replaced by new CVI Melles Griot part number

**Dual Band HEBBAR™ Coatings**

Description	Wavelength Range (nm)	Reflectance (%)	Optimized for Angle of Incidence (degrees)	COATING SUFFIX	
				FORMER‡	REPLACED BY
HEBBAR™ 450-700nm and 1064nm	450-700 and 1064	$R_{avg} < 0.60$	0	/083	HE-450-700/1064
HEBBAR™ 780-830nm and 1300nm	780-830 and 1300	$R_{avg} < 0.40$	0	/084	HE-780-830/1300

‡ Former Melles Griot part number is replaced by new CVI Melles Griot part number

**Extended-Range HEBBAR™ Coating**

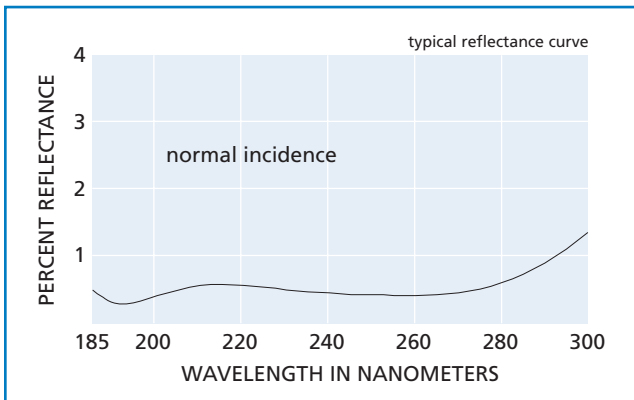
Description	Wavelength Range (nm)	Reflectance (%)	Optimized for Angle of Incidence (degrees)	COATING SUFFIX	
				FORMER‡	REPLACED BY
HEBBAR™ 420-1100nm	420-1100	$R_{avg} < 0.50$	0	/073	HE-420-1100

‡ Former Melles Griot part number is replaced by new CVI Melles Griot part number

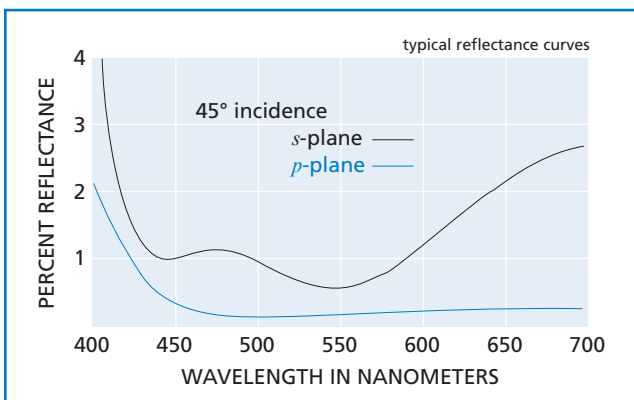
## BBAR-Series Coatings

CVI Melles Griot offers six overlapping broad band antireflection (BBAR) coating designs covering the entire range from 193 nm to 1600 nm. This includes very broad coverage of the entire Ti:Sapphire region. The BBDS coatings are unique in the photonics industry by providing both a low average reflection of  $\leq 0.5\%$  over a very broad range and also providing the highest damage threshold for pulsed and continuous wave laser sources (10J/cm<sup>2</sup>, 20ns, 20Hz at 1064nm and 1MW/cm<sup>2</sup>, CW at 1064 respectively). Typical performance curves are shown in the graphs for each of the standard range offerings. If your application cannot be covered by a standard design, CVI Melles Griot can provide a special broad band antireflection coating for your application.

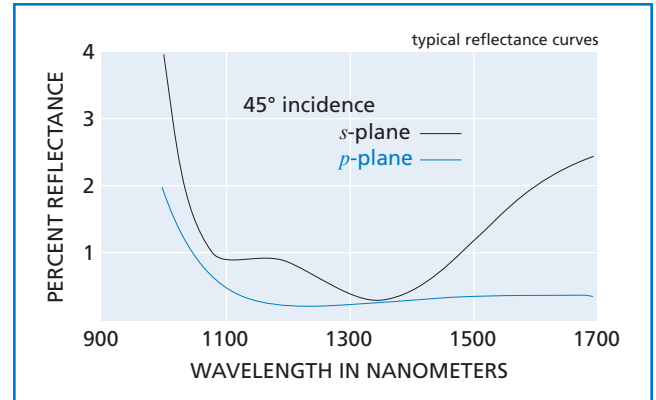
CVI Melles Griot also provides three mid infrared and far infrared broad band antireflection coatings from 2.0  $\mu\text{m}$  to 12.0  $\mu\text{m}$ . These coatings are available on a wide range of materials including Si, Ge, ZnS, ZnSe, or CaF<sub>2</sub>. Our standard coatings cover 2 to 2.5  $\mu\text{m}$ , 3 to 5  $\mu\text{m}$  and the 8 to 12  $\mu\text{m}$  region. Custom coatings are also available for mid and far infrared applications.



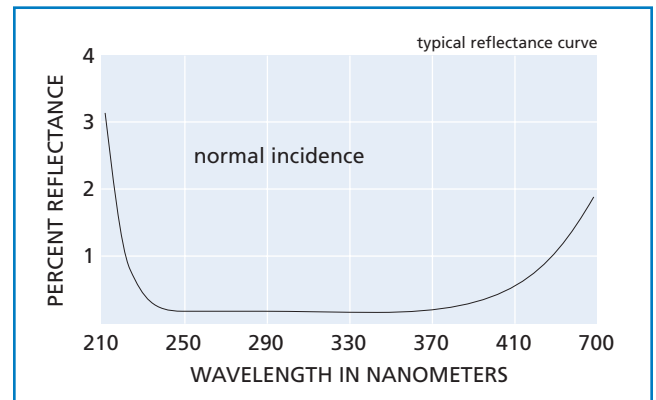
BBAR 193-248 coating for the UV region (0° incidence)



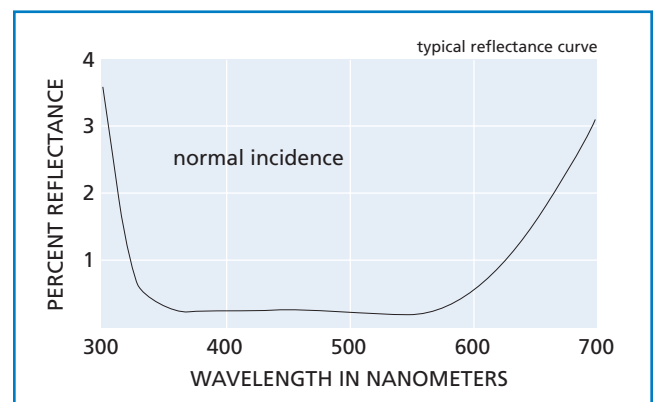
BBAR/45 425-675 coating for the visible region (45° incidence)



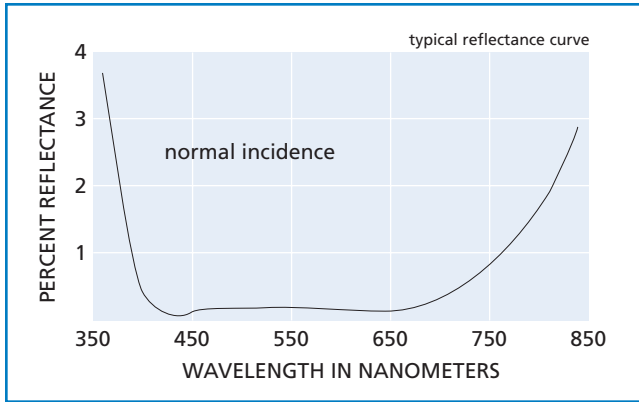
BBAR/45 1050-1600 coating for the NIR region (45° incidence)



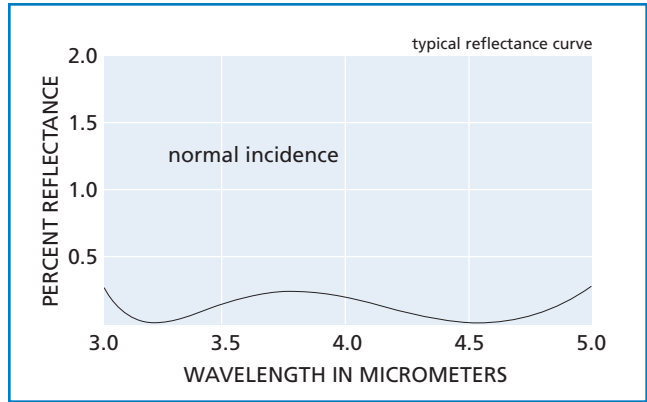
BBAR 248-355 coating for the UV region (0° incidence)



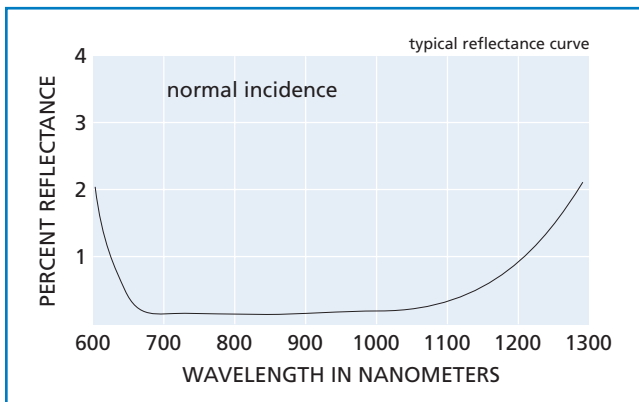
BBAR 355-532 coating for the UV region (0° incidence)



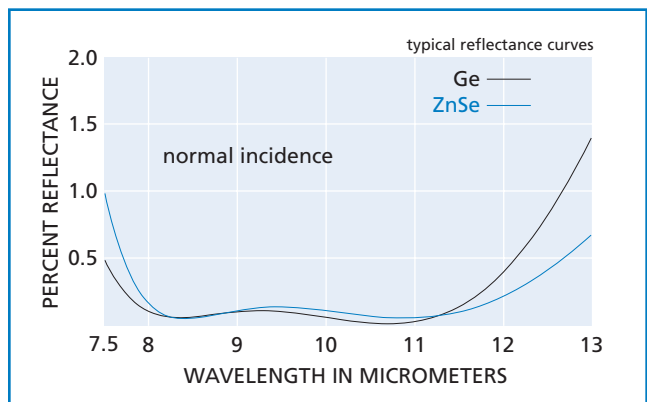
**BBAR 425-675 coating for VIS and NIR regions (0° incidence)**



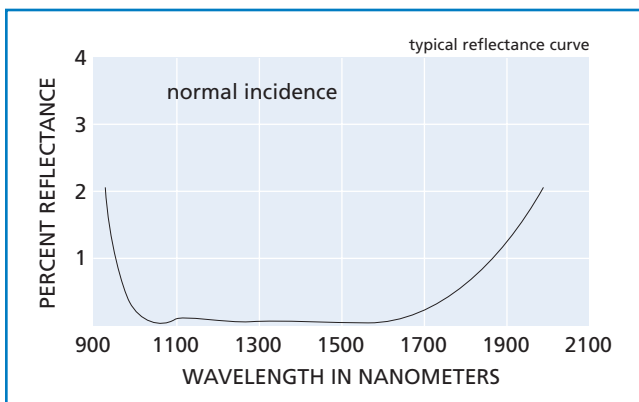
**BBAR 3500-5000 coating for the IR region (0° incidence)**



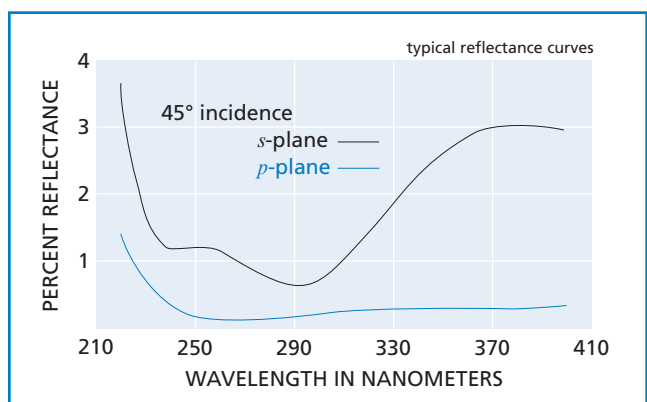
**BBAR 670-1064 coating for VIS and NIR regions (0° incidence)**



**BBAR 8000-12000 coating for the IR region (0° incidence)**



**BBAR 1064-1600 coating for VIS and NIR regions (0° incidence)**



**BBAR/45 248-355 coating for the UV region (45° incidence)**

## V-Coatings

CVI Melles Griot V-type AR Coatings are the best choice for a single laser wavelength or multiple, closely-spaced wavelengths. Examples are the principle argon laser lines at 488nm and 55nm, the neodymium transitions in a variety of host materials at 1047-1064nm, and the individual excimer laser lines.

CVI Melles Griot will manufacture V-Type AR coatings for wavelengths from 193nm to 10.6 $\mu$ .

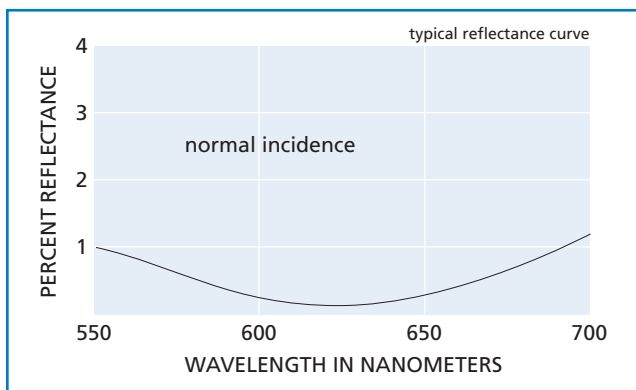
V-type AR coatings on Fused Silica, Crystal Quartz, Suprasil, and BK7 have damage threshold of 15J/cm<sup>2</sup> at 1064nm, 20ns, 20Hz. Typical performance can often exceed 20J/cm<sup>2</sup>.

Damage thresholds for AR coatings on SF11 and similar glasses are limited not by the coating, but by the bulk material properties. Our damage testing has shown a damage threshold for SF11 and similar glasses to be 4J/cm<sup>2</sup>.

When ordering, be sure to specify the following:

- Wavelength
- Substrate material
- Angle of incidence
- Polarization
- Fluence in J/cm<sup>2</sup>

The reflectance curve for a typical V-coating, on BK7 glass, designed for operation at 632.8 nm is shown below.



### Example of a V-coating for 632.8 nm

- Near-zero reflectance at one specific wavelength and incidence angle
- Maximum reflectance often less than 0.1%
- Standard coatings available for most laser lines
- Custom center wavelengths at specific angles of incidence available per request

The following table lists our standard V-coating designs for zero degree and 45° angles of incidence.

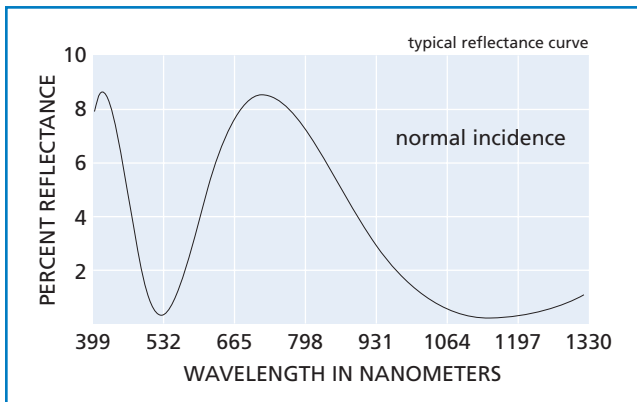
### V-Coating Center Wavelengths

Wavelength (nm)	Laser Type	Maximum Reflectance (%)	COATING SUFFIX	
			FORMER <sup>‡</sup>	REPLACED BY
193	ArF	0.5	/101	193-0
248	ArF	0.25	/102	248-0
266	Nd 3rd harmonic	0.25	/103	266-0
308	XeCl	0.25	/104	308-0
351	Ar ion	0.25	/105	351-0
364	Ar ion	0.25	/107	364-0
442	HeCd	0.25	/111	442-0
458	Ar ion	0.25	/112	458-0
466	Ar ion	0.25	/113	466-0
473	Ar ion	0.25	/114	473-0
476	Ar ion	0.25	/115	476-0
488	Ar ion	0.25	/116	488-0
496	Ar ion	0.25	/117	496-0
502	Ar ion	0.25	/118	502-0
514	Ar ion	0.25	/119	514-0
532	Nd 2nd harmonic	0.25	/122	532-0
543	HeNe	0.25	/121	543-0
633	HeNe	0.25	/123	633-0
670	GaAlAs	0.25	/128	670-0
694	Ruby	0.25	/124	694-0
780	GaAlAs	0.25	/163	780-0
830	GaAlAs	0.25	/166	830-0
850	GaAlAs	0.25	/167	850-0
904	GaAs	0.25	/125	904-0
1064	Nd	0.25	/126	1064-0
1300	InGaAsP	0.25	/168	1300-0
1523	HeNe	0.25	/169	1523-0
1550	InGaAsP	0.25	/169	1550-0

<sup>‡</sup> Former Melles Griot coating suffix is replaced by new CVI Melles Griot coating suffix

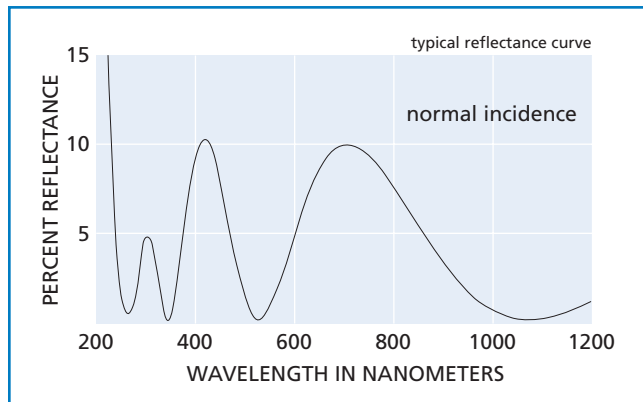
## Double-V and Triple-V Coatings

CVI Melles Griot offers Double-V and Triple-V multilayer antireflection coatings for use in Nd:YAG laser systems at normal incidence. Highly damage resistant, electron beam deposited dielectrics are used exclusively as coating materials. As shown in the curves, the antireflection peaks at the harmonics are quite narrow. Also, due to the coating design and dispersion, they do not fall exactly at a wavelength ratio of 1 : 1/2 : 1/3. Consequently, the reflectivity specifications of these AR coatings are not as good as V-coatings for any one wavelength. CVI Melles Griot offers these Double-V coatings on W2 windows, in all standard sizes. Contact CVI Melles Griot for the performance of 45° Double-V and Triple-V AR coatings or for other harmonic combinations.



**Double-V antireflection coating for 532 nm and 1064 nm**

- Designed for normal incidence
- $R < 0.3\%$  1064 nm
- $R < 0.6\%$  at 532 nm
- Damage threshold 5 J/cm<sup>2</sup> at 532 nm
- Damage threshold 10 J/cm<sup>2</sup> at 1064 nm



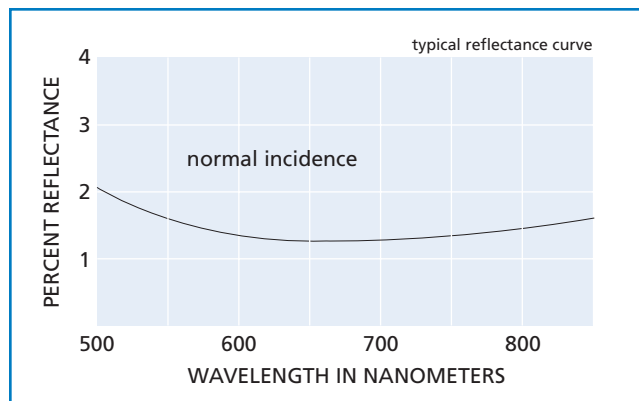
**Triple-V antireflection coating for 355 nm, 532 nm, and 1064 nm**

- Designed for normal incidence
- $R < 0.3\%$  1064 nm
- $R < 0.6\%$  at 532 nm
- $R < 1.5\%$  at 355 nm

## Single-Layer MgF<sub>2</sub> Coatings

Magnesium fluoride (MgF<sub>2</sub>) is commonly used for single-layer antireflection coatings because of its almost ideal refractive index (1.38 at 550 nm) and high durability. These coatings can be optimized for 550 nm for normal incidence, but as can be seen from the reflectance curves, they are extremely insensitive to wavelength and incidence angle.

Single-layer antireflection coatings for use on very steeply curved or short-radius surfaces should be specified for an angle of incidence approximately half as large as the largest angle of incidence encountered by the surface.

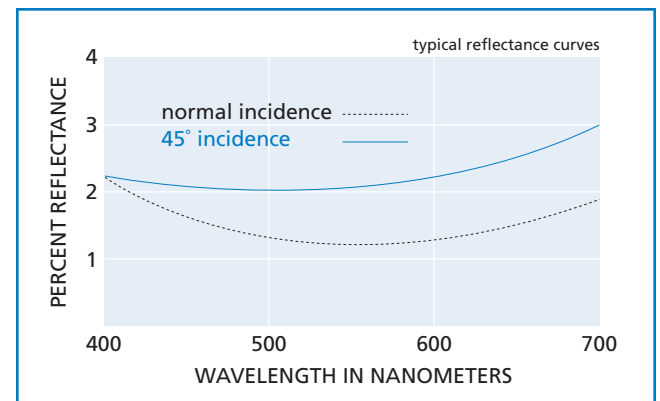


### Single-layer MgF<sub>2</sub> 520-820 nm coating

- Optimized for 670 nm, normal incidence
- Useful for most visible and near-infrared diode wavelengths
- Highly durable and insensitive to angle
- Damage threshold: 13.2 J/cm<sup>2</sup>, 10-nsec pulse at 532 nm typical

## Single-Layer MgF<sub>2</sub> Antireflection Coating Normal Incidence

Wavelength Range (nm)	Maximum Reflectance on BK7 (%)	Maximum Reflectance on Fused Silica (%)	COATING SUFFIX
400-700	2.0	2.25	SLMF-400-700
520-820	2.0	2.25	SLMF-520-820



### Single-layer MgF<sub>2</sub> 400-700 nm coating

- Popular and versatile antireflection coating for visible wavelengths
- Highly durable and most economical
- Optimized for 550 nm, normal incidence
- Relatively insensitive to changes in incidence angle
- Damage threshold: 13.2 J/cm<sup>2</sup>, 10-nsec pulse at 532 nm typical