BEAM

ENGINEERING FOR ADVANCED MEASUREMENTS Co.

MATERIALS

Azobenzene liquid crystals

Azobenzene monomers

Chiral azobenzene dyes

Photoalignment materials

Fast azobenzene liquid crystals with enhanced visible photosensitivity

Synthetic intermediates

LASER BEAM AND OPTICS CHARACTERIZATION SYSTEMS

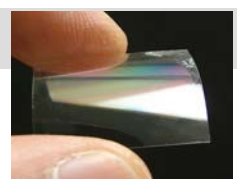
Crystal-Scan optical multimeter

Microscanning beam profiler

Express-collimator

Las-Air high power beam sampler

PHOTONICS COMPONENTS AND SYSTEMS



Achromatic polarization rotators

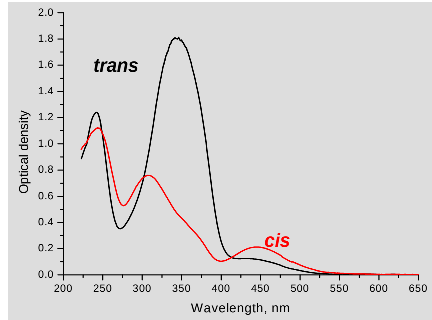
Eclipsor sensor protector

Polymer films for optical information recording, UV visualization and dosimetry

Broadband IR visualization windows

WE SOLVE EXTRAORDINARY PROBLEMS IN OPTICS!

AZOBENZENE LIQUID CRYSTALS



BEAM Co.'s azobenzene liquid crystals are photosensitive materials for photonics, nonlinear optical applications, optical information recording and processing using low power laser beams (10^{-7}-10^{-3} W).

Item #	Chemical name	Nematic range [°C]	Minimum order [g]
Single component			
D307	4-heptyl-4'-propylazobenzene	3-34	2
D308	4-octyl-4'-propylazobenzene	15 – 25[1)]	2
CAB6	4-cyano-4'-hexyloxyazobenzene	99 - 116	2
CAB7	4-cyano-4'-heptyloxyazobenzene	91 - 110	2
CAB8	4-cyano-4'-octyloxyazobenzene	102 - 111	2
Multicomponent			
1005	N/A	12.5 - 48.5	2
1205	N/A	8 – 59	2
5721	N/A	8 – 70	2
13C5	N/A	T_{clear}: custom[2)]	2
8621	N/A	22 - 72[3)]	2
8721	N/A	28 – 72[3)]	2
4915	N/A	-7 - 57	2
[1)]Monotropic smectic A phase below -16°C.			
[2)]Clearing point adjustable between 29°C-46°C.			
[3)]Monotropic smectic A phases below nematic range.			

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Selected Room Temperature Azobenzene LC Material Datasheet

LC	T [°C]	n_2 [cm²/W] [(a)]	E_{inc} [J/cm²] [(b)]	E_{iso} [J/cm²] [(c)]	Δn [(d)]	D [cm²/s] [(e)]	$\varepsilon_\perp$	$\varepsilon_\parallel$	U_{Fr} [V]
1005	12.5 N 48.5 I	$2.0\cdot10^{-1}$	0.073	0.39	0.18	$5.3\cdot10^{-6}$	3.0	3.4	8.2
1006	15 N 53 I	$2.1\cdot10^{-1}$	0.074	0.39	0.18	$5.2\cdot10^{-6}$	3.2	3.6	9.7
1007	17 N 52 I	$2.4\cdot10^{-1}$	0.077	0.51	0.18	$5\cdot10^{-6}$	3.2	3.7	9.9
1205	8 N 59 I	$2.1\cdot10^{-1}$	0.13	0.73	0.21	$6.3\cdot10^{-6}$	3.2	4.0	9.5
1207	16.5 N 63.5 I	$1.9\cdot10^{-1}$	0.14	0.82	0.20	$6.2\cdot10^{-6}$	3.2	3.9	9.8
5721	8 N 70 I	$1.2\cdot10^{-1}$	0.19	1.35	0.23	$3.6\cdot10^{-6}$	2.6	3.3	15
8621	SmA 22 N 72 I	$1.1\cdot10^{-1}$	0.16	1.64	0.20	$6.1\cdot10^{-6}$	3.0	3.3	19.6
8721	SmA 28 N 72I	$1.1\cdot10^{-1}$	0.16	1.68	0.21	$8.7\cdot10^{-6}$	3.1	3.2	22.8
4911	2 N 56 I	$1.9\cdot10^{-1}$	0.075	0.52	0.18	$4.7\cdot10^{-6}$	3.3	3.9	20.5
4915	-7 N 57 I	$2.1\cdot10^{-1}$	0.067	0.47	0.18	$4.1\cdot10^{-6}$	3.1	3.7	17
4955	4 N 63 I	$2.1\cdot10^{-1}$	0.13	0.93	0.20	$4.4\cdot10^{-6}$	3.0	3.7	19.8
4913	3 N 52 I	$2.0\cdot10^{-1}$	0.076	0.60	0.20	$4.2\cdot10^{-6}$	3.0	3.6	18
4953	4 N 57 I	$2.0\cdot10^{-1}$	0.10	0.79	0.21	$4\cdot10^{-6}$	3.0	3.5	16.3
3178	18 N 41.5 I	$1.8\cdot10^{-1}$	0.058	0.28	0.14	$5.5\cdot10^{-6}$	2.4	3.2	8.5
3155	3 N 48 I	$2.2\cdot10^{-1}$	0.11	0.43	0.20	$5.1\cdot10^{-6}$	2.6	3.3	7.5
D307	3 N 34 I	$3.2\cdot10^{-1}$	0.016	0.1	0.20				

(a) λ = 532 nm, $I = 4.4\cdot10^{-7}$ W/cm², **E**||**n** (**E**: light polarization; **n**: LC orientation), L = 10 μm.

(b) λ = 409 nm, $I = 6.2\cdot10^{-3}$ W/cm², L = 10 μm, **E**||**n** (L is the thickness of LC layer).

(c) λ = 409 nm, $I = 6.2\cdot10^{-3}$ W/cm², L = 10 μm, **E**||**n.**

(d) λ = 633 nm, T = 23°C

(e) λ = 633 nm, T = 23°C

Constant of nonlinear refraction n_2: determines the change in the refractive index $n - n_0$ of the material under the influence of a light beam of power density I according to the formula $n - n_0 = n_2 I$.

Incubation energy E_{inc}: determines the amount of light energy that the LC has to be exposed to in order to start photoinduced mesophase-isotropic phase transition.

Transition energy E_{iso}: determines the amount of light energy that LC has to be exposed to in order for the material to be transformed into isotropic phase.

Optical anisotropy Δn: is defined as the difference between the principal values of the refractive indices of LC.

Constant of "orientation diffusion D: allows to evaluate the free relaxation time t of LC director reorientation in cells of thickness L with hard anchoring boundary conditions with the aid of the formula $\tau = L^2/D$. The constant of "orientation diffusion" D is related with the orientational viscosity γ and the elastic constant K_1 of the liquid crystal by the expression $D = \pi^2 K_1/\gamma$.

Constants of dielectric susceptibility: $\varepsilon_\perp$ and $\varepsilon_\parallel$ are the principal values of the dielectric susceptibility of NLC at 1 kHz.

Freedericks transition threshold U_F: the minimum voltage necessary to apply to the NLC cell in order to induce NLC reorientation.

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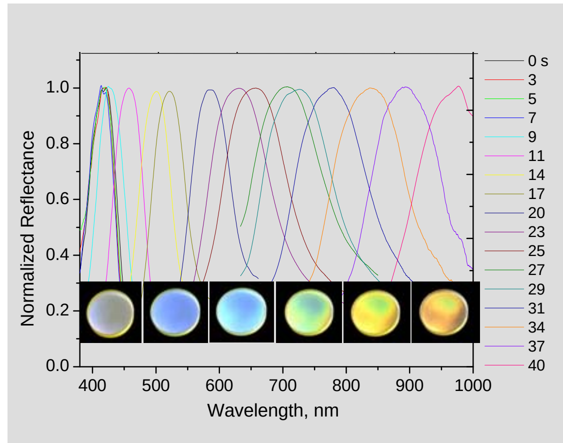
CHIRAL AZOBENZENE DYES

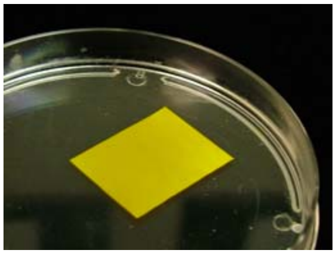
Chiral azobenzene dyes are used for producing phototunable bandgap materials (cholesteric liquid crystals)

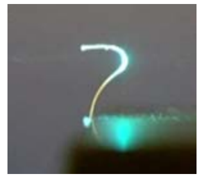


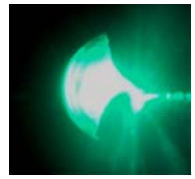
Item #	HTP [mm^{-1}]	Min. Order
ChAD-1-R	10 (in 5CB)	2 g
ChAD-1-S	-10 (in 5CB)	2 g
ChAD-2-R	22 (in 1444)	2 g
ChAD-2-S	-22 (in 1444)	2 g
ChAD-3C-R	30 (in 1444)	100 mg
ChAD-3C-S	-30 (in 1444)	100 mg
AA-Bn11-R	30 (in 1444)	100 mg
AA-Bn11-S	-30 (in 1444)	100 mg
It-12-R	30 (in 1444)	100 mg
It-12-S	-30 (in 1444)	100 mg

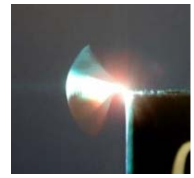
Note 1: Data on Helical Twisting Power (HTP) are approximate and are obtained with the material kept in dark for 24 hours.
Note 2: The letters R and S in the name of the material refer to right-hand and left-handed materials, respectively.
Note 3: The materials starting with AA in the name are diacrylates.

Azobenzene Monomers

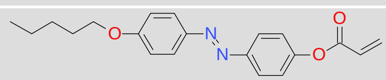
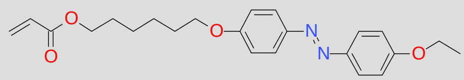
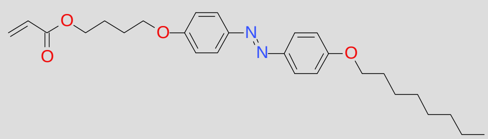
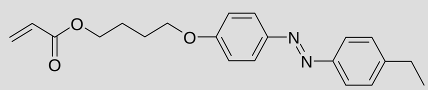
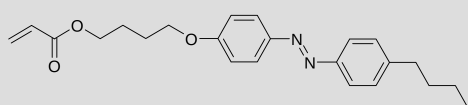
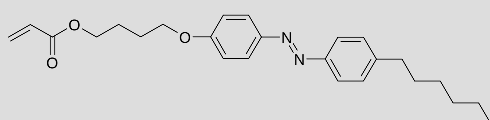




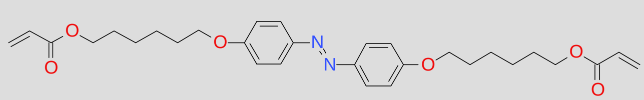
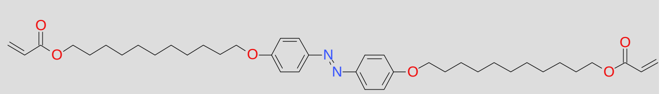




Acrylates

Name	PTT	Structure
A0Z5	Cr 84 N 115 Iso	
A6Z2	Cr 97 N 98 Iso	
A4Z8	Cr 72 N 95 Iso	
A4Z2n	Cr 59 Iso Iso 35 Cr	
A4Z4n	Cr 57 Iso Iso 41 N 37 Cr	
A4Z6n	Cr 49 S 52 N 54 Iso Iso 52 N 38 S 25 Cr	

Diacrylates

A6ZA6	Cr 102 Iso	
A11ZA11	Cr 92 N 94 Iso Iso 92 N 75 Cr	

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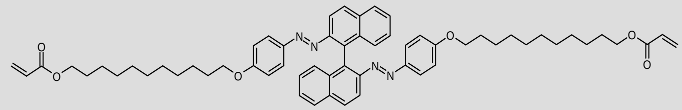
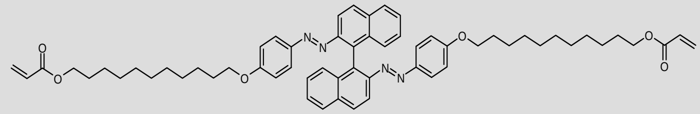
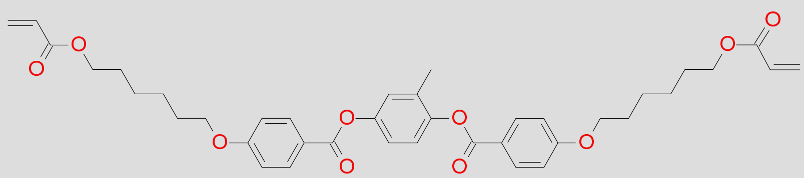
Chiral Azobenzene Monomers

Diacrylates

AA-Bn11-R	Chiral (Right-handed)	
AA-Bn11-S	Chiral (Left-handed)	

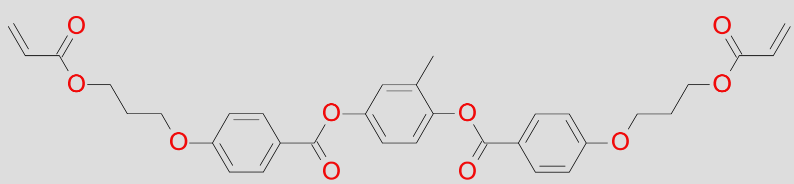
Reactive Mesogenes (non-Azobenzene)

1,4-Bis-[4-(6-acryloyloxyhexyloxy)benzoyloxy]-2-methylbenzene



Cr 86 N 118 Iso

1,4-Bis-[4-(3-acryloyloxypropyloxy)benzoyloxy]-2-methylbenzene



Cr 70 N 126 Iso

Material	**Min. order [g]**
Azo-monomers: acrylates	2
Azo-monomers: diacrylates	2
Azo-monomers: chiral diacrylates	0.1
Reactive mesogenes (non-azo)	5

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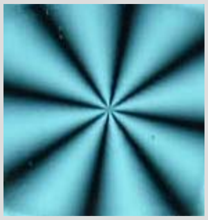
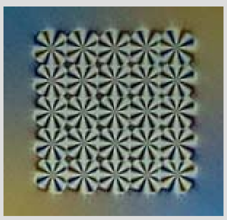
PHOTOALIGNMENT MATERIALS





Liquid crystal polymer polarization grating, spiral phase plates and polarization converters produced with the aid of photoalignment technique.

BEAM Co.'s photoalignment materials are based on azobenzene. Using different molecular structures allows us to offer materials optimized for different radiation wavelengths. The alignment axis is perpendicular to polarization and is reversible when used with liquid crystals. The materials were tested to provide high resolution patterns required for polarization gratings and spiral phase waveplates.

The technology involves spin coating and solvent evaporation that can be performed even at room temperature.

SPECIFICATIONS				
Item code	Λ_{max} [nm]	E [J/cm^2]		
		λ = 458 nm	λ = 325 nm	λ = 365 nm
PAAD-22	367	0.6	0.3	0.5
PAAD-23	403	4.5	7.2	9
PAAD-26	429	3	12.6	14.4
PAAD-27	393	0.3	2.7	1.1
PAAD-29	404	3	12.6	No

E – exposure energy, λ_{max} – peak absorption wavelength, λ – exposure wavelength

The materials are shipped in a solution ready for spin coating.
Minimum order: 2g.
Price: Custom quotation.

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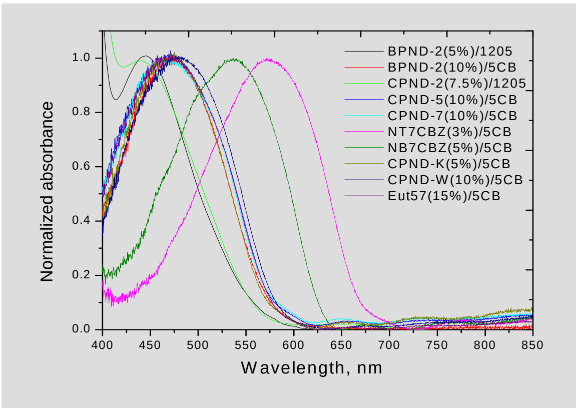
Fast Azobenzene Liquid Crystals with Enhanced Visible Photosensitivity



New azobenzene LCs have enhanced photosensitivity for visible wavelengths and can be used for optical switching of nanosecond pulses as well as cw laser beams.

Material Name	T_c [°C]	λ_m [nm]	α [cm^{-1}]	τ_r [s]	**Minimum order [g]**
BPND-2(5%)/1205	58	445 (cis)	2100	~10^5	2
BPND-2(10%)/5CB	30.5	471	5880	0.1	2
CPND-2(7.5%)/1205	60	442 (cis)	2330	~10^5	2
CPND-5(10%)/5CB	38.5	471	5360	~ 1	2
CPND-7(10%)/5CB	39	471	5650	0.9	2
NT7CBZ(3%)/5CB	39	574	4790	0.002	2
NB7CBZ(5%)/5CB	43	537	6540	0.003	2
CPND-K(5%)/5CB	36	473	3050	~ 1	2
CPND-W(10%)/5CB	34.5	481	6070	~ 1	2
Eut57(15%)/5CB	41.5	471	7370	~ 1	2

T_c: clearing temperature; λ_m: wavelength of maximal absorption; α absorption coefficient at 532 nm wavelength; τ : cis-isomer lifetime

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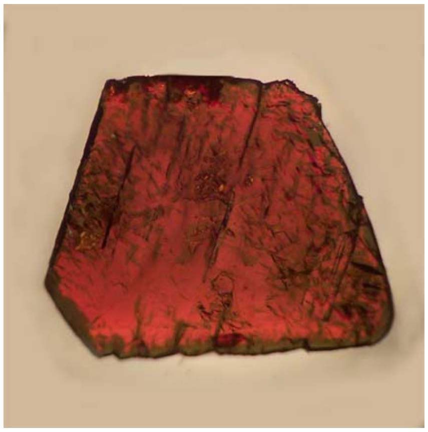
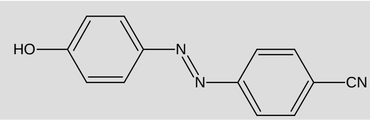
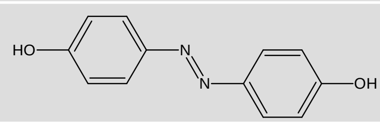
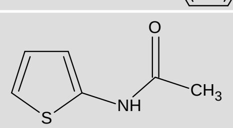
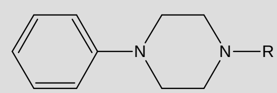
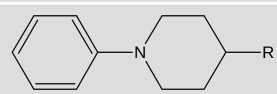
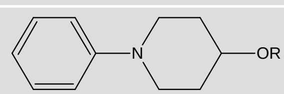
SYNTHETIC INTERMEDIATES



Micrograph of crystal DHAB

Building blocks for organic synthesis, particularly for photoresponsive azo LC polymers.

Item#	Chemical name	Formula	Minimum order [g]
CHAB	4-Cyano-4'-hydroxyazobenzene		2
DHAB	4.4'-Dihydroxyazobenzene		2
2-ADTHP	2-Acetamidothiophene		2
NPNRC-n	N-Alkyl-N'-phenylpiperazines, n=3-8		2
NP4RC-n	N-Phenyl-4-alkylpiperidines, n=2-8		2
NP4RO-n	N-Phenyl-4-alkoxypiperidines, n=2-8		2

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CRYSTAL - SCAN

MODULAR, RECONFIGURABLE, FAST, PRECISE

CSX-300

Winner of the Photonics Circle of Excellence Award

CSX-400

CSX-500

U.S. Patent # 6,678,042

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CRYSTAL-SCAN FUNCTIONS

Crystal-Scan is an interactive modular system for laser beam and optics characterization easily reconfigurable for high-precision and fast measurements of several parameters of laser beams, focusing optics and other optical components that are substantial for most laser applications.

The base models allow:

- high precision determination of focus position
- measuring diameter of focused laser beams
- measuring peak power density of the beam
- characterization of quality of lenses and objectives

Crystal-Scan is the only commercially available device with the range of focal waist measurements from less than *1 μm and up to 100 μm* diameter*.* It can be *set up within minutes,* and performs the *measurement within seconds*.

Optional accessories extend the capabilities of the system to measuring:

- laser beam divergence
- quality factor
- diameter of unfocused laser beams (mircoscanning configuration), and
- power of unfocused laser beams (mircoscanning configuration).

Measurements of power and beam diameter in Microscanning configuration, are performed on-line, without introducing any appreciable distortion into the beam.

The educational model CSX-300 (educational model) allows simplified insertion and removal of lenses without affecting the alignment of the overall system. In a single laboratory hour, students will be able to verify all main laws governing laser beam propagation, and the effect of aberrations.

A reliable and an affordable measuring tool for everyday needs of optics professionals and laser users…

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Crystal – Scan Optical Multimeter Specifications

Device feature / Model	CSX-400	CSX-500	CSX-300
Waist measurement range	2 μm - 200 μm	0.5 μm - 100 μm	3 μm - 150 μm
Unfocused beam width measurements range	100 μm - 5 mm	100 μm - 3 mm	100 μm - 5 mm
Laser power range	1 mW – 10 W	1 mW – 10 W	1 mW – 10 W
Damage threshold	1 kW/cm^2 - 1 MW/cm^2	1 kW/cm^2 - 1 MW/cm^2	1 kW/cm^2 - 1 MW/cm^2
Power density range	10 W/cm^2 – 1 MW/cm^2	10 W/cm^2 – 1 MW/cm^2	10 W/cm^2 – 1 MW/cm^2
Wavelength range	0.4 μm - 1.8 μm	0.4 μm - 1.8 μm	0.4 μm - 1.8 μm
Aperture of sensor head	12.5 mm or 25.4 mm	0.4” x 0.4"	12.5 mm or 25.4 mm
Measurement time	30 s	20 s	30 s
Absolute standard error	< 4 %	< 4 %	< 4 %
Weight	546 g	412 g	574 g
Dimensions	3.25” x 8” x 1.5”	1.5” x 2” x 6”	3.25” x 9.5” x 1.5”
Power supply	110 V/220 V	110 V/220 V	110 V/220 V
Data acquisition and display	Desktop or Notebook	Desktop or Notebook	Desktop or Notebook
Lead Time	6 weeks	6 weeks	3 weeks
Noninear Optical Element			
	LC-VL1	LC-VL2	LC-IL
Wavelength range	0.4 μm – 0.7 μm	0.4 μm – 1.8 μm	0.9 μm – 1.3 μm
Power range	1 mW - 100 mW	100 mW - 10 W	1 mW - 100 mW
Maximum power density	1 kW/cm^2	1 MW/cm^2	1 kW/cm^2
Clear aperture sizes available	12.5 mm, 25.4 mm, 10 mm x 10 mm		
Photodetector*			
	PDA-55	PDA-155	PDA-400
Wavelength range	0.4 μm – 1.1 μm	0.2 μm – 1.1 μm	0.7 μm – 1.8 μm
* Thorlab parts			

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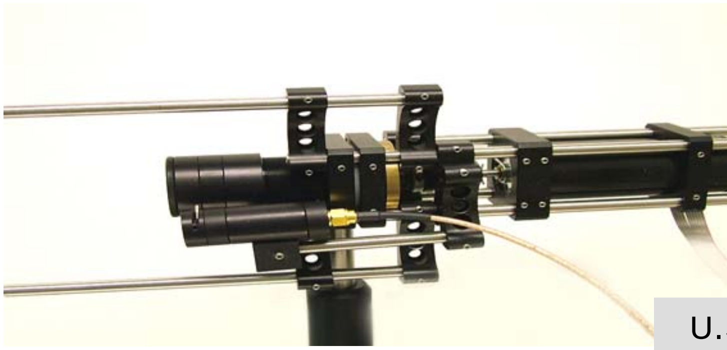
MICROSCANNING BEAM PROFILER



U.S. Patent # 6,526,077

The ***Microscanning Beam Profiler*** has been developed for measuring the diameter of laser beams on-line, without introducing any appreciable distortion into the beam. Unique features of the device include its applicability to measuring arbitrarily high power and large area cw laser beams

Microscanning Beam Profiler can be mounted and stay directly in the beam path during operation of the laser. For laser beams with essentially non-Gaussian profile, Microline will output the beam diameter defined as the size of localization of 86.5% of the total laser beam power. Once calibrated, it also will provide the total power of the beam.

Device feature / Model	**CSX-600HP**
Waist measurement range	20 μm – 100 μm
Unfocused beam width measurements range	1 mm – 50 mm
Laser power range	5 W – 100 W
Damage threshold	10 MW/cm^2
Power density range	> 1 kW/cm^2
Wavelength range	0.4 μm – 1.8 μm
Measurement time	20 s
Time between measurements	1 s
Absolute standard error	< 5%
Weight	2 kg
Dimensions	30 cm x 6.5 cm x 10.5 cm
Power supply	110 V/220 V
Data acquisition and display	Desktop or Notebook
Lead time	6 – 8 weeks

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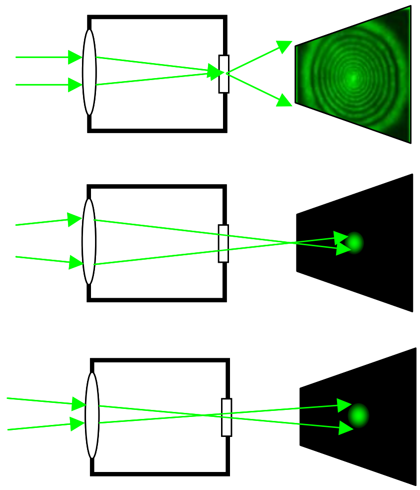
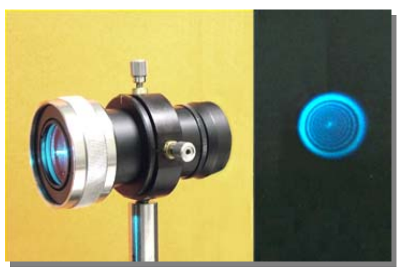
EXPRESS COLLIMATOR (X-COLLIMATOR)





The *X-Collimator* has been developed for testing collimation of laser beams and quick alignment of optical systems to get the best collimation.

The device outputs a strongly diverging beam with typical pattern consisting of a number of concentric rings. Both the divergence and the number of rings are maximum when the best collimation is obtained. Simply observing for the changes in the divergence of the beam at the output of the device while aligning lenses allows achieving the best collimation of a system of lenses within seconds.

The *X-Collimator* also allows visual monitoring and evaluation of divergence, quality and peak power density of laser beams.

Device feature	Feature value	Note
Average power	1 mW – 1 W	Specify range, cw or quasi-cw
Wavelengths	0.4 μm – 1.5 μm	Requires IR viewer for IR operation
Precision	10^{-3} – 10^{-5} rad	Varies with beam quality, wavelength, and required power range
Weight	100 - 300 g	Varies for different models
Length	2” – 4”	May vary for different models
Power supply	None	
Lead time	2-3 weeks	

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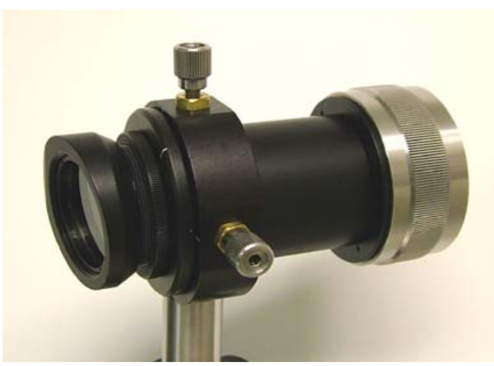
Express Collimator Models

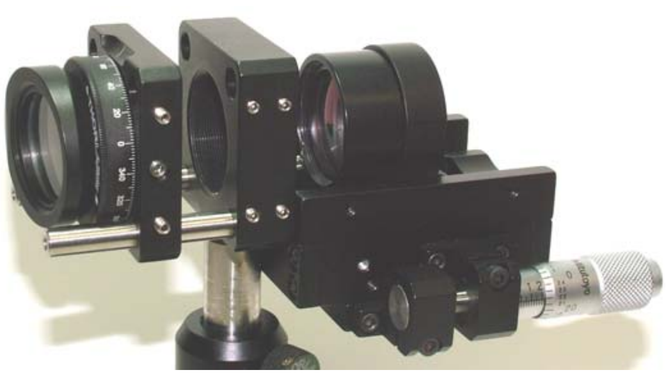
Model XC

This is the base model. Coarse adjustments are possible, but it is not practical to perform them on-line.



Model XCA

Z-translating lens mount allows on-line fine adjustment of the distance between the lens and the nonlinear optical sensor element. X-Y translating mount allows using different areas of the nonlinear optical sensor material. The price of the translators is added to the price of the base model shown below.



Model XCU

Long range Z-translating lens mount allows calibration of the device for a wide range of wavelengths and laser beam sizes. Rotation stage mounted radiation sensor head allows optimizing the signal for polarized beams.

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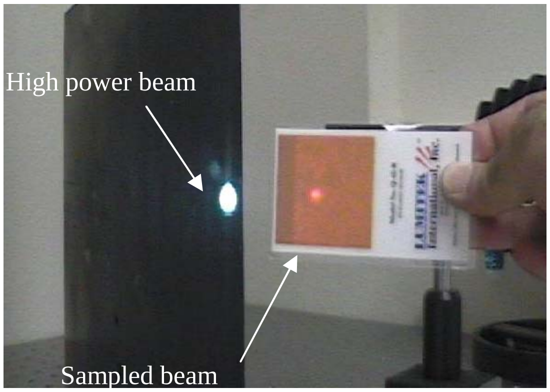
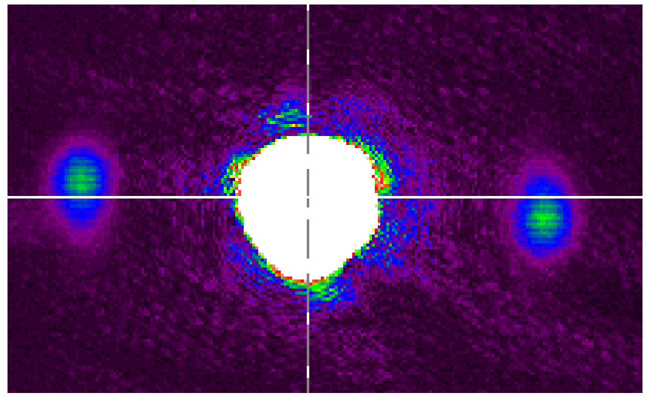
LAS-AIR High Power Beam Sampling System





LAS-AIR makes possible sampling of high energy/power laser beams through generation of an ultrasound grating in air or in other gaseous propagation medium of the laser beam. Its unique features include:

- no upper limit to the power of the lasers beam for profiling
- no distortions introduced into the beam
- electrically controlled attenuation of the sampled beam to any desired level

SPECIFICATIONS		
Device feature	**Feature value**	**Note**
Sampling ratio	$10^{-3} – 10^{-4}$	
Wavelengths	0.5 μm – 10.6 μm	
Laser power	> 10 mW	at visible wavelengths
Damage threshold	Not applicable	
Beam size	< 2”	
Weight	200 g	Sampling element only
Size	1” x 2”	Sampling element only
Price	Custom quotation	Includes sampling element and its controller, CCD and profiling software optional.
Lead time	8 – 10 weeks	Varies depending on the laser system

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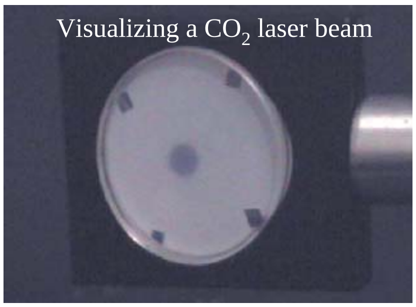
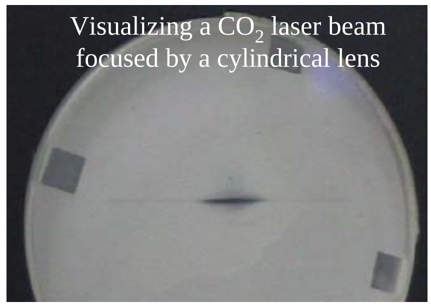
Broadband Infrared
Visualization and Alignment Windows


Visualizing a CO_2 laser beam


Visualizing a CO_2 laser beam focused by a cylindrical lens

The area of the window subject to infrared laser beam (particularly, CO_2 laser beam) becomes translucent, and the beam propagates through it. The clearly visible translucent spot allows to perform conveniently all the alignment tasks as well as to judge about the power and energy distribution of the beam. Broadband IR viewers are available for laser beam power operation range extending from 100 mW to 3 W. The response time is around 50 ms being a function of the laser beam power. These IR viewing films are inexpensive and can be manufactured in different sizes.

Device feature	Feature value	Note
Peak power density	1 – 10 W/cm^2	Depends on the wavelength of the laser beam
Minimum power	>5 mW	Depends on the wavelength of the laser beam
Damage threshold	> 10 W/cm^2	Depends on required sensitivity
Resolution	>10 lines/mm	
Wavelengths	Near-to-far IR	
Aperture	1”	Other sizes and shapes available
Response time	< 1 s	Depends on power density
Lead time	6 – 8 weeks	

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Eclipsor for Sensor Protection

The ***Eclipsor*** is used for sunlight mitigation in situations when the Sun is jamming the observation of the scenery around it. The Eclipsor protects the sensor (eye, CCD) from being blinded while maintaining overall transmission.

Device feature	Feature value	Note
Degree of attenuation	100 - 5000	
Response time	50 ms – 1 s	
Relaxation time	100 ms – 10 s	
Sensitivity	1 μW – 10 mW	Varies depending on nonlinear optical material
Aperture	0.5” – 2”	Custom sizes and shapes possible
Operation temperature	0ºC – 80ºC	
Operation temperature range	±10ºC	
Transmission	Up to 40%	λ = 532 nm
Weight	20 g - 200 g	Varies for different models
Dimensions	1.5” x 2” x 6”	Varies for different models
Power supply	110 V/220 V	
Lead time	4 weeks	

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Achromatic Polarization Rotators



These optical components are made to rotate polarization of a laser beam by a fixed angle according to your specification. The rotation angle does not depend on wavelength of radiation.

Model	PR-VIS	PR-MIR	PR-FIR
Rotation angle	0 – 90º	0 – 90º	0 – 90º
Wavelengths	0.4 μm – 1.8 μm	3.4 – 6.1 μm	μm
Transmission	92% without AR coating		
Substrate material	BK7	CaF_2	ZnSe
Aperture	1" standard. Other sizes available		
Lead time		2 - 4 weeks	

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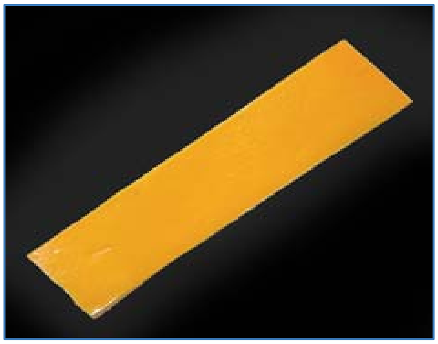
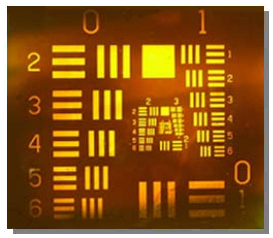
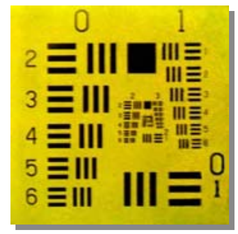
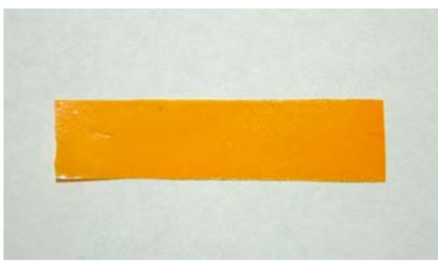
Polymer Films for Optical Information Recording, UV Visualization and Dosimetry









Call for custom specifications

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