THz Time Domain Spectrometer and Accessories

DAHENG NEW EPOCH TECHNOLOGY, INC.

大恒光电 Daheng Optics

CIP-TDS

Terahertz Time-Domain Spectrometer

Typical applications

- Spectroscopic material characterization
- Optical pump terahertz probe(Optional)
- Non-linear spectroscopy

Features

- Broadband sensitivity up to 3.5 THz
  High dynamic range
- Transmission and reflection modes
  Quick N2 purging
- Turnkey operation
- Open architecture
- USB 2.0 connectivity
- Remote operation via network
- Imaging, gas cell, attenuated-total
- reflection, optical-pump terahertz-probe
- options available

Figure 1. CIP-TDS system. External oscillator laser system not shown.

Specifications

Laser source:	Ti:S Oscillator or Fiber based
Bandwidth1:	0.1-3.5THz
Frequency resolution:	＜5GHz
Terahertz Emitter:	LT-GaAs PC Antenna
Terahertz detector:	ZnTe Electro-Optical Crystal
Scanning range *2:	＞150mm（＞500ps）
Min.Scanning resolution:	＜2μm
Dynamic range:	＞70dB
Operational Geometry:	Transmission or Reflection
Analytical area *3:	Φ13mm
Software	Terahertz Analysis and Control (TAC) software with plug-in architecture for custom application development
Control Device:	Standard PC or Laptop（windows XP/7/8）
Size (LxWxH) / Weight:	640mm×460mm×370mm/30kg

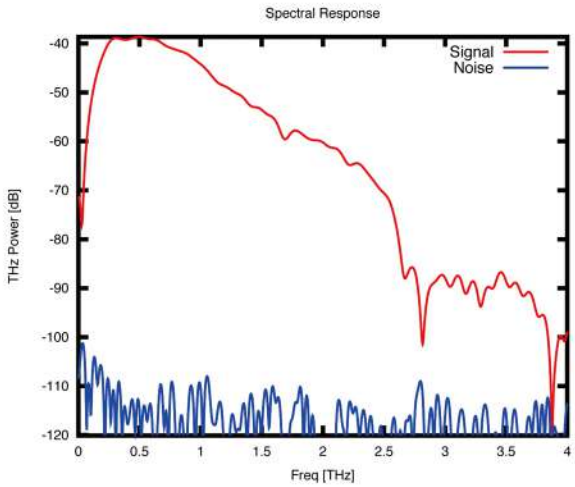

Figure 2. Typical TDS spectrum.

1. Spectral Range is dependent on pump laser pulse width. For best results out to 4.0 THz, a pulse width of 80fs or less is recommended with an average pump power of

Common configurations

Oscillator laser CIP-TDS Spectrometer is required Ti:S oscillator or Fiber oscillator (500mw - 50 fs pulse) - complete system.

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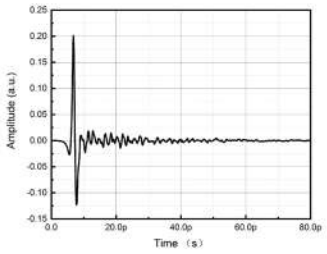
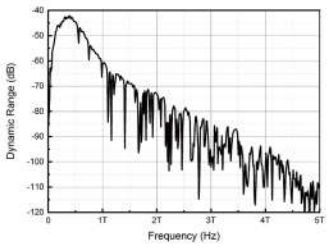
CIP-FICO

Fiber-Coupled Terahertz Time Domain System





Typical FICO spectrum

Features

- Independent fiber-coupled Tx and Rx heads
- Real-time spectroscopy
- Broadband sensitivity up to 4.0 THz
- Transmission and reflection modes
- Multiple lens options to accommodate a variety of imaging conditions
- Measurement point indicated by laser guide for precise alignment

Capabilities

- Stand-off reflection measurements
- Excellent for spectroscopic and imaging applications, including non-destructive testing
- Penetrates many dielectric materials
- Thickness and coatings measurements
- Optional XY imaging stage for fast and convenient imaging measurements

Specifications

Bandwidth1:	0.1-4THz
Frequency resolution:	＜5GHz
Time resolution	20fs
Min.Scanning resolution:	＜2μm
Dynamic range:	＞70dB
Operational Geometry:	Transmission Reflection Pitch-catch
Software	Terahertz Analysis and Control (TAC) software with plug-in architecture for custom application development
Control Device:	Standard PC or Laptop（windows XP/7/8）

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CIP-TDS-DAHENG OPTICS

大恒光电 Daheng Optics

CIP–ABCD

Ultra-Broadband, High Electric Field Terahertz Time-Domain Spectrometer

Overview

Terahertz Air Biased Coherent Detection (CIP-ABCD) is a radical new technique that uses airplasma to both generate and detect ultrabroadband terahertz radiation. With CIP-ABCD it is possible to reach bandwidths in excess of 20 THz limited only by laser pulse duration with no phonon absorption or damage threshold because no solid material is involved in the generation or detection. CIP-ABCD also generates high terahertz electric fields that enable non-linear spectroscopy.

Daheng New Epoch Technology,Inc. Terahertz Time Domain Spectrometer offers a convenient integrated package with a large sample chamber to accommodate a variety of experimental requirements, including optical-pump terahertz probe (OPTP) and integration with cryostats for low temperature measurements. The CIP-ABCD requires an amplifier laser system.

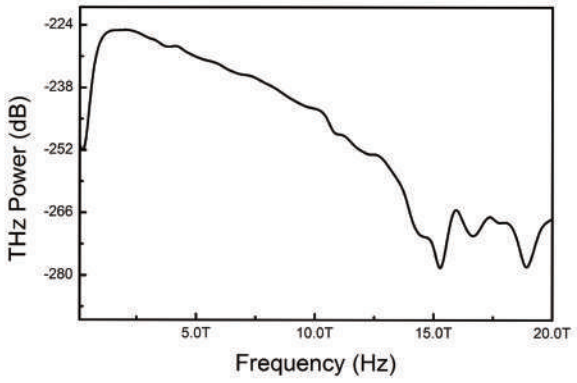
Typical applications

- Spectroscopic material characterization
- Optical pump terahertz probe(Optional)
- Non-linear spectroscopy

Features

- Ultra-broad bandwidth (>10 THz), gapless spectral coverage from mm-wave to FIR
- High THz electric field (>100 kV/cm), nonlinear spectroscopy
- Higher SNR below 10 THz than cryo-cooled FTIR
- Room-temperature detector
- Large sample chamber
- Customizable software

Figure 1. ABCD system. External amplifier laser system not shown



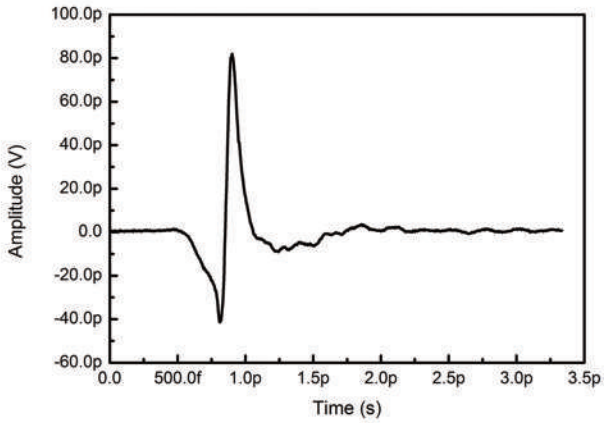


Figure 2. Typical ABCD spectrum. With a pump pulse durationof <35 fs, bandwidths of >20 THz are possible.

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CIP–ABCD–DAHENG OPTICS

大恒光电 Daheng Optics

CIP-ABCD

Ultra-Broadband, High Electric Field Terahertz Time-Domain Spectrometer

Specifications

Laser source:	Ti:S Amplifier
Bandwidth:	0.1-10THz
Frequency resolution:	＜5GHz
Terahertz Emitter:	Air Plasma
Terahertz detector:	Air Plasma
Scanning range *2:	＞150mm（＞500ps）
Min. Scanning resolution:	＜2μm
Dynamic range:	＞60dB
Operational Geometry:	Transmission or Reflection
Analytical area *3:	Φ13mm
Software	Terahertz Analysis and Control (TAC) software with plug-in architecture for custom application development
Control Device:	Standard PC or Laptop（windows XP/7/8）
Size (LxWxH) / Weight：	1000mmX675mmX213mm/60kg

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CIP-ABCD-DAHENG OPTICS

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DH–LTGAAS–L50

THz Photoconductive Antennas

Features

- Broadband THz emission (> 3THz)
- High Dynamic Range (>60bB)
- Linear Polarization
- High-repeatability mounting system
- SMA or HVM-500 connector
- Designed for operation at 780 / 800nm

Applications

- THZ Time Domain Spectroscopy for
- Non-destructive testing
- Non-contact measurement
- Chem/Bio analysis & characterization

Specifications

PART#	MATERIAL	GAP SIZE	V_{MAX}[1]	P_{MAX}[2]
DH-LTGAAS-L50	LT GaAs	50μm	100V	50mW

1.Maximum bias amplitude for safe,long-tem operation of antenna without degradation
2.Maximum pump beam intensity recommended to prevent antenna damage,assuming 100fs pulses and a repetition rate from 20-100 MHz.Shorter pulse durations or lower repetition rates may require lower pump power.

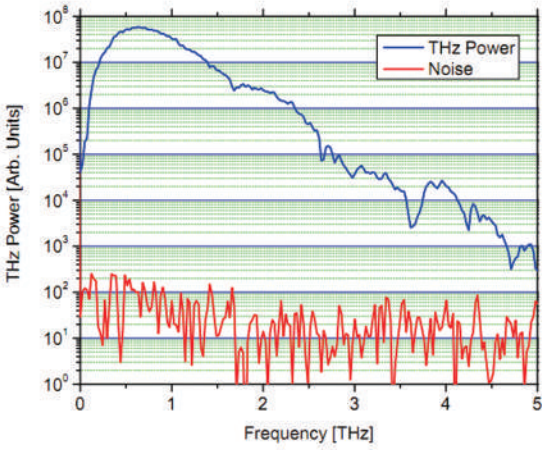

Figure 1. Stripline antenna (PCA-LTGAAS-L50) measured with EO detection with <110> ZnTe (1mm thick), Pump beam: 780nm, 100 fs, 10mW average power at 50 MHz repetition rate.

DH-LTGAAS-L50 - Stripline

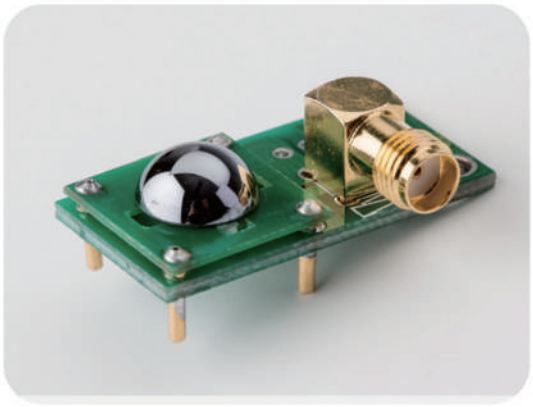

Figure 2. DH-LTGAAS-L50 THz Photoconductive Antennas

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DH–LTGAAS–L50 THZ PHOTOCONDUCTIVE ANTENNAS

大恒光电 Daheng Optics

HVM–500

High Voltage Modulator

Overview

Pulsed Terahertz (THz) generation uses a photoconductive (PC) antenna often relies on an optical chopper to modulate the THz signal measured by a lock- in amplifier. However, electronic and laser noise below 2 kHz and unstable chopper modulation can limit the dynamic range of a THz system. The HVM-500USB offers the flexibility to select a modulation frequency in a “quiet” part of your lab’s electronic noise spectrum, and since it is frequency coupled to the TTL output of your lock-in, you can be sure to minimize the noise characteristics of your system. The HVM-500 is designed to work in THz Time Domain Spectrometers using either photoconductive antennas or electro-optical (EO) detectors, and is also perfectly matched for EO detection using an auto-balanced detector like the ABL-100.

Figure 1. HVM-500 high voltage modulator

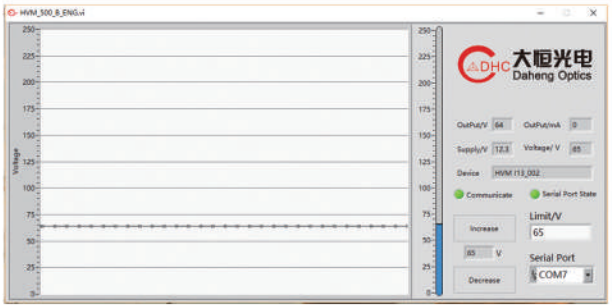

Figure 2. Labview control window

Features

- Photoconductive antenna burn-out protection
- User-programmable current limit
- Anti-surge / slow power-up cycle
- Microcontroller stablized voltage output
- Toggle up/down front panel voltage control
- Settings memory
- Unipolar and bipolar outputs
- USB control
- Labview tool for antenna alignment
- User configurable output settings
- Labview VIs provided for integrated control

Specifications

Output Voltage Amplitude	25V-250V
Output Current (Max)	25mA
Modulation Frequency Range	AC Coupled (default)1KHz-100KHz DC Coupled (option)50Hz-100KHz
Output Waveform	Square wave
Referebce Input	5V TTL
Output Connection:	BNC
Operating Temperature	-10°C to 50°C
Dimensions (L x W x H)	189×82×50(mm)
Weight:	800g

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HVM–500 HIGH VOLTAGE MODULATOR

大恒光电 Daheng Optics

DH–ZAP–APD

Air Photonics Detector Module

Overview

The ZAP-APD detector module is a device for measure ultra-broadband THz pulsed utilizing the air biased coherent detection (ABCD) technique. This module is a subsection of the CIP-ABCD Terahertz time-domain spectrometer, and purchasing it separately provides an economical path for broadband coherent THz detection. Bandwidths from 0.1 THz spanning out to 30 THz have been demonstrated using this system, but is limited by the specifications of the laser and the THz generation source.

The THz generation, optical path delays, detection electronics (Preamp and Lock-in Amplifier), and the laser source are provided separately by the end user. For this reason, the ZAP detector module is designed for experienced optical users. Furthermore, the module requires both large optical pulse energies (~100 J) and high voltages (~1 kV). Appropriate care should be undertaken when using this module.

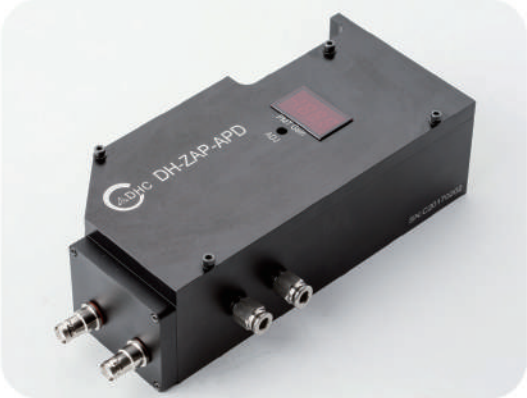

Figure 1. Photo of ZAP detector module.

Features

- Ultra-broad bandwidth (0.1-30 THz), gapless spectral coverage from mm-wave to FIR
- Room-temperature detector
- Easy alignment and operation

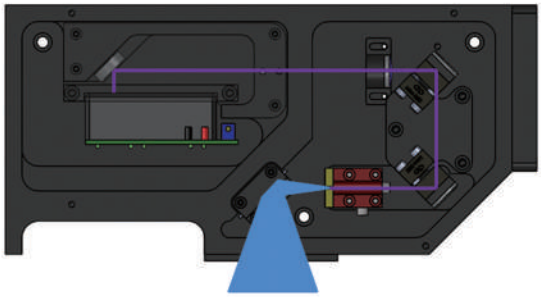

Figure 2. Optical beam path of the ZAP detector module

Specifications

Power Supply:	5V DC
Spectral Range:	0.1 – 30 THz
Peak Frequency:	10 THz
DNR (Frequency Domain)*:	60 dB (Typical); 70 dB Max
DNR (Time Domain)*:	70 dB (Typical); 80 dB Max
Dimensions:	200mm x 100mm x 60mm
Weight:	1600g
Operating Temperature:	15°C to 35°C
Standard Accessories (QTY):	HVM 2KV (1) 5VDC Power Supply (1) USB Cable (1) High voltage cables (3) Silicon window (1)

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DH–ZAP–APD AIR PHOTONICS DETECTOR MODULE

大恒光电 Daheng Optics

THz-HVM2KV

High Voltage Modulator For APD Detector

Overview

This High Voltage Modulator (THz-HVM) is designed to supply a single-ended or pseudo square wave bias for THz-ABCD (Air Biased Coherent Detection). It can accept standard TTL input triggers with frequencies ranging from up to 10 kHz with a pulse width of ≥ 0.1μs, which accommodates most amplified laser trigger outputs. There is a selector switch on the device to select a output TTL divider which can select between DC, TTL/2TTL/3 TTL/4TTL/6TTL/8 and TTL/16.The THz-HVMC2KV utilizes dual square wave output switch both adjustable amplitude of up to 1.5 kV and phase to create a pseudo-square wave with amplitude as high as 3kV.

Figure 1. THz-HVM2KV high voltage modulator

Specification

Power Supply:	100-120VAC or 180-240VAC50-60Hz
Modulation Frequency:	Up to 10kHz
Reference Input:	5V TTL; Pulse width ≥0. 1μs; Active Low
Output Voltage Amplitude:	0V -1.5 kV Single-ended or 0-3KV Pseudo (Square wave)
Output Voltage Stability:	<0.05% RMS Fluctuation(After 30min warm-up)
Output Current:	10 mA Maximum
Output Connection:	3×SHV Connectors (2×HV Output and 1×HVGND)
Dimensions:	360×260×137(L×W×H in mm)
Weight:	10 kg
Operating Temperature:	-20°C to 60°C(No condensation)
Accessories:	Power cord×1 SHV High voltage Cable (1m)×1 Modulation Signal Cable×1

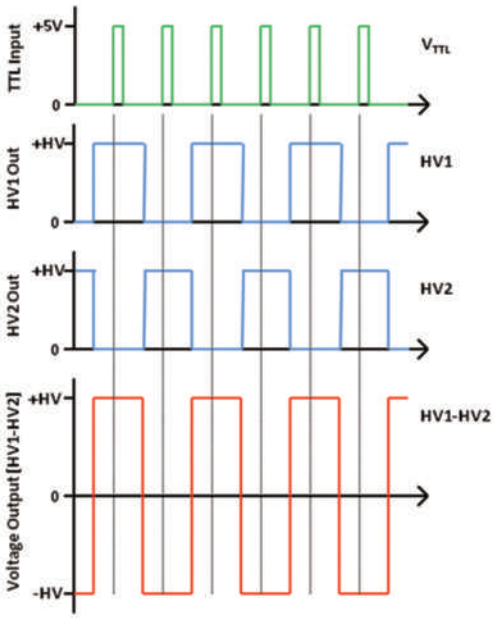

Figure 2. Illustration of high voltage and timing waveforms generated by the THz-HVMC2KV set to TTL/2 for the shown TTL input pulse train. When two electrodes are biased by HV1 and HV2, the bias electric field is a pseudo square wave with a p-p amplitude of 2HV.

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THz-HVM2KV HIGH VOLTAGE MODULATOR

大恒光电 Daheng Optics

ABL–100

Daheng New Epoch Technology Inc

Overview

The ABL-100 is an integrated balanced detection device with automatic tuning for hands-free and long-term stable operation, compensating drifts due to changes in humidity and temperature. Balanced detection is achieved when S and P polarizations of the probe beam are balanced to give zero net current in absence of terahertz. An electro-optic crystal breaks the balance when it senses the presence of a terahertz wave.

Figure 19. ABL-100 unit. EO crystal is not shown. EO crystal and focusing lens are not included.

Features

- Hands free, set and forget operation
- High sensitivity wide area photo-diodes
- Small footprint, integrated package
- Easy alignment and operation
- Anti-reflection coatings for all optics
- High-extinction ratio calcite Wollaston prism (<5 10^{-6})
- User selectable balance point

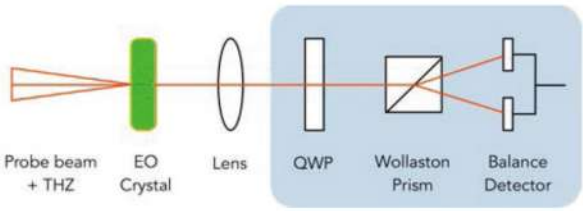

Figure 20. Typical EO sensing schematic. The Quarter Wave Plate (QWP) balances the detector in absence of terahertz radiation so that net current is zero. Terahertz illuminating the EO crystal will cause changes in its birefringence, breaking the balance between S and P polarizations. Shaded area indicates components included in ABL-100.

Specifications

Model[1]	ABL-100	ABL-100-1kHz	ABL-100-10Hz
Modulation range	DC - 300 kHz	1 - 5 kHz	<100 Hz
Laser repetition rate	≥10 MHz	1 - 5 kHz	<100 Hz
Wavelength	740 - 860 nm		
Voltage/Current Mode Output (max)	±5 V / 1 μA		
Output Connector	SMA		
Dimensions / Weight	4.5" x 2" x 2.25" / 0.5 lb.		

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大恒光电 Daheng Optics

OPTICAL ACCESSORIES

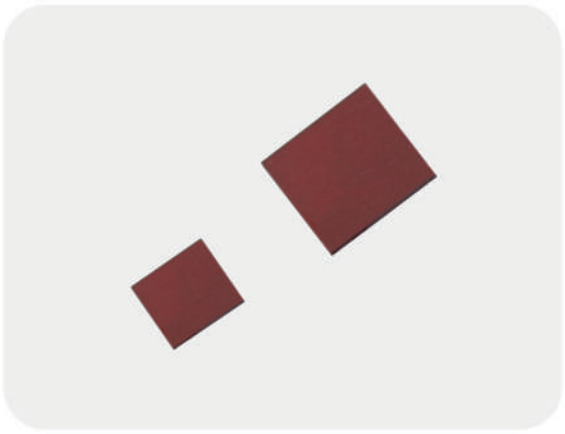
Off-Axis Parabolic Mirror

Item #	DH-OAP-2	DH-OAP-4	DH-OAP-6
Diameter	2" (50.8 mm)	2" (50.8 mm)	2" (50.8 mm)
Reflected Focal Length (RFL)a	2" (50.8 mm)	4" (101.6 mm)	6" (152.4 mm)
Parent Focal Length	1" (25.4 mm)	2" (50.8 mm)	3" (76.2 mm)
Thickness		2.47" (62.8 mm)	
Off-Axis Angle		90°	
Bottom Mounting Holes		Three 8-32 Taps	

HR Si

Diameter (mm)	50.8
Thickness (mm)	3mm/2mm
Flatness (RMS)	λ/2
Other	customized available

ZnTe Crystal



Dimension(mm)	10*10*1(2)	5*5*1(2)
Surface Quality	III	
Flatness (RMS)	λ/2, λ=632.8nm	

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OPTICAL ACCESSORIES

FREFACE

Daheng Optics, based in Beijing, China, is a technical company specialized in optics. Its main business includes design and manufacture of optical components, modules, sub-systems assemblies and systems. Wealthy experiences in engineering and production, and service flexibility have been meeting our customer demands since 1987. Our company has grown steadily, up to now 150 people employed. Lead by an experienced technical team, most employees are skilled technicians for professionally dealing on fine optics, fine mechanics and special tools. Qualified technical department inspects our products at 100% level for quality control.

Research and Development

Daheng Optics possesses a strong professional design team for research and development with lens designers, mechanical design, control and integration engineers. Utilizing professional tools such as ZEMAX and ProE, the core design and engineering team offers solutions for OEM projects and products.
We serve and support our customers over the complete engineering cycle, from the conceptual design phase to the final delivery of the systems.

Optical Manufacture Raw Materials

Lens blanks made of optical materials in the form of round disks or per-forms are received. We use approximately 200 different optical quality glass type, including fused silica, calcium fluoride, germanium, zinc sulfide and filter glasses.

Pre-grinding

Lens blanks (round disks or pre-forms) are pre-grinded with diamond fitted tools, each side separately to meet different curvature requirements.

Fine-grinding

Fine-grinding of the lens to the required radii is done with specialized tools, onto which pellets are glued. Diamond grains sized between 5 to 25 microns are sintered in these pellets.

Polishing

Tools lathed of aluminum and plated with a polyurethane foil for polishing the radii of the lens are used. The foils glued onto the tools are prepared by special counter tools to achieve the required precision. Cerium oxide is mainly used as the polishing medium. We use an in-process interferometer to conduct contact-free measurement for lens surface. The measurement results are used for adjusting the tools to achieve the requirements.

Centering

After the polishing of both radii, the lens has to be centered to its optical axis. For this purpose, a laser beam is launched to the lens, of which its optical axis is precisely aligned to a centering machine. A chuck is used to fit its position and its rim is ground centrically using one or two diamond grinding discs. During the same process, the chamfers are also centered.

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