

PolarCam™

4D Technology

Snapshot Micropolarizer Camera

The PolarCam micropolarizer camera captures a snapshot image of multiple polarization angles from each video frame, without image blur. Compact, fast and field-proven, these unique cameras enable a range of image enhancement techniques and polarimetric measurements, for applications in process control, medical imaging, remote sensing and more.

Proprietary micropolarizer technology enables the PolarCam's broad spectral response, wide angular bandwidth and high extinction ratio. The micropolarizer array is bonded directly to the sensor and includes no moving parts, providing a fully solid state, Division of Focal Plane (DoFP) configuration.

High-resolution PolarCam cameras are available with 1.0, 2.0 and 3.8 mega-pixel sensors. The video rate of up to 164 full frames per second ensures fast capture of quickly changing scenes.

Optional PolarView™ software provides real-time display and calculation of key polarization parameters, including Degree of Linear Polarization (DoLP), Angle of Linear Polarization (AoLP), linear Stokes parameters (S_0 , S_1 and S_2) and more. Use the many included tools to process and analyze the data, then save images and movies of each parameter for comprehensive analysis.

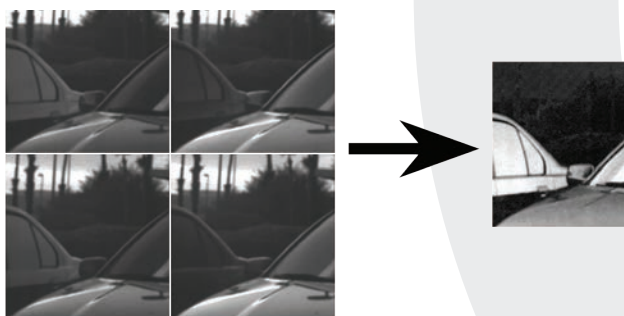
An optional high speed computer system maximizes camera performance. 4D Technology can also provide complete illumination and imaging solutions based on the PolarCam. Contact 4D for more on custom imaging and sensing solutions.



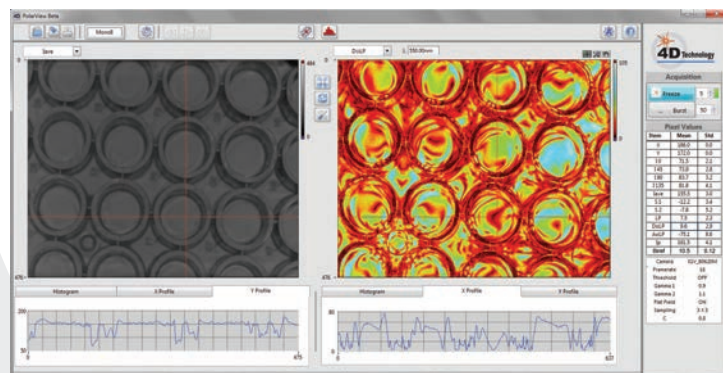
PolarCam Cameras

APPLICATIONS

- Image Enhancement
- Glare Reduction and Haze Removal
- Birefringence Measurement
- Industrial Monitoring
- Polarization Microscopy
- Stress and Strain Characterization
- 3D Reconstruction
- Medical Imaging Enhancement
- Autonomous Vehicle Vision



Parsed pixelated camera polarization images are shown on the left. On the right, the contrast of the sky and trees in the background is reduced while the contrast of the two cars in the foreground is dramatically increased.



PolarCam map of birefringence in well plates due to stress. Average Intensity is shown on the left; the Degree of Linear Polarization (DoLP) is shown on the right.

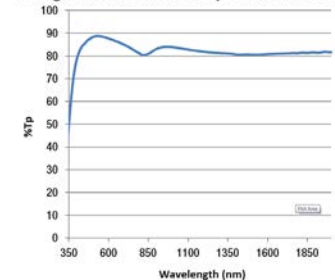
PolarCam™

Specifications

Description	All PolarCam Models
Configuration	Snapshot Micropolarizer Camera Array
Acquisition Mode	Simultaneous polarization imaging (0, 45, 90, 135° linear polarizations)
Transmission	> 70%
Extinction Ratio	> 30:1
Color Format	Monochrome
Bit Depth	8–12-bit
Exposure	Global electronic shutter
Operating Temperature	10–50° C (50–122° F), non-condensing
Storage Temperature	-20–80° C (-4–176° F), non-condensing
Computer System	Optional high performance desktop or laptop PC, Windows® operating system
Software	Optional PolarCam™ Software Developers Kit (SDK) Optional PolarView™ Polarization Software: Live Video; capture and save images and bursts (movies); Calculated Output: Intensity; Averaged Intensity; Enhanced Polarization Image (I _p); Linear Stokes Parameters S ₀ , S ₁ , S ₂ ; Degree of Linear Polarization (0–100%, ±1%); Angle of Linear Polarization (-180–180°, ±1°); Birefringence (0–135 nm, ±1.0 nm at λ=500 nm) Processed frame rate is processor and camera dependent
Warranty	One Year, limited, standard; extendable; software upgrades free during warranty period

Description	Model			
	G1	G2	U2	U4
Sensor Type	CMOS Sony IMX174	CMOS Sony IMX174	CMOS Sony IMX174	Interline transfer CCD ON Semiconductor KAI04070
Pixel Size	5.86 μm	5.86 μm	5.86 μm	7.4 μm
Min. Usable Pixels	1000 x 1000 1.0 MP	1700 x 1200 2.0 MP	1700 x 1200 2.0	1950 x 1950 3.8 MP
Frame Rate	42 fps	42 fps	164 fps	14 fps
Saturation Capacity	33ke-	33 ke-	33ke-	44ke-
Dark Noise	6.6 e-	6.6 e-	6.6 e-	3 e-/s
Quantum Efficiency	76% @ 460 nm	76% @ 460 nm	76% @ 460 nm	76% @ 470 nm
Synchronization Triggering	No	No	Yes	Yes
Lens Mounting Type	C-Mount	C-Mount	C-Mount	F-Mount
Physical Envelope	40 x 40 x 90 mm (1.6 x 1.6 x 3.5 in)	40 x 40 x 90 mm (1.6 x 1.6 x 3.5 in)	40 x 40 x 90 mm (1.6 x 1.6 x 3.5 in)	60 x 60 x 95 mm (2.4 x 2.4 x 3.7 in)
Weight	287 g (0.63 lbs)	287 g (0.63 lbs)	270 g (0.60 lbs)	210 g (0.46 lbs)
Power Requirement	3 W, 12 VDC Power Over Ethernet	3 W, 12 VDC Power Over Ethernet	3.4 W, 12 VDC Power Over USB 3.0	8 W, 12 VDC
Interface	GigaBit Ethernet 10/100/1000, 802.3, Ethernet V2.0, IPv4, IGMPv.2, UDP and ICMP, and Geni-Cam		USB 3.0	USB 3.0

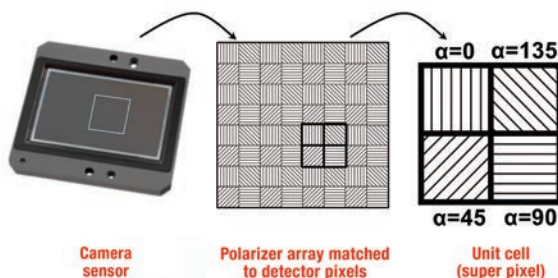
Wiregrid Polarizer Broad Spectral Bandwidth



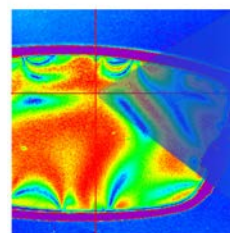
Wiregrid polarizers are suitable for use with cameras across a broad spectral bandwidth range from the UV to the near IR. Courtesy of Moxtek, Inc.



PolarCam is available as an OEM camera or as part of a complete testing system. Shown here is the PolarCam Birefringence Testing Station.



A pattern of polarizers with four discrete polarizations (a "super pixel") is repeated over the entire micropolarizer array. The size and spacing of the micropolarizer elements is chosen to match the size and pitch of the camera sensor. The four polarizer orientations enable the linear Stokes parameters to be determined, from which the degree and angle of linear polarization can be determined.



Pixel Values		
Item	Mean	Std
X	50.0	0.0
Y	50.0	0.0
I0	154.0	6.3
I45	231.7	6.3
I90	128.2	11.7
I135	50.5	10.3
Iave	141.1	5.5
S1	25.8	10.6
S2	181.2	5.7
LP	91.6	3.4
DoLP	65.1	5.0
AoLP	41.0	1.5
lp	86.1	7.6
Biref	10.2	0.11

PolarView software calculates, in real time, the Mean and Standard Deviation (Std) of parameters including DoLP, AoLP, Birefringence and the Enhanced Polarization Image (Ip).

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