

The background features a dark blue gradient with several large, overlapping, semi-transparent circles in shades of blue and purple. A horizontal band of a slightly different shade of blue runs across the middle of the image.

SONY
Polarsens
technology guide

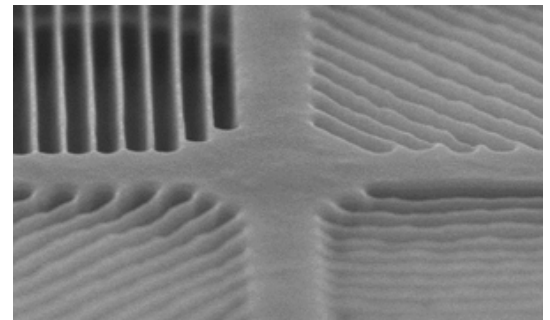
MACNICA

SONY

Polarization Image Sensor Technology Polarsens™

OVERVIEW

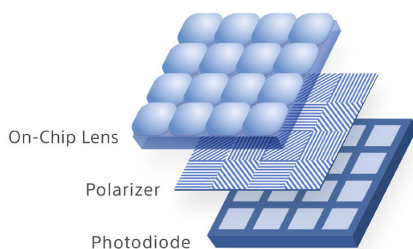
Polarsens is a CMOS image sensor pixel technology that has multiple different angled polarizer formed on chip during semiconductor manufacturing process, allowing highly accurate alignment with pixel. This solves problems in a variety of industrial fields.



Polarizer image
Source: Sony, IEDM2013, Lecture number 8.7

TECHNICAL FEATURES

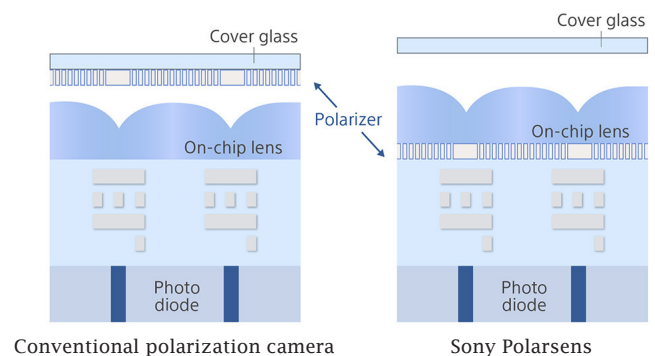
Four directional polarizer is formed on the image sensor



Sony's polarization image sensor is equipped with polarizers in four directions, enabling the acquisition of polarization images in four directions in a single shot. From the luminance values of the polarizers in each direction, the direction of polarization (direction of light oscillation) and polarization intensity (degree of polarization) can be calculated. Combining these with signal processing at a later stage makes it possible to obtain polarization information in real time.

Polarizer is formed on chip under the on-chip lens layer

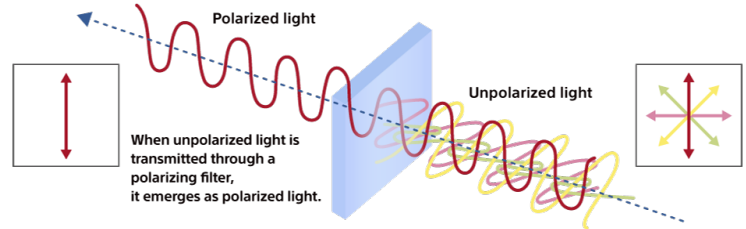
While a typical polarization camera consists of a polarizer attached to the surface of the image sensor, Sony's polarization image sensor has a polarizer placed under the On-Chip Lens. The closer the polarizer and photodiode are, the less light leaks into adjacent pixels, resulting in better extinction ratio characteristics and grazing incidence characteristics.



Sony's polarizing image sensors form the polarizer on a semiconductor process, which is superior in terms of the precision of polarizer formation and placement, homogeneity, mass production, and durability compared to conventional polarizing image sensors with a laminated structure. Furthermore, by adding an anti-reflection layer on top of the polarizer, the effects of flare and ghosting are greatly reduced.

What is polarization?

Light has physical elements: brightness (amplitude), color (wavelength) and polarization (vibration direction). Lights from the Sun or fluorescent lamps vibrate in various directions and is called unpolarized light. Sony's polarization sensor has wire-grid polarizers. Parallel light against polarizer passes through it, while perpendicular light is cut off at the polarizer.



Degree of polarization and polarization direction

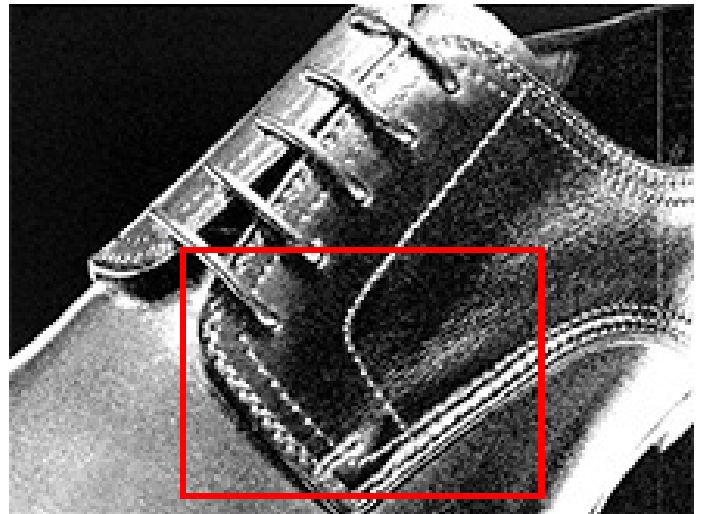
Polarization can be described by two attributes: the degree of polarization or how much the light is polarized and the direction of polarization or in which direction the lightwave is vibrating. This information can be used for various applications such as surface scratch detection, particle inspection, distortion and shape recognition which has traditionally been difficult to detect.

Example of degree of polarization (DoP)

When we look at an object, we usually see light reflected and scattered from its surface. The polarization of the reflected light varies depending on the material, color, unevenness, and other surface conditions of the object, as well as the angle of reflection.



Normal image



Degree of polarization image

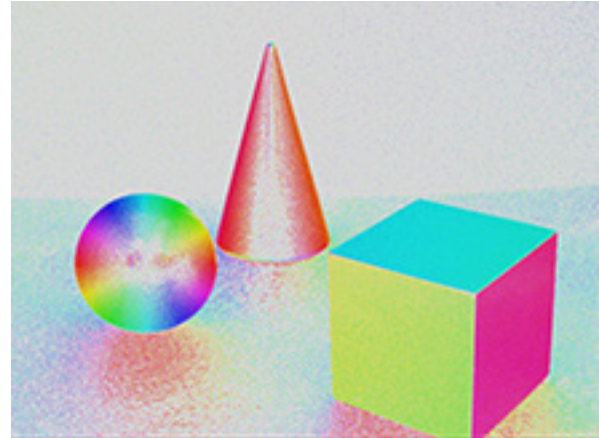
The image on the right is a display showing the degree of polarization. The higher the polarization, the whiter it shows, and the lower the polarization, the blacker it is. If you look inside the red frame, you can see the stitches better than in the normal image because of the large difference in polarization between the leather and the threads used to sew the leather.

Example of polarization direction

Polarization direction provides the direction information of reflected plane of an object.

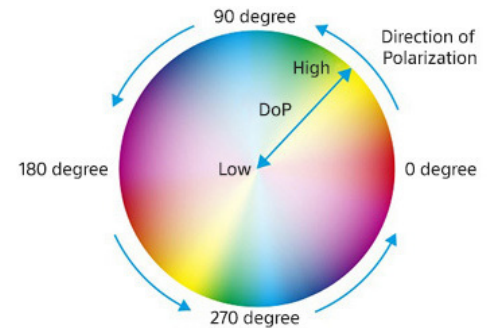


Normal image



Polarization direction image

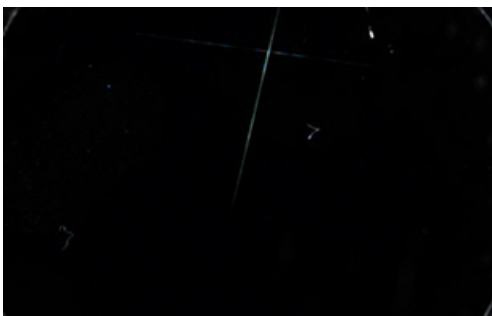
The direction of polarization image shows the angle of the polarization in color using HSV color mapping. In this example, the upper side of the cube is highlighted in light blue, meaning that the angle of the polarization is 90 degree.



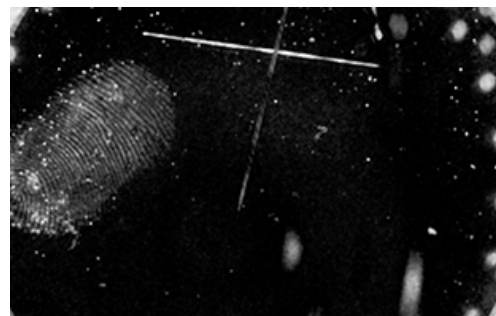
APPLICATIONS

Plane surface fine scratch detection

To detect fine scratches on perfectly plane surfaces like glasses at manufacturing sites, it is necessary to distinguish between scratches and stains. Since scratches differ from stains in that they have a specific orientation, polarization image sensors can be applied to focus on those properties. Polarization image sensors can reliably identify differences in the degree of polarization at uneven areas and others, accurately perceiving scratches with a specific direction and detecting them while distinguishing them from stains with random irregularities.



Normal image



Degree of polarization image

These examples show dents and dust on a homogenous glass plane. We can easily find scratches and stains (fingerprints and dust) due to differences in the degree of polarization.

Filling Inspection

Filling status can be detected at the manufacturing site by using the difference in polarization. For example, in picking LSI chips, it is possible to check whether the chips are in the correct position. In pharmaceutical manufacturing, the difference in polarization between tablets and aluminum sheets can be used to check the filling of tablets.



Normal image



Degree of polarization image

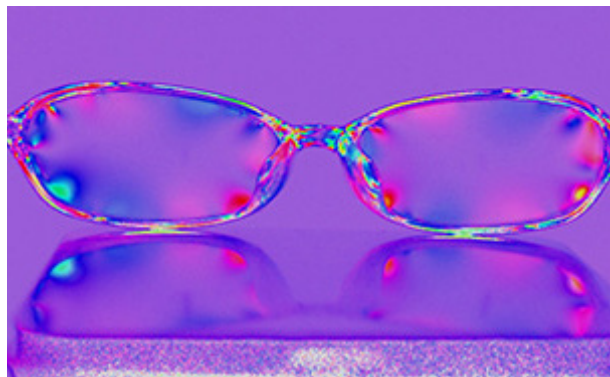
The large difference in polarization between the tablet and the aluminum sheet makes it easy to see whether the tablet is filled or not (right).

Distortion inspection

Polarization image sensors can be used for distortion inspections in various manufacturing industries. They can accurately detect the presence of distortion without becoming confused by color or reflections, and can even detect the direction of distortions.



Normal image

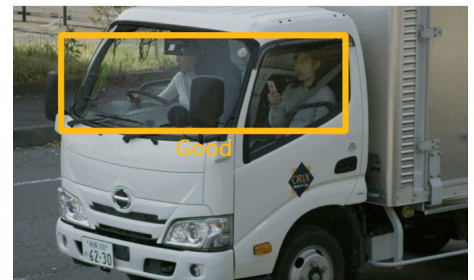
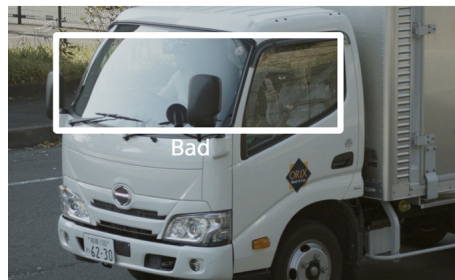
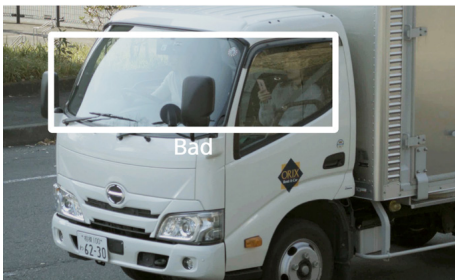
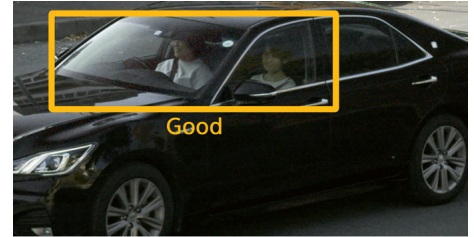


Polarization direction image

With the information of direction of polarization, we can identify both distortions and the direction of distortion of the plane.

Occupant counting and recognition in vehicles (glass reflection removal)

In observations conducted by fixed-point cameras for the enforcement of traffic regulations, reflections of light by vehicle windshield, caused by certain angle of the sun in a certain time of a day or certain angle of windshield, becomes obstacles in identifying number of occupants in vehicles or recognizing their certain attributes. By appropriately setting polarization image sensors, the amount of reflected light can be reduced or removed, making it easier to conduct necessary detection and recognition to enforce the regulations.



Interference from reflected light makes it difficult to see the vehicle interior.

A polarizing filter can be used to remove the reflected light. However, reflected light may remain depending on vehicles (window angle).

Polarization image sensor can remove the reflected light regardless of the vehicle type, improving the accuracy of the count of occupants or face recognition.

Sony's Polarsens™ Sensors are available through **Macnica Americas, Inc.**

The seeds of tomorrow. ●

MACNICA

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