



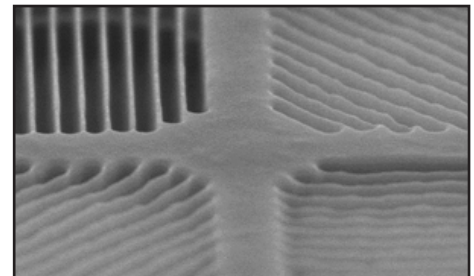
**SONY**  
**Polarsens**  
**technology guide**

# SONY

## Polarization Image Sensor Technology Polarsens™

### OVERVIEW

Polarsens is a CMOS image sensor pixel technology that has several different angle polarizer formed on chip during the semiconductor process allowing highly accurate alignment with pixel. This allows it to solve issues faced in various industrial areas.

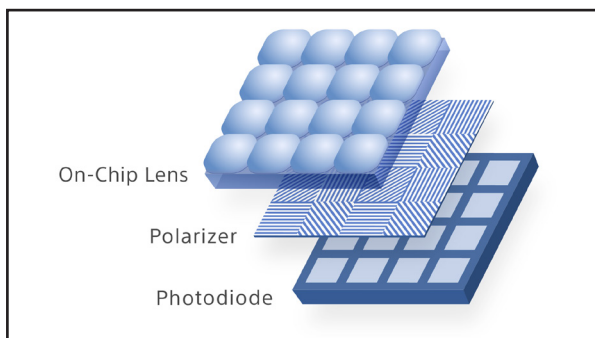


Polarizer image

Source: Sony, IEDM2013, Lecture number 8.7

### TECHNICAL FEATURES

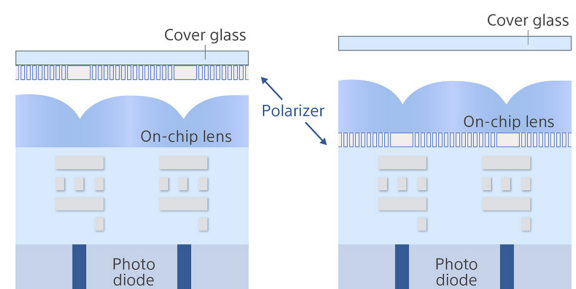
**Four directional polarizer is formed on the image sensor**



Sony's polarization sensor can capture a four directional polarization image in one shot by the four directional polarizer. It can calculate the direction and degree of polarization (DoP) based on the intensity of each directional polarization. Together with subsequent signal processing, it can capture the polarization information in real time.

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

With conventional types of polarization sensors, the polarizer is attached on top of the on-chip lens layer, however with Sony's polarization sensor, the polarizer is formed on chip under the on-chip lens layer. A shorter distance between the polarizer and the photodiode improves the extinction ratio and the incident angle dependence.



Since the polarizer is formed during the semiconductor process, form and formulation of polarizer, uniformity, mass productivity and durability are excellent compared to conventional polarization sensors. Furthermore, Sony's Polarization sensor is covered with an anti-reflection layer which helps to reduce reflectance and avoids poor flare and ghost characteristics.

### ***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***

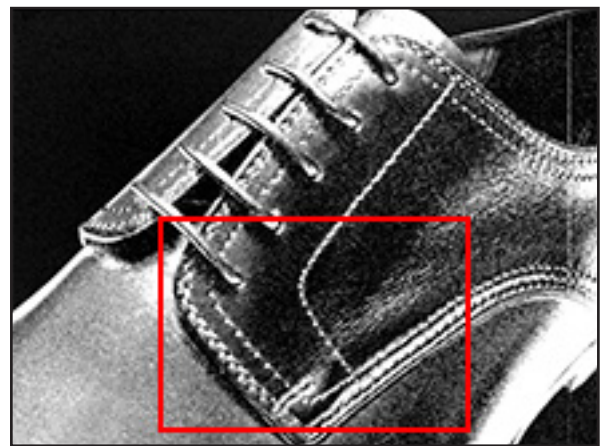
Polarization has two physical information, which are the degree of polarization and the direction of polarization. This information can be used for various applications such as surface scratch detection, particle inspection, distortion and shape recognition which has traditionally been difficult to detect.

### ***Example of degree of polarization (DoP)***

The light is reflected by the surface of the object in polarized and unpolarized lights. The DoP of the reflected light depends on the surface condition (material, color, roughness, etc...) and the angle of reflection.



Normal image

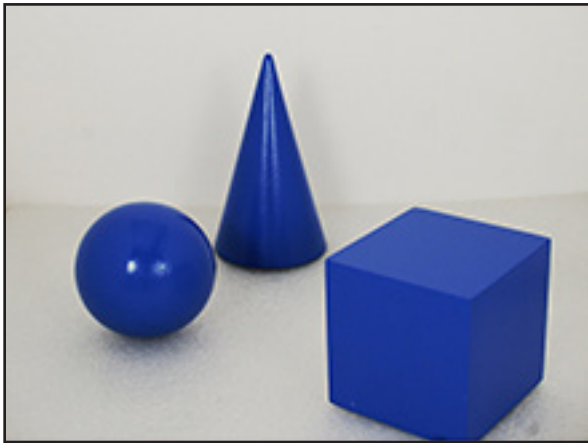


Degree of polarization image

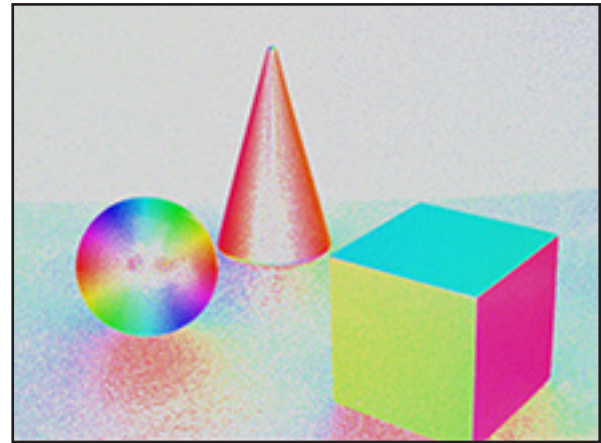
In the degree of polarization image, the white is high polarization and black is low polarization. As example, the stitch is easily visible due to the difference in the degree of polarization of the thread and leather.

## Example of polarization direction

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



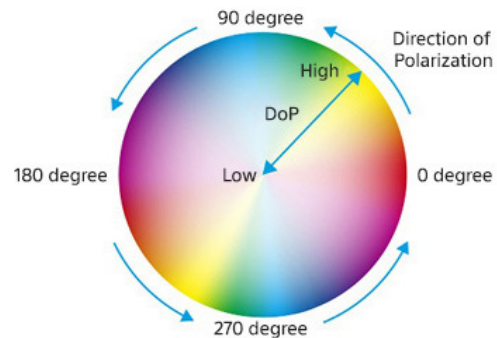
Normal image



Polarization direction image

The direction of polarization image shows the angle of the polarization direction in color using HSV color mapping.

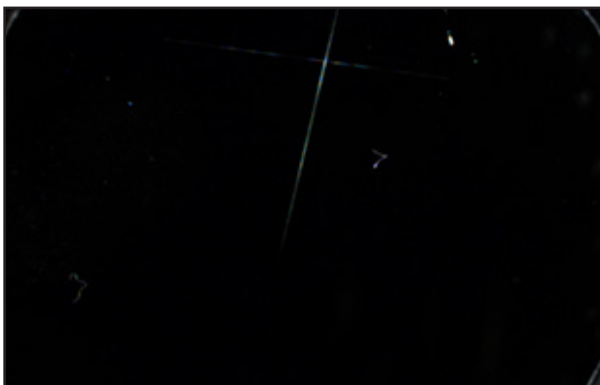
In this example, the upper side of the cube is highlighted in light blue, meaning that the angle of the polarization direction is 90 degrees.



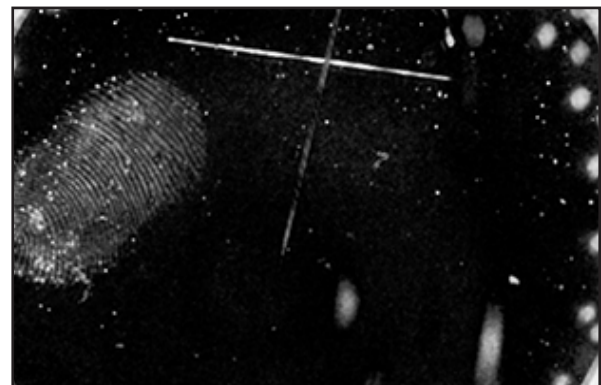
## APPLICATIONS

### Plane surface fine scratch detection

To detect fine scratches on plane surfaces which are completely uniform, like glass 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 between uneven areas, accurately perceiving scratches with a specific direction and detecting them while distinguishing them from stains which have 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.

## Container content inspections

Differences in the degree of polarization can be utilized at manufacturing sites to detect container content. For example, in picking work for LSI chips, they can be used to confirm whether chips have been placed to fit in the correct position. In pharmaceutical manufacturing, differences in the degree of polarization between tablets and aluminium sheets can be applied to confirm tablet container content.



Normal image



Degree of polarization image

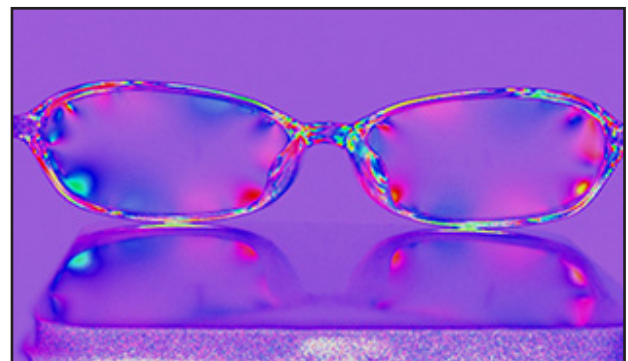
Thanks to the difference in the degree of polarization between the tablet and the aluminium package, it is easy to identify whether the tablets are filled in or not.

## 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

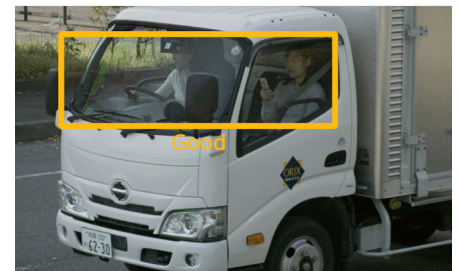
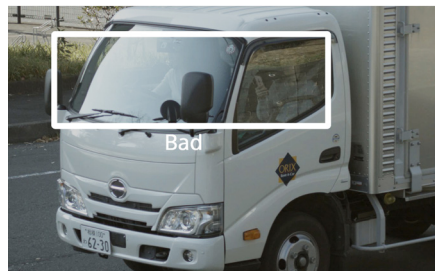
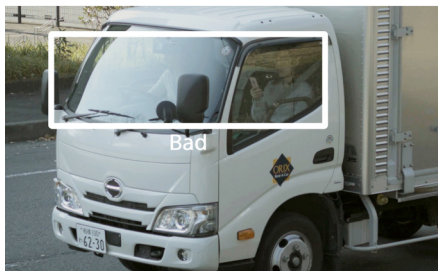
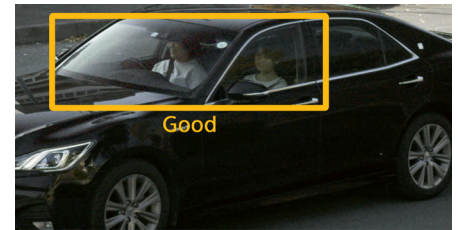


Polarization direction image

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

## Confirmation of number of individuals in vehicles (reflection removal)

In observations conducted by fixed-point cameras for the enforcement of traffic regulations, light can be reflected by vehicle windshields depending on the time period and angle, making it impossible to identify individuals in the vehicle. By setting polarization image sensors as appropriate, this reflected light can be reduced or removed, allowing the number of individuals in the vehicle to be detected.



Without polarizing filter

With polarizing filter

Polarization image sensor (Polarsens)

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 the vehicle (window angle).

Using a polarization image sensor can remove the reflected light regardless of the vehicle type, improving the accuracy of face recognition.

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Sony's Polarsens™ sensors are available through **Macnica ATD Europe**.

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**MACNICA**  
ATD EUROPE

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