

## Polarization Image Sensor

**IMX250MZR / MYR** : Diagonal 11.1 mm (Type 2/3) Approx. 5.07M-Effective Pixel Monochrome/Color Polarization CMOS Image Sensor

**IMX253MZR / MYR** : Diagonal 17.6 mm (Type 1.1) Approx. 12.37M-Effective Pixel Monochrome/Color Polarization CMOS Image Sensor

**Polarsens**

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.

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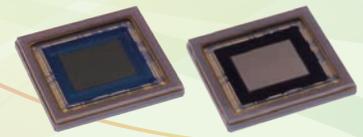


Photo: IMX250MZR / MYR

## Polarization Image Sensor with Four-Directional on-chip Polarizer and global shutter function

Sony Semiconductor Solutions has launched a polarization image sensor (polarization sensor): 3.45 $\mu$ m pixel size with four-directional polarizer which is formed on the photodiode of the image sensor chip\*1. This polarization sensor is targeting the industrial equipment market.

In addition to capturing brightness and color\*2, this image sensor can also capture polarization information that cannot be detected by a normal image sensor. This polarization sensor can be used in many applications in the industrial field, such as inspection when visibility and sensing are difficult.

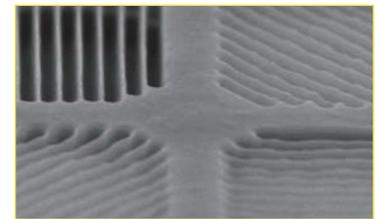
\*1. IMX250MZR/MYR (5.07M-Effective Pixel) were launched in September/December 2018.

IMX253MZR/MYR (12.37M-Effective Pixel) are planned to be launched in September/October 2019.(As of 24th January 2019)

\*2. IMX250MYR(color)/IMX253MYR(color) only.

## Characteristic

- Four-Directional Polarizer formed on chip
- Global shutter function
- High frame rate
- ROI mode, Trigger mode



Polarizer image  
Source: Sony, IEDM2016, Lecture number 8.7

## Four directional polarizer is formed on the image sensor

Sony Semiconductor Solutions' polarization sensor can capture a four directional polarization image in one shot by the four directional polarizer (Fig.1). 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\*3 in real time\*4.

\*3. Degree of Polarization and Direction of Polarization

\*4. Subject to subsequent signal processing power.

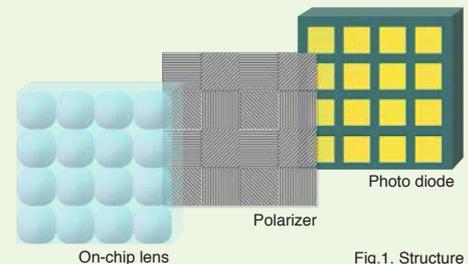


Fig.1. Structure

## 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 (Fig.2), however with Sony Semiconductor Solutions' polarization sensor the polarizer is formed on chip under the on-chip lens layer (Fig.3). A shorter distance between the polarizer and the photodiode improves the extinction ratio\*5 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 Semiconductor Solutions' Polarization sensor is covered with an anti-reflection layer which helps to reduce reflectance and avoids poor flare and ghost characteristics.

\*5. Extinction Ratio

Extinction ratio is a specification to measure polarization. The extinction ratio of polarization image sensor is the ratio between the sensitivity of transmission axis light and the sensitivity of extinction axis light (the sensitivity of transmission axis light / the sensitivity of extinction axis light). The higher the number, the better the specification and performance.

## Structure Comparison

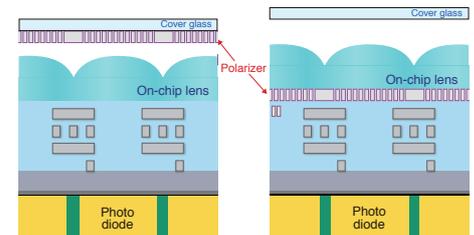


Fig.2. Structure of Conventional Polarization sensor

Fig.3. Structure of Sony Semiconductor Solutions' Polarization sensor

### Global Shutter function

Industrial applications require imaging of fast-moving objects. However, existing CMOS image sensors are unable to accurately identify fast-moving objects, due to the focal plane distortion, which is caused by the rolling shutter function. The IMX250MZR/MYR, IMX253MZR/MYR address this issue by providing an analog memory inside each pixel and realizing the global shutter function to enable high-picture-quality without focal plane distortion.

### High Frame Rate

The column-parallel A/D conversion technology of Sony's CMOS image sensors is used to realize high-speed imaging of up to 163.4 [frame/s] (ADC 8 bit) for the IMX250MZR/MYR, 68.3frame/s (ADC 8 bit) for the IMX253MZR/MYR. Increasing processing speed for industrial applications.

### ROI mode and trigger mode

The IMX250MZR/MYR, IMX253MZR/MYR are equipped with variety of functions necessary for industrial applications, such as ROI Mode and Trigger Mode. ROI Mode crops required areas, and up to 8 x 8 = 64 locations can be set with IMX250MZR/MYR. In addition to setting the 8 x 8 = 64 locations, IMX250MZR/MYR provides greater freedom for specifying regions and allows overlap of specified regions. Various exposure methods are provided for trigger mode, which controls the exposure time using an external pulse.



Glass inspection (scratch and stain)



Fig.4. Normal image

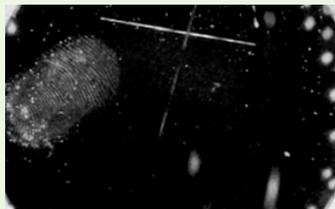


Fig.5. Degree of Polarization image

These examples show dents and dust on a homogenous glass plane. We can easily find scratches and stains (fingerprint and dust) due to differences in the degree of polarization (Fig.4,5).

Tablet filling inspection



Fig.6. Normal image

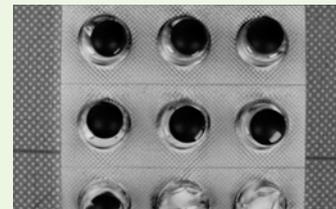


Fig.7. Degree of Polarization image

Thanks to the difference in the degree of polarization between the tablet and the aluminum package, it is easy to identify whether the tablets are filled in or not (Fig.7).

Distortion inspection



Fig.8. Normal image



Fig.9. Polarization Direction image

With the information of direction of polarization, we can identify both distortions and the direction of distortion of the plane (Fig.9).

Removal reflection



Fig.10. Normal image



Fig.11. Removed reflection image

Polarization information can be used to remove reflections (Fig.11). Sony Semiconductor Solutions' polarization sensor has a four-directional polarizer, which can simultaneously remove the reflections in multi planes.(Fig.11)

All images were generated by Sony Semiconductor Solutions' polarization sensor's evaluation board.

<Table 1> Device Structure

Item		IMX250MZR / MYR	IMX253MZR / MYR
Features		Four-directional Polarization	
Image size		Progressive scan mode : Diagonal 11.1 mm (Type 2/3) Full-HD mode : Diagonal 7.7 mm (Type 1/2.35)	Progressive scan mode : Diagonal 17.6 mm (Type 1.1)
Number of effective pixels		2464 (H) × 2056 (V) Approx. 5.07 M pixels	4112 (H) × 3008 (V) Approx. 12.37 M pixels
Unit cell size		3.45 μm (H) × 3.45 μm (V)	
Optical blacks	Horizontal	Front : 0 pixels, rear : 0 pixels	
	Vertical	Front : 10 pixels, rear : 0 pixels	
Input drive frequency		37.125 MHz / 54.0 MHz / 74.25 MHz	
Package		226-pin LGA	
Supply voltage VDD (Typ.)		3.3 V / 1.8 V / 1.2 V	

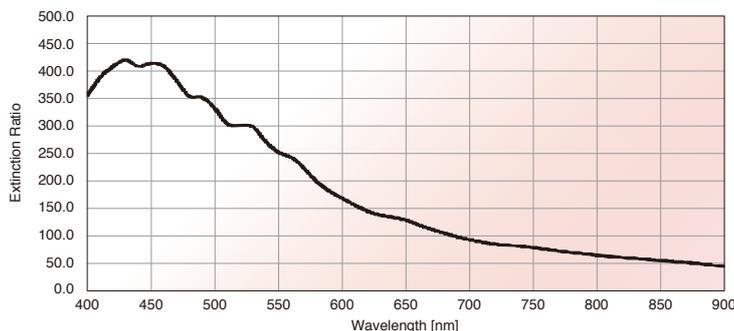
<Table 2> Image Sensor Characteristics

Item		IMX250MZR / MYR	IMX253MZR / MYR	Remarks
sensitivity (monochrome)	Typ.[F8]	342 mV	TBD	3200 K, 706 cd/m <sup>2</sup> , 1/30s accumulation
Sensitivity (color)	Typ.[F5.6]	430 mV	TBD	
Saturation signal	Min.	1001 mV	TBD	Tj = 60 °C

<Table 3> Basic Drive Mode

Product name	Drive mode	Recommended number of recording pixels	ADC [bit]	Frame rate (Max.) [frame/s]
IMX250MZR/MYR	Progressive scan	2448 (H) × 2048 (V) Approx. 5.01 M pixels	12	89.5
			10	144.7
	Full-HD	1920 (H) × 1080 (V) Approx. 2.07 M pixels	12	120.0
			10	120.0
IMX253MZR/MYR	Progressive scan	4096 (H) × 3000 (V) Approx. 12.29 M pixels	12	46.4
			10	64.6
			8	68.3

IMX250MZR  
IMX253MZR (TBD)  
Omnidirectional Extinction Ratio (Min.)



Subject to test and environment conditions