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# Automotive Camera Tier2 Suppliers Research Report, 2022-2023

Mar. 2023

# The automotive camera market maintains a pattern of "one superpower and several great powers".

Automotive cameras are used to focus the light reflected from the target onto the CIS after refraction. From the automotive camera industry chain, it can be seen that main upstream companies are: lens, optical filter, and protective film companies which are committed to processing raw materials and making them into basic hardware such as lenses, optical filters and protective films; main downstream players are: Tier1 suppliers and camera module packaging companies.

***At present, the automotive camera module market features a pattern of "one superpower and several great powers", that is, Chinese manufacturer Sunny Optical Technology rules the roost, and Japanese, Korean and other Chinese manufacturers compete in the second echelon.***

***"One superpower" is Sunny Optical Technology***, the automotive camera industry bellwether that has grabbed the biggest share of the global market for many years in a row. The company shipped 67.98 million automotive cameras in 2021, and 78.91 million units in 2022, with a stable market share higher than 30%.

***"Several great powers" refer to the several leaders in the second echelon***, mainly Japanese, Korean and other Chinese manufacturers, commanding 2% to 10% of the market. The traditional "great powers" are led by Japanese, Korean and Taiwanese optics companies, including Maxell (Japan), Nidec Sankyo (Japan), Sekonix (South Korea) and Largan Precision (China Taiwan). Among them, Maxell took an 8% share in the global automotive camera market in 2021.

***Meanwhile Chinese companies such as Lianchuang Electronic Technology and OFILM begin to edge into the "great powers" club.***

Lianchuang Electronic Technology shipped about 8 to 9 million automotive cameras in 2022, and its major customers were Tier1 suppliers such as Valeo, Continental, Aptiv, ZF and Magna. OFILM set foot in automotive cameras by acquiring Fujifilm in 2018. Up to now, OFILM has mass-produced 5M front view cameras, 3M/8M side view cameras, 1M/2.5M surround view cameras, 2M electronic exterior mirror cameras, and 1M/2M in-cabin DMS/OMS cameras. In 2022, OFILM shipped about 4 million automotive cameras.

In addition, the established optics companies like Phenix Optics and Dongguan Yutong Optical Technology (YTOT) have also made deployments in the automotive market. Among them, Phoenix Optics has launched more than ten types of automotive cameras; YTOT, a leader in the field of security cameras, bought a 20% stake in Jiuzhou Optical in 2022, one of its attempts to step into the automotive camera market. In the future, these old optics companies will take further efforts to seize a share of the automotive camera market.

# Automotive CIS offers increasing performance, up to 8M resolution and 140dB HDR.

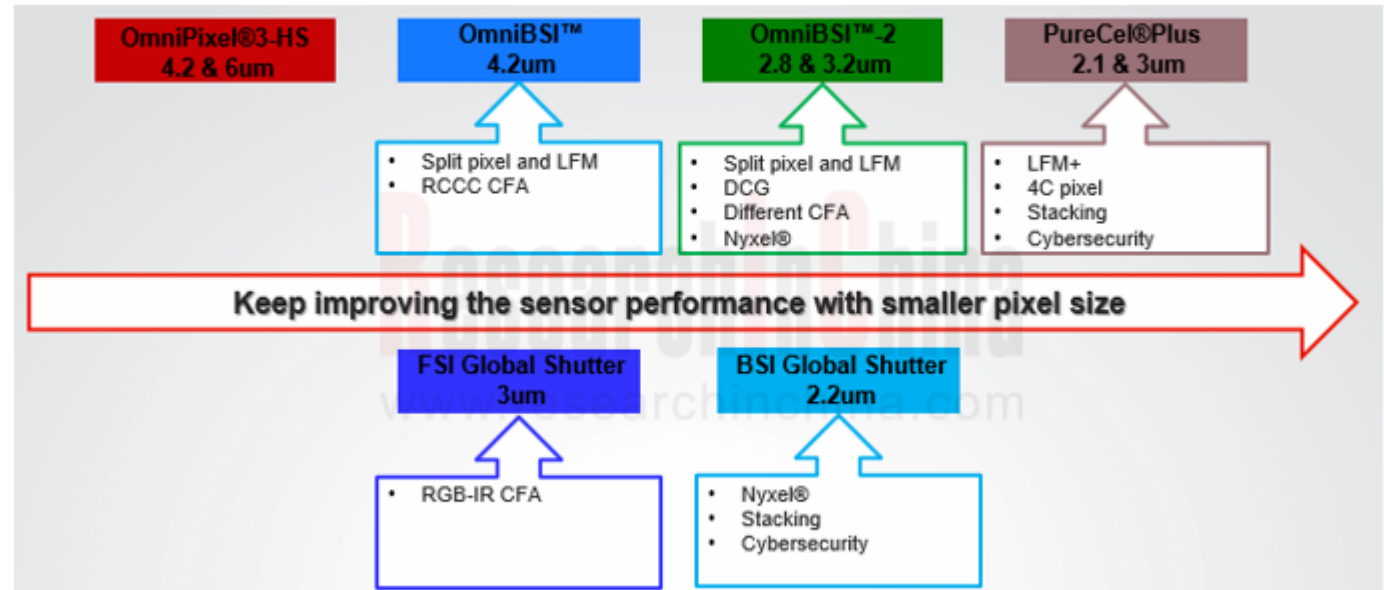
The working process of CIS (CMOS image sensor) generally covers several links: reset, photoelectric conversion, integration, and readout.

In terms of the camera industry chain, the upstream CIS manufacturers include: CIS intellectual property (IP) companies specializing in CIS design and selling IPs to CIS companies; wafer companies providing silicon chips; OSAT companies engaged in cutting and packaging processed wafers. As with the automotive camera industry, downstream manufacturers are Tier 1 suppliers and camera module packaging companies.

*In the trend for vehicle intelligence, the increasing camera pixels also pose higher technical requirements for CIS. As automotive cameras tend to be miniaturized and lightweight, pixel size cut and architecture upgrade have become most commonplace.*

Take OmniVision's CIS process iteration as an example: in the iteration of processes like OmniPixel<sup>®</sup>3-HS, OmniBSI<sup>™</sup> and PureCel<sup>®</sup>Plus, the pixel size has been reduced from 4.2 $\mu$ m to 2.1 $\mu$ m. By specific products, OX08B40 unveiled by OmniVision in 2021 delivers 8MP resolution and adopts the PureCel<sup>®</sup> Plus-S pixel architecture, a technology that uses a stacked architecture for high resolution with a smaller chip size.

## Iteration History of OmniVision's CIS Processes



Source: OmniVision

In addition to resolution, HDR is also one of the key technical parameters of CIS. In type's term, front/side view cameras have begun to pack 140dB HDR CIS, while rear/surround view cameras are still at the 120dB stage. As core sensors for advanced AD, front/side view cameras need to quickly recognize details in brightness and darkness in different lighting conditions and accurately capture images when driving at high speeds. 120dB HDR therefore is the basic requirement, and 140dB HDR is the current trend. Some manufacturers have also laid out 140+dB HDR. One example is ON Semiconductor which announced the launch of a 150dB HDR vehicle CIS in October 2022 and planned to start producing it in 2024. In the future, CIS for ADAS may reach 150+dB HDR. Rear/surround view cameras generally still offer 120dB, and will evolve to 140dB in the future. For example, CIS OX01E20 for surround/rear view, announced by OmniVision in 2023, supports 140dB HDR, 1.3MP resolution, and LED flicker mitigation (LFM).

# Products of Some Leading CIS Manufacturers

Products of Some Leading CIS Manufacturers

Manufacturer	Product	HDR	Overview
OmniVision	OX01E20	140dB	Support surround/rear view Launched in 2023, support 1.3MP resolution, HDR, and LED flicker mitigation (LFM)
ON Semiconductor	AR0820AT	140dB	Support front/side view Support 8.3MP resolution and HDR, and adopt DR-Pix™ technology Already applied in AutoX RoboTaxi and together with Desay SV supply to NIO
Sony	IMX490	120dB in normal mode; up to 140dB in priority mode	Support front/side view Support 5MP resolution, HDR and LED flicker mitigation (LFM) The front-view camera of Tesla HW4.0 will use this CIS
SmartSens	SC850AT	140dB	Support front/side view Support 8.3MP resolution and LED flicker mitigation (LFM), and carry dual HDR technology In addition to Staggered HDR, also support SmartSens' proprietary technology PixGain HDR®

# Automotive ISP solutions tend to be diversified, and AI ISP will become a development trend.

Among automotive camera component modules, ISP (image signal processor) is a core component for adjusting images. To achieve ideal imaging effects, ISP Tuning is an essential step.

In addition to conventional ISPs, there are also another two types of mainstream ISP solutions: CIS integrated ISP, and ISP integrated autonomous driving SoC. The solutions become diversified.

The diversity of ISP solutions and the necessity of ISP Tuning make ISP seen in multiple links of the camera industry chain.

The importance of ISP and its low requirement for fixed hardware architecture make itself a high ground leading manufacturers from various fields contend to gain. Players often deploy 1 or 2 solutions.

For example, Fullhan Microelectronics specializes in ISP products; SmartSens has launched several ISP-integrated CIS products; OmniVision makes layout of "ISP + ISP-integrated CIS"; NXP and Nextchip deploy "ISP + ISP-integrated autonomous driving SoC". Moreover, autonomous driving SoC companies like Mobileye, Nvidia and Black Sesame Technologies have also rolled out ISP-integrated autonomous driving chips.

### Comparison of ISP Solutions

ISP Solution	Overview	Product Example
<b>ISP chip</b>	Conventional ISP solution, integrated in cameras; high performance but high cost	FH8322 released by Fullhan Microelectronics in June 2021 supports 1920x1080@30fps, and 3-frame synthetic HDR, with the maximum dynamic range up to 120dB, LSC, AE, AWB, etc.
<b>CIS-integrated ISP</b>	A solution often launched by CIS leaders, featuring low latency, high scalability and compatibility, and great configurability, but with relatively simple algorithms and weak processing capabilities	OX01E20, an automotive CIS product released by OmniVision in January 2023, supports surround view systems and rear-view cameras, and delivers 1.3M resolution. Its functions include AEC, AGC, AWB, defective pixel correction, tone mapping, etc.
<b>ISP-integrated Autonomous Driving SoC</b>	Migrate the ISP to the high-compute SoC, offering big benefits in cost, deployment, ISP imaging and autonomous driving algorithm integration, and support higher ISP bandwidth	HuaShan 2 A1000 Pro released by Black Sesame Technologies in April 2021 supports L3/L4, and delivers 8MP solution and 106TOPS compute. It also supports 20 cameras, and enables such functions as 140dB HDR, LFM, and low-light offline noise reduction.

## Besides diversity of solutions, AI ISP is also an important development direction of ISP.

ISP covers dozens of image signal processing algorithms, but the coordination of so many algorithms requires a lot of debugging efforts. At present, the development of visual ADAS systems still relies on manual ISP Tuning. OEMs like Tesla and NIO are still recruiting a large number of image quality tuning engineers. Yet manual tuning takes a long time and requires very specialist ISP Tuning engineers.

In recent years, using AI for image enhancement has gradually become a new research hotspot in the industry, having made remarkable progress. Applying AI for real-time tuning, especially the efficient implementation of AI ISP functions in the computing environment on the terminal side, can achieve better results than conventional ISP Tuning.

For example, Ambarella announced an artificial intelligence image signal processor (AISP). Ambarella's new AI based ISP architecture uses neural networks to augment the image processing done by the hardware ISP integrated into its SoCs. This approach enables color imaging with low light at very low lux levels and minimal noise, a 10 to 100X improvement over state-of-the-art traditional ISPs, and new levels of high dynamic range (HDR) processing with more natural color reproduction and higher dynamic range.

Ambarella's CV3 AI domain controller family already packs AISP, with up to 500 eTOPS of AI compute. The ISP can simultaneously support more than 20 cameras connected through MIPI VC, and can meet the requirements for high-performance stereo and dense optical-flow engines.

**Ambarella CV3 Integrated with AISP**



Source: Ambarella

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## Beijing Headquarters

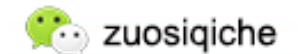
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