Independent Research on CMOS Image Sensor (CIS) Market

Confidential

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For and on behalf of
Frost & Sullivan (Beijing)Inc., Shanghai Branch Co.

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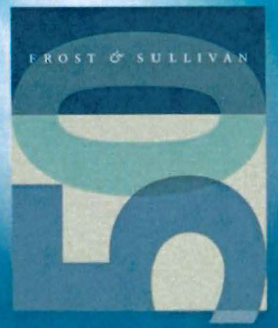
Frost & Sullivan



Scope

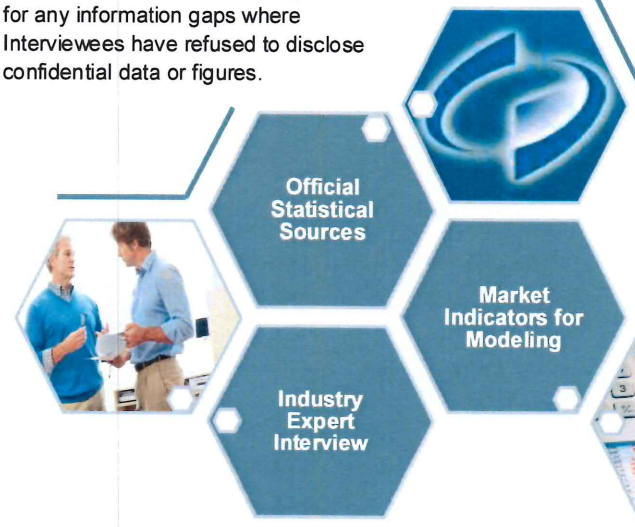
■ **The project scope is defined as follows:**

Research Period	• **Historical Year: 2020-2024** • **Base Year: 2024** • **Forecast Year: 2025-2029**
Geographic Scope	• **Global Range** • **The PRC**
Target Market	• **CIS Market**

Limitation

■ **Source of Information**

- Interviews with industry experts and competitors will be conducted on a best-effort basis to collect information in aiding in-depth analysis for this report.
- Frost & Sullivan will not be responsible for any information gaps where Interviewees have refused to disclose confidential data or figures.
- The study took 2024 as the base year and 2025-2029 as the forecast period. However, as the point of this study being 2025, some of the figures of 2024 may not be available at the moment from public statistical sources. Frost & Sullivan will use the latest information available (e.g. 2023) or make projections based on historical trends.



- Under circumstances where information is not available, Frost & Sullivan in-house analysis will be leveraged using appropriate models and indicators to arrive at an estimate.
- Source of information will be stated in the right-hand corner at the bottom on each slide for easy reference.

Methodologies and Assumptions

Methodologies and Assumptions

- Frost & Sullivan is an independent global consulting firm, which was founded in 1961 in New York. It offers industry research and market strategies and provides growth consulting and corporate training. Its industry coverage in includes consumer products, commercial aviation, automotive and transportation, chemicals, materials and food, energy and power systems, environment and building technologies, healthcare, industrial automation and electronics, industrial imaging and machinery, and technology, media and telecom.
- The Frost & Sullivan's report includes information on the CMOS Image Sensor (CIS) market.
- Frost & Sullivan has conducted detailed primary research which involved discussing the status of the industry with certain leading industry participants. Frost & Sullivan has also conducted secondary research which involved reviewing company reports, independent research reports and data based on its own research database. Frost & Sullivan has obtained the figures for the estimated total market size from historical data analysis plotted against macroeconomic data as well as considered the above-mentioned industry key drivers.
- Frost & Sullivan's Market Engineering Forecasting Methodology integrates several forecasting techniques with the Market Engineering Measurement-based System. It relies on the expertise of the analyst team in integrating the critical market elements investigated during the research phase of the project. These elements include:
  - ✓ Expert-opinion forecasting methodology
  - ✓ Integration of market drivers and restraints
  - ✓ Integration with the market challenges
  - ✓ Integration of the Market Engineering Measurement trends
  - ✓ Integration of econometric variables
- In preparing the Report, Frost & Sullivan conducted detailed primary research which involved in-depth telephone and face-to-face interviews with industry participants. Frost & Sullivan also conducted secondary research which involved reviewing annual reports, industry publications and data based on its own research database. Frost & Sullivan obtained the figures for various market size estimates from historical data analysis plotted against macroeconomic data, and considered related industry drivers. Its forecasting methodology integrates several forecasting techniques with its internal analytics of critical market elements investigated in connection with its market research work. These elements primarily include identification of market drivers and restraints and integration of expert opinions. In preparation of the Frost & Sullivan Report, Frost & Sullivan assumed: (1) social, economic and political environments are likely to remain stable in the forecast period; (2) related industry key drivers are likely to drive the market in the forecast period.

Agenda

1 *Overview of Global CMOS Image Sensor Market*

2 *Overview of CMOS Image Sensor Market in the PRC*

3 *Competitive Landscape*

4 *Appendix*

Overview of Global CMOS Image Sensor Market

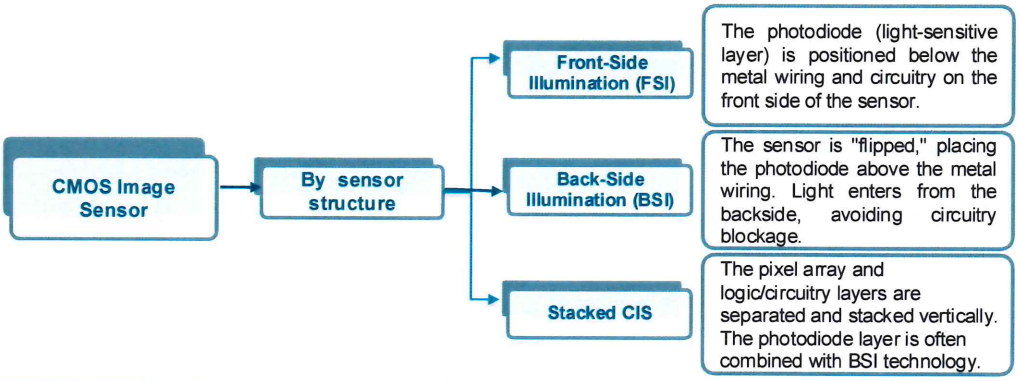
Definition and Classification

Definition

- CIS is an optical sensor built using CMOS technology, designed to convert light signals into electrical signals, and subsequently into digital data through integrated readout circuits. As the core component of camera modules, CIS plays a critical role in applications such as consumer, prosumer, automotive, security, industrial imaging, medical, defense and aerospace, and scientific imaging. Compared with traditional CCD sensors, CIS offers advantages like lower power consumption, higher integration, reduced cost, and higher frame rate, making it the dominant technology in current imaging market.

Classification

- CIS can be classified into three types based on the sensor structure: FSI, BSI, and stacked CIS. Among these, stacked CIS offers significant improvements in image quality by increasing the area of pixel layer in the sensing unit, which also helps to effectively reduce circuit noise, adding more functionalities of the sensor. Regarding the shutter exposure method, CIS can be divided into rolling shutter and global shutter. The global shutter is the preferred choice for industrial imaging and high-speed photography applications, as it captures the entire image at once, avoiding distortion in fast-moving scenes.



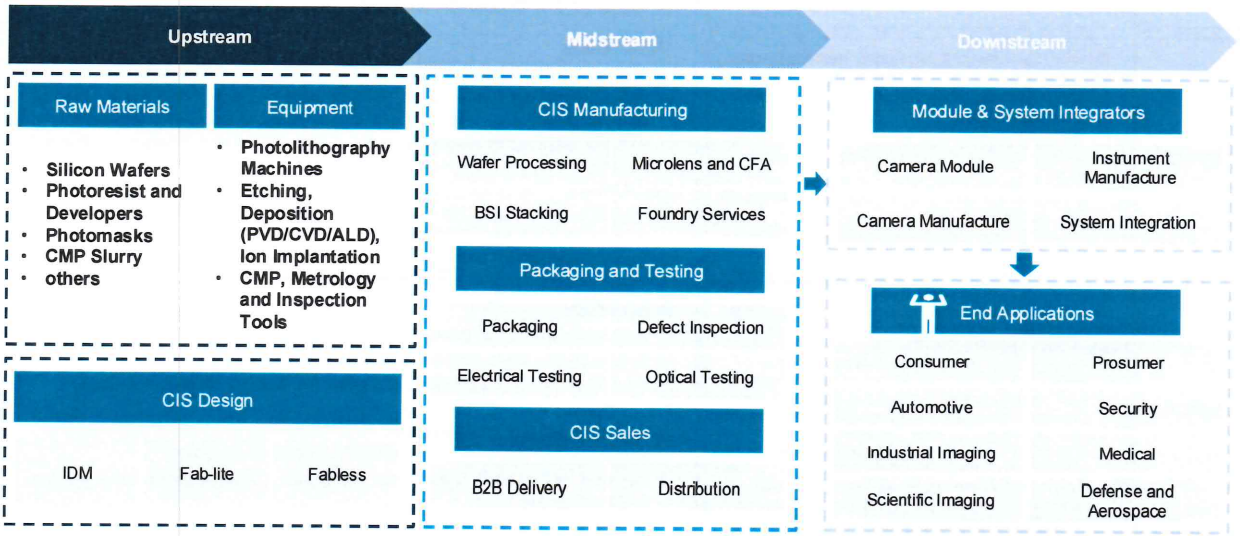
Source: Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Value Chain Analysis

The value chain of cultural products comprises three key segments: the upstream focuses on idea generation and raw material procurement, while the midstream deals with solution offerings that encompass both tangible and intangible products. The downstream segment involves service delivery and product distribution.

- The upstream segment covers raw material sourcing, equipment, and CIS design. Raw materials include silicon wafers, photoresists, and other components. CIS design companies typically operate under three models: Fabless (design only), Fab-lite (design with partial wafer manufacturing capabilities), and IDM handling design to wafer production in-house.
- The midstream segment includes CIS manufacturing, involving processes such as wafer processing, BSI stacking, microlens and CFA and foundry services, as well as packaging and testing. It also covers CIS sales, where CIS is sold directly to module makers or OEMs, or distributed via distributors and representatives.
- The downstream segment involves module, camera manufacture, instrument and system integrators, for various end applications, covering the fields of industrial imaging, medical, scientific imaging, consumer, prosumer, automotive and defense and aerospace. As a fabless CIS design company, we operate in the upstream segment of the industry value chain, focusing primarily on the design, development, testing, and sales of high-performance CMOS image sensors while outsourcing the wafer manufacturing processes to world-class
- production partners.



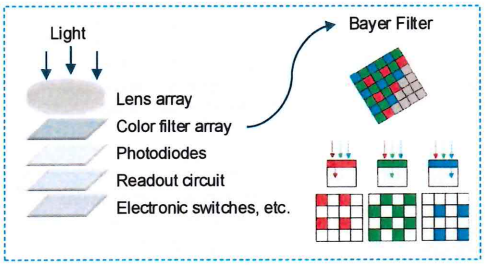
Source: Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Working Principle Analysis

CIS Working Principle Analysis

Photonic to Electric Conversion



Electric Signal Processing

- Charge Accumulation
- Charge Amplifier
- Row/Column Selection Circuit

Analog to Digital Conversion

- Analog-to-Digital Converter
- Parallel Conversion with Multiple Channels
- Digital Pixel

Digital Signal Processing and Output

Image Signal Processor	Interface
Processes the digital signal, performing tasks like denoising, color correction, sharpening, etc.	Processed image data is output through interfaces (such as MIPI, LVDS) to external devices.

- In terms of structure, CIS adopts a highly integrated architecture consisting of a pixel array, row/column drivers, timing controller, ADC, data output interface, and control logic. A CIS operates by exposing a pixel unit to impinging light photons, where each pixel consists of a microlens that focuses incoming light through a color filter onto a photodiode, converting photons into electrical charge. After exposure, in a classic 4T pixel structure, the charge is transferred via a transfer gate to a floating diffusion node, where it is converted into a voltage signal. This signal is then amplified by a source follower and selectively read out through a row select transistor. Finally, the voltage is sent to column readout circuits, digitized by an ADC, and processed into image data, completing the conversion from light to digital image.

Source: Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Downstream Application Market Analysis – Consumer/ Security/ Automotive

Consumer	Consumer refer to electronic devices designed for personal or household use, including: • **Mobile Devices**: Smartphones, tablets, laptops • **Wearables**: Smartwatches, AR/VR headsets, wireless earbuds • **Display Devices**: TVs	**Market drivers** **Smartphone Multi-Camera Boom**: Average cameras per phone rose. **Video-First Social Media**: TikTok/YouTube drove adoption of 4K/60fps in mid-range phones. **AI Computational Photography**: Night mode portrait bokeh relying on multi-frame CIS processing. **Future trends** **Cost-Effective Innovation:** Reduce multi-camera costs， and improves dynamic range, reducing reliance on external, boosting integration of CIS and AI. **Application-Specific Demand:** Foldables with Ultra-thin CIS modules.
Security	Security (Surveillance & Monitoring) refers to systems that utilize visual sensing technology for environmental monitoring, target identification, and risk warning, including: • **Video Surveillance**: IP cameras, CCTV systems • **Access Control**: Facial recognition gates, smart locks • **Industrial Security**: Facility inspection, hazardous area monitoring • **Public Safety**: Traffic violation capture, crowd behavior analysis	**Market drivers** **Smartphone Multi-Camera Boom**: Average cameras per phone rose. **Video-First Social Media**: TikTok/YouTube drove adoption of 4K/60fps in mid-range phones. **AI Computational Photography**: Night mode portrait bokeh relying on multi-frame CIS processing. **Future trends** **Cost-Effective Innovation:** Reduce multi-camera costs， and improves dynamic range, reducing reliance on external, boosting integration of CIS and AI. **Application-Specific Demand:** Foldables with Ultra-thin CIS modules.
Automotive	Automotive CIS (CMOS Image Sensor) is the core component of vehicle-mounted cameras, converting optical signals into electrical signals to provide environmental perception data for autonomous driving and advanced driver assistance systems. Key functional modules include: • **ADAS CIS**: Used for systems like lane departure warning (LDW), automatic emergency braking (AEB), and traffic sign recognition (TSR). Typical applications include front-view cameras and surround-view cameras . • **In-Cabin CIS**: Monitors driver fatigue, passenger behavior, and child presence detection. • **Imaging CIS**: Supports surround-view systems (e.g., 360° panoramic cameras) and rearview cameras (high dynamic range, HDR).	**Market drivers** **Regulatory Mandates:** Safety standards (e.g., EU NCAP) mandated ADAS adoption. **Vehicle Intelligence:** OEMs increased camera for vehicle. **Cost Reductions:** Low-resolution CIS prices fell, enabling mass-market adoption. **Future Trends** **High Resolution & Sensor Fusion: High Quality** CIS will become mainstream with longer detection range, integrated with LiDAR/radar for redundancy. **Advanced Automotive-Grade Tech**: LED flicker mitigation (LFM) enhanced low-light performance.

Source: Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Downstream Application Market Analysis – Prosumer/ Industrial Imaging

Prosumer

CIS serve as the core imaging technology in prosumer devices, bridging consumer and professional markets. They range from compact, mid-resolution sensors for hobbyists to high-performance, large-format sensors with advanced features like HDR, stacked design, and RAW support for professional creators.

General Applications

- Compact Digital Cameras (DSC)
- Entry-Level Drones
- Mid-Range Action Cams
- Vlog Cameras

High-End Applications

- High-End Mirrorless / DSLR Cameras
- Professional Drones (e.g., DJI Inspire series)
- High-FPS Action / 360° Cams
- AI-Integrated Imaging Systems

Market drivers

- **Rising Demand for Image Quality:** Users seek better resolution, color accuracy, and low-light performance
- **Content Creation Boom:** Growth in vlog, short videos, and social media drives demand for pro-level devices. New use cases (e.g., aerial, sports) demand high-speed, stabilized CIS performance
- **Manufacturing Tech Advancements:** Progress in BSI, stacked CMOS, and hybrid integration enhances performance.

Future trends

- **Stacked CMOS Mainstream Adoption:** Enables fast readout, real-time HDR, and AI-powered functions.
- **Expansion of Global Shutter Use:** Reduces motion distortion, ideal for fast movement and aerial photography.
- **High Frame Rate & 8K Video Support:** Meets demand for slow motion, cinematic 8K/120fps content.

Industrial Imaging

CIS in the industrial imaging sector supports a wide spectrum of applications. In general use, it enables basic 2D imaging functions such as barcode scanning and object detection in cost-sensitive environments. In advanced use, it supports high-resolution imaging with features like global shutter, HDR, 3D ToF (Time-of-Flight), and hyperspectral sensing, which are essential for high-speed inspection, precision metrology, and AI-powered vision systems.

General Applications

- Barcode & QR Scanning
- Packaging Inspection
- Object Detection & Tracking
- Positioning & Alignment
- Factory Monitoring

Advanced Applications

- High-Speed Inspection
- 3D Vision & ToF Imaging
- Hyperspectral Imaging
- AI-Powered Machine Vision
- Precision Metrology

Market drivers

- **Rise of Smart Manufacturing (Industry 4.0):** Demand for automation, digitization, and real-time quality control.
- **Cost-efficiency & Miniaturization:** Preference for compact, lower-power, integrated CIS over CCD solutions.
- **Data Precision & Traceability:** High-resolution CIS enhances measurement accuracy and production traceability.

Future Trends

- **Wider Adoption of Global Shutter CIS:** Eliminates motion blur in high-speed industrial processes.
- **Integration with AI and Edge Processors:** Enables smarter, on-device image analysis and defect classification.
- **3D Imaging & ToF Sensors:** Expands into depth sensing for robotic vision and industrial 3D inspection.

Source: Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Downstream Application Market Analysis – Medical/ Defense & Aerospace/ Scientific Imaging

Medical

CIS is a core imaging component in modern medical devices, converting light into electrical signals to enable real-time, high-precision imaging, including:

- **Diagnostic Imaging:** Digital X-ray, CT detectors, fundus cameras, OCT systems…
- **Minimally Invasive Imaging**: Capsule endoscopy, flexible endoscopes…
- **Laboratory & Life Sciences:** Digital pathology scanners, fluorescence microscopes…
- **Surgical Visualization:** Surgical microscopes…
- **Ophthalmic Imaging:** Retinal scanners, slit-lamp cameras, OCT…
- **Wearable & Remote Monitoring:** Skin condition analyzers…

Market drivers

- **Need for High-Resolution & Real-Time Imaging:** Advanced diagnostics and surgical visualization require sharp, fast imaging.
- **Expansion of Telemedicine & Home Healthcare:** Increased use of wearable and remote monitoring devices drives CIS usage.

Future trends

- **Higher Resolution & Smaller Pixel Pitch:** Supports ultra-fine imaging for pathology and cellular studies.
- **Cross-Industry Tech Migration:** CIS innovations from smartphones and automotive sectors are entering medical use.

Defense & Aerospace

CIS is critical components in modern defense and aerospace imaging systems, including:

- **Surveillance and Reconnaissance:** Drones (UAVs), satellite imaging payloads, border patrol systems…
- **Spaceborne Imaging:** Earth observation satellites, astronomical telescopes…
- **Pilot and Crew Vision Systems:** Earth observation satellites, astronomical telescopes…
- **Navigation and Obstacle Avoidance:** Vision-based navigation systems in UAVs or spacecraft…
- **Others**

Market drivers

- **Radiation-Hardened Technology Maturity:** CIS is increasingly designed for radiation tolerance, enabling space applications.
- **Multi-Spectral and IR Imaging Needs:** CIS with integrated filters and extended spectral range support multi-domain awareness.

Future trends

- **Extended Spectral Imaging (UV to LWIR):** Expands CIS utility across infrared and ultraviolet bands for tactical advantage.
- **Radiation-Hardened CIS Design Advancement:** Facilitates long-duration deep space missions and high-orbit satellite imaging.

Scientific Imaging

CIS serves as critical optoelectronic components in modern scientific imaging, used across disciplines such as biology, chemistry, physics, and materials science, including:

- **Imaging & Analysis**: Fluorescence microscopes, confocal microscopes, astronomical telescopes …
- **Spectral & Composition Detection:** Raman spectrometers, FTIR, UV-Vis spectrophotometer…
- **High-Speed Capture**: High-speed cameras, shock testing, combustion imaging…
- **Low-Light/Long-Exposure**: Particle detection systems, deep-space astronomy, single-molecule imaging…
- **Automated Control & Feedback:** Lab automation systems, micro-manipulation platforms, robotic vision…

Market drivers

- **Rising Demand for High-Quality Imaging:** Scientific research requires ultra-high resolution, low noise, and high sensitivity.
- **System Miniaturization and Integration:** CIS enables compact, integrated systems through SoC capabilities.
- **Need for Real-Time Data Acquisition:** Higher frame rates and low-latency imaging are critical in many experimental scenarios.

Future Trends

- **Ultra-High Resolution and Dynamic Range:** Enables detailed observation of microstructures and complex samples.
- **Event-Based and Time-Resolved Imaging:** Supports capturing nanosecond-scale transient phenomena in physical and chemical experiments.

Source: Frost & Sullivan

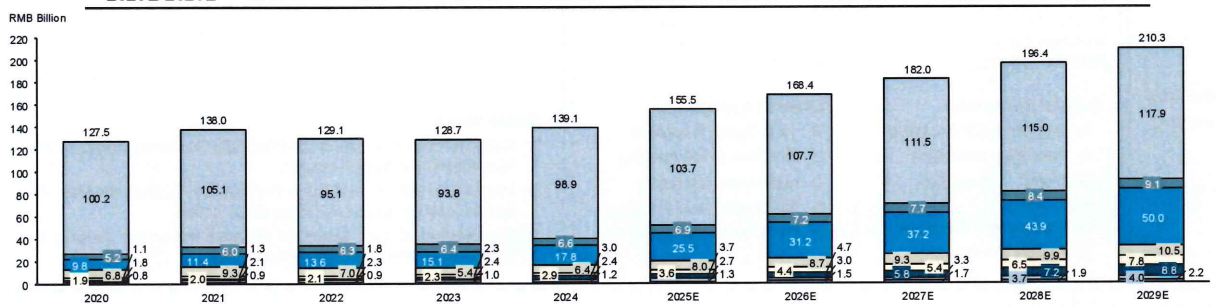
Overview of Global CMOS Image Sensor Market

Market Size of Global CIS Market

- From 2020 to 2024, the global CIS market experienced moderate growth, with the total revenue increasing from RMB127.5 billion to RMB139.1 billion, representing a CAGR of 2.2%. The decline in the global CIS market size from 2021 to 2023 was driven by pandemic-induced weakened demand for consumer electronic. From 2021 to 2023 as a result of mainly resulted from earlier supply chain disruptions, including capacity constraints at foundries and OSAT providers, material shortages, and logistics bottlenecks during the pandemic, to secure supply, the Company and its customers placed front-loaded orders and built safety stocks. As consumer electronics demand softened and capacity normalized from the second half of 2022, this mismatch led to a slowdown in inventory consumption, further exacerbated by macroeconomic uncertainties such as rising inflation and reduced capital expenditures. As inventories were gradually digested and consumer markets stabilized, demand started to rebound. From 2025 to 2029, the growth in global CIS market size is projected to accelerate, with the total revenue expected to rise from RMB155.5 billion in 2025 to RMB210.3 billion in 2029, representing a CAGR of 7.8%. From 2020 to 2024, the global CIS market was still dominated by consumer electronics, but smartphone and other end markets became saturated, demand slowed, and inventory overhang led to price declines, resulting in a CAGR of only about 2.2%. During the same period, high-value segments such as automotive (particularly ADAS), industrial vision, and medical imaging recorded rapid growth, gradually increasing their share and diversifying the application mix.
- In terms of applications, consumer CIS segment remains the dominant force, accounting for more than 71% in 2024. The prosumer market primarily includes professional photography and video and other high-end consumer imaging devices. Its market size grew from RMB5.2 billion in 2020 to RMB6.6 billion in 2024, representing a CAGR of 5.9%. The market size of industrial imaging CIS increased from RMB1.9 billion in 2020 to RMB2.9 billion in 2024, representing a CAGR of 12.2%. The medical imaging sector demonstrated the most robust performance, with the market size nearly tripling from RMB1.1 billion in 2020 to RMB3.0 billion in 2024, representing a CAGR of 29.1%. Meanwhile, the market size of scientific imaging increased from RMB0.8 billion to RMB1.2 billion, with a CAGR of 10.3%. These segments, though smaller in absolute scale compared to consumer electronics, have increasingly contributed to the overall diversification of the demand base in CIS industry.
- The market entered from 2023 to 2024 at a low base during an industry-wide destocking phase. From 2024 to 2029, growth is expected to accelerate to a CAGR of 8.6%, supported by demand recovery and a rising share of automotive, industrial, and medical applications. In addition, higher value per unit driven by more cameras per vehicle, higher resolution, and added functionalities, together with technology-driven ASP uplift from wider adoption of stacked CIS, global shutter, HDR, and NIR/ToF technologies, will further contribute to market expansion.
- During the period from 2025 to 2029, the prosumer CIS market is expected to maintain steady growth, reaching RMB8.1 billion by 2029, driven by rising demand for high-quality imaging in drones, action cameras, and personal content creation. Medical imaging sector is expected to maintain strong growth, reaching RMB6.6 billion by 2029, with a projected CAGR of 24.0% from 2025 to 2029. It is driven by rising demand for high-resolution diagnostic imaging systems, an aging population, and increased healthcare investments. Industrial imaging sector is anticipated to expand rapidly, with the size rising to RMB7.8 billion at a CAGR of 21.0% from 2025 to 2029, supported by the widespread deployment of AI-powered visual inspection solutions, demand for real-time defect detection on high-speed production lines, and growing investment in smart robotics that require high-precision sensing. Growth in scientific imaging is forecast to accelerate at a CAGR of 12.7% from 2025 to 2029, fueled by expanding research funding, broader applications in life sciences and microscopy, and increasing demand for higher-resolution sensors in advanced laboratories.
- The global industrial and scientific imaging CIS markets are expected to grow significantly faster than the overall CIS, supported by distinct structural drivers. For industrial imaging, broader penetration of factory automation and machine vision is increasing camera deployment per production line, while adoption of advanced specifications such as global shutter, HDR, NIR/SWIR sensitivity, LED-flicker mitigation, and high-reliability packaging is driving sustained ASP uplift. For scientific imaging, ongoing substitution of CCD by sCMOS is creating structural volume growth, complemented by new applications in life sciences, digital pathology, microscopy and astronomy that require higher sensitivity, lower noise and faster frame rates. Defined refresh cycles for research and scientific equipment further support predictable mid-term demand. Together, these segments benefit from a smaller base and ongoing migration toward higher-value specifications, while avoiding the volume saturation and pricing pressure faced by consumer and prosumer CIS, thereby enabling faster and more sustainable growth.

Market Size of Global CIS Market, Breakdown by Application, by Sales Revenue 2020-2029E

CAGR	Consumer	Prosumer	Automotive	Security	Industrial Imaging	Medical Imaging	Scientific Imaging	Defence & Aerospace	Total
2020-2024	-0.3%	5.9%	16.1%	-1.6%	12.2%	29.1%	10.3%	7.6%	2.2%
2025E-2029E	3.3%	7.3%	18.4%	6.9%	21.0%	24.0%	12.7%	10.0%	7.8%

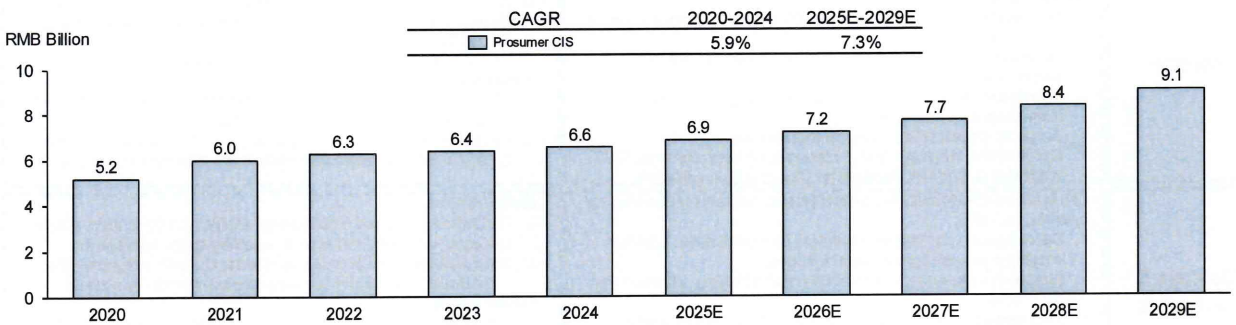


Source: Annual Reports, Frost & Sullivan

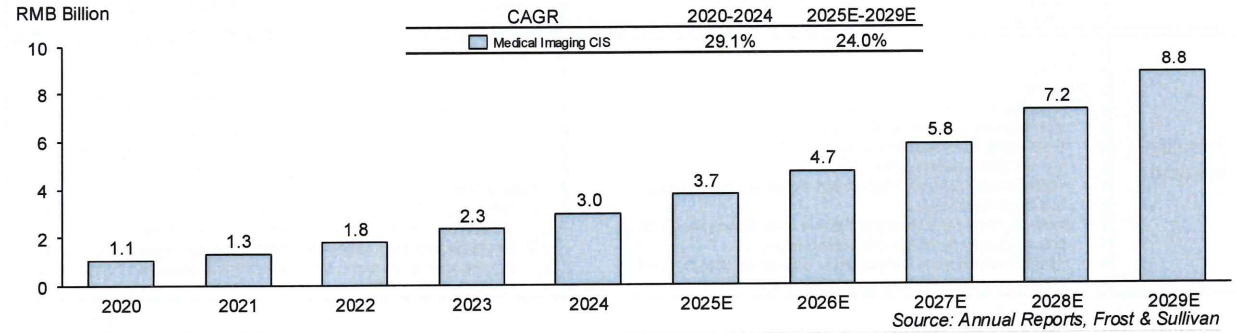
Overview of Global CMOS Image Sensor Market

Market Size of Global CIS Market and Breakdown by Prosumer, Industrial Imaging, Medical Imaging and Scientific Imaging (1/2)

Market Size of Global Prosumer CIS Market, by Sales Revenue, 2020-2029E



Market Size of Global Medical Imaging CIS Market, by Sales Revenue, 2020-2029E

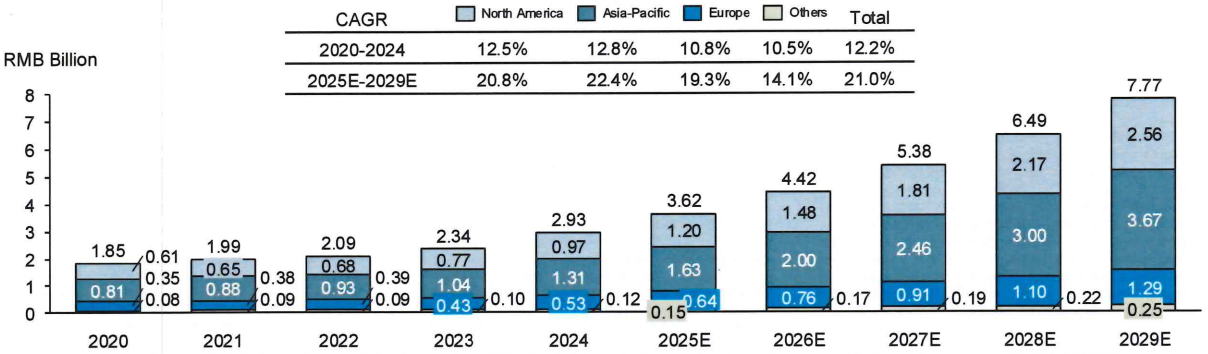


Source: Annual Reports, Frost & Sullivan

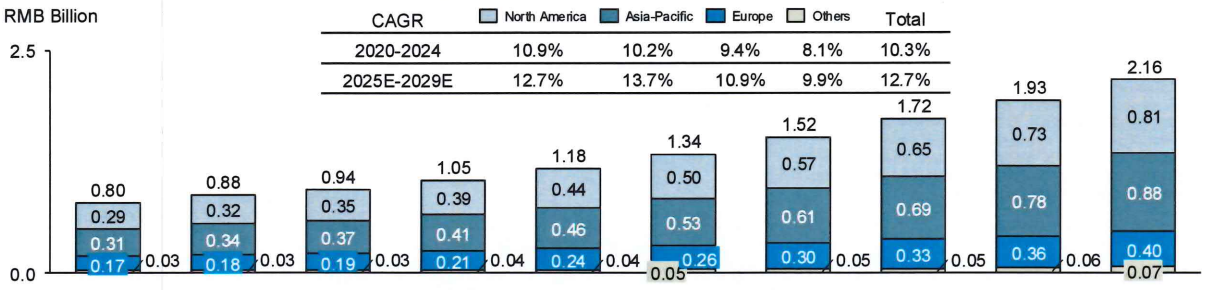
Overview of Global CMOS Image Sensor Market

Market Size of Global CIS Market and Breakdown by Prosumer, Industrial Imaging, Medical Imaging and Scientific Imaging (2/2)

Market Size of Global Industrial Imaging Market, Breakdown by Region, by Sales Revenue 2020-2029E



Market Size of Global Scientific Imaging Market, Breakdown by Region, by Sales Revenue 2020-2029E



Note: Others include South America, Africa.

Source: Annual Reports, Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Market Drivers

Market Drivers

Accelerated Technological Advancement

- Pixel size reduction has been a fundamental driver of CIS performance improvement in consumer applications. With advanced process nodes, pixel sizes continue to shrink while maintaining or enhancing light sensitivity through optimized optical structures. This enables higher resolution in compact designs, which is essential in mobile, tablet and computer applications. Backside illumination improves low-light performance by relocating metal wiring behind the photodiode, while stacked CIS architecture separates the pixel array from logic circuits. This allows for higher data throughput and advanced on-chip functions such as multi-frame processing, HDR imaging, and on-chip image processing which are critical for professional imaging and machine vision. Technological advancement in sensor design, such as high dynamic range, high frame rate, low noise, low power and high sensitivity, is also rapid evolving. On the HDR advancements, including digital-overlap HDR and per-pixel exposure control, address the need for accurate imaging in complex lighting conditions. These technologies are widely applied in automotive systems, industrial inspection, and scientific measurement. Faster readout speeds and the adoption of global shutter technology further enable distortion-free image capture in high-speed imaging, high-end industrial imaging, and professional imaging applications such as cinematography. Improvements in power efficiency, noise reduction and high sensitivity through low-power design, power mode control, and thermal noise suppression enhance reliability in mobile and low-light environments, especially in medical and laboratory settings. These innovations underscore the accelerating pace of CIS technology evolution and its expanding market relevance.

Incremental Demand

- The increasing need for automation in industries such as factory automation, logistics and positioning, as well as high-end industrial inspection and metrology is pushing demand for high-performance CIS. The wide adoption of CIS in the production line increases throughput, reduces costs while improves quality. In scientific imaging sector, high performance image sensor demand is driven by the continuous advancements in research areas such as astronomy, material science, biology, DNA sequence, etc. Higher resolution, improved sensitivity, and faster readout speeds are essential for capturing more detailed data, driving the growth of CIS in this field. For prosumer, the rise of content creation, including photography, cinematography, and broadcasting, continues to boost CIS demand, requiring sensors with higher resolution up to thousands of frames per second, improved low-light performance, and enhanced dynamic range. In medical imaging, CIS adoption is being driven by the demand for diagnostic techniques and portable imaging devices. Medical applications such as endoscopy, and diagnostic cameras require high-resolution and low-noise sensors to ensure accurate results. The rising focus on patient care and the growing need for real-time and on-site diagnostics are pushing demand for CIS in medical imaging technologies.

Ecosystem Transformation

- Mature CMOS processes and mass production capabilities have driven continuous cost reductions per unit, cementing CMOS as the dominant technology over CCD in high-end imaging systems. Regionalized supply chain strategies are accelerating, with Asia leading manufacturing and packaging/testing, while North America and Europe retain leadership in sensor IP and algorithm development, forming a complementary "from R&D to manufacturing" ecosystem. The CIS market for consumer application is highly concentrated with manufacturers in Japan, Korea, and China. Similarly, the competition in automotive and security applications are also concentrated and highly competitive with suppliers in North America and China. Due to widely spread requirements and specifications, the competition in scientific imaging, industrial imaging, medical imaging, prosumer, aerospace and defense is less intense and the competitive dynamic and trend is towards technology and performance. The players have been significantly consolidated through acquisitions and mergers in the past decade to strengthen and expand the position in these high value-added market segments. In addition, the sustained capital investments in vision technologies empower startups to innovate rapidly, fostering healthy competition with incumbents and collectively expanding the overall market scale.

Source: Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Future Trends

Pursuit of High Performance and Intelligence

The global CIS market is evolving toward higher resolution, lower power consumption, and enhanced optical performance. The maturing of stacked sensor architecture, which separates the pixel and logic layers, significantly improves processing efficiency and image quality. Functionality, feature or even intelligence integrated in the logic layer at the sensor level, is becoming a key trend. Integrating AI accelerators, signal processors, and embedded algorithms directly into the sensor chip is becoming increasingly important. This enables real-time edge computing functions such as object detection, scene classification, and event recognition during image capture. Such capabilities are particularly valuable in automotive vision, surveillance, and smart manufacturing systems. Additionally, the industry is seeing rapid advancements in high dynamic range and high-speed readout technologies. Features like digital-overlap HDR, regional exposure control, and global shutter architectures are improving performance in complex lighting and fast-motion environments. These technologies are essential for professional imaging, robotics, and scientific imaging. Lastly, the trend toward low power consumption and system-level integration continues to strengthen. Through advanced packaging, multi-mode power management, and thermal noise suppression, CIS is becoming more efficient and compact, enabling new applications in mobile healthcare, wearables, and portable diagnostics.

Application-Oriented Vision Solution Driving Market Growth

Application oriented vision solution is emerging as a key trend driving future growth of the CIS market, as image sensing technology expands from consumer electronics into a wide array of high-potential industries. In industrial imaging sector including machine vision, growing automation in manufacturing and logistics is increasing the need for precise detection, real-time analysis, and robotic control. This pushes the development of sensors with faster frame rates, global shutter functionality, and integrated processing capabilities. In medical devices, there is a growing need for sensors with superior low-light performance and extended dynamic range. The scientific research and instrumentation field is also expanding CIS usage. Applications such as microscopy, spectroscopy, and environmental observation require sensors that perform under low light and extreme conditions, driving the need for high-performance and customizable CIS solutions. Smart city initiatives are also fuelling demand for high-frame-rate and high-reliability image sensors in surveillance, intelligent transportation, and unmanned retail, positioning these sectors as key contributors to the continued expansion of global CIS market.

Ecosystem Collaboration and Industry Chain Integration

Single companies can no longer optimize the entire value chain alone, making collaborative innovation and vertical integration essential. At the upstream level, leading CIS companies are strengthening partnerships with foundries and OSAT (outsourced semiconductor assembly and test) providers to accelerate the adoption of nodes, stacking technologies, and global shutter architectures. Open platform models are also emerging, where design houses co-develop solutions with EDA and IP vendors to shorten development cycles and improve customization. In the midstream, collaboration between sensor makers, lens suppliers, ISP vendors, and AI chip developers is deepening. Through joint optimization, these players work together to enhance image quality, computational efficiency, and application-specific tuning, which is critical for use cases such as automotive vision systems, diagnostic imaging devices, and industrial inspection tools. At the downstream level, more terminal device manufacturers are engaging in the early stages of sensor definition. By co-developing sensor specifications and interface standards with CIS providers, they ensure better system-level performance and faster time to market. This reverse-driven model is becoming the industry norm. Additionally, new application frontiers such as AI vision, low-power imaging, and 3D sensing are promoting the formation of cross-domain ecosystems. Companies from different segments are working together to integrate image capture, edge processing, and cloud analytics into unified solutions, accelerating the deployment of CIS in next-generation scenarios. The future of the global CIS industry will be shaped by collaborative ecosystems, vertically integrated supply chains, and platform-based innovation.

Future Outlook

Source: Frost & Sullivan

Overview of Global CMOS Image Sensor Market

Laws and Regulations

Regulations	Country	Issue time	Issue department	Description
Creating Helpful Incentives to Produce Semiconductors for America Act (CHIPS ACT OF 2022)	US	2022.09	House Senate	The act establishes and provides funding for the Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America International Technology Security and Innovation Fund to (1) provide for international information and communications technology security and semiconductor supply chain activities, including to support the development and adoption of secure and trusted telecommunications technologies, secure semiconductors, secure semiconductors supply chains, and other emerging technologies; and (2) carry out the Multilateral Semiconductors Security Fund and the Multilateral Telecommunications Security Fund.
INFORMATION AND COMMUNICATIONS TECHNOLOGY INDUSTRY PROMOTION ACT	South Korea	2022.06	Ministry of Industry and Information	The policy direction of the Korean Government can be summarized into the following three categories; (1) building sufficient ICT infrastructure, (2) improving information and communication environment, and (3) providing more ICT education.
Integrated Innovation Strategy 2024	Japan	2024.06	Ministry of Industry and Information Technology Ministry of Education Ministry of Science and Technology People's Bank of China, China Banking and Insurance Regulatory Commission National Energy Administration	Fusion energy and quantum technologies are emerging technologies that will spawn new industries. AI, biotechnology, materials, semiconductors, and Beyond 5G (6G) are fundamental technologies that support. Japan's economy and society, and they are becoming increasingly important in Japan's economic growth. With regard to these key technologies, we will strongly promote R&D, industrialization, and human resource development by integrating technologies across fields from a bird's-eye perspective.
Korea's National Quantum Strategy	South Korea	2023.06	Ministry of Science and ICT	The National Quantum Strategy emphasizes R&D for quantum technologies, with a strong focus on integrating quantum computing and quantum sensors with traditional semiconductor chips. Given the critical role semiconductors play in quantum systems, there is significant policy support aimed at advancing the development of semiconductor chips for quantum applications. The South Korean government is providing financial incentives and funding to both public and private companies involved in semiconductor manufacturing, particularly those focusing on quantum-related chips.
National Strategy for Advanced Manufacturing	US	2022.10	National Science and Technology Council Executive Office of the President	Semiconductors are the foundation of microelectronics, and advances in semiconductor technology are critical for national security and for almost every sector of the economy. The strategy encourages significant federal and private sector investment in semiconductor R&D. For CIS, this translates to funding for improving sensor technologies, such as better image resolution, faster processing speeds, and reduced power consumption.
High-Tech Strategy 2025	German	2019	Federal Government of Germany	The High-Tech Strategy 2025 places a strong emphasis on increasing funding for R&D in the semiconductor sector. For CIS, this means more resources dedicated to improving imaging technologies, miniaturization, higher resolution, and faster processing speeds in sensors. The strategy encourages the development of new semiconductor materials and fabrication processes, which are crucial for advancing CIS technology. Innovations in materials like graphene or wide-bandgap semiconductors could lead to enhanced sensor performance, particularly in terms of sensitivity and speed.

Source: Government websites of different countries, Frost & Sullivan

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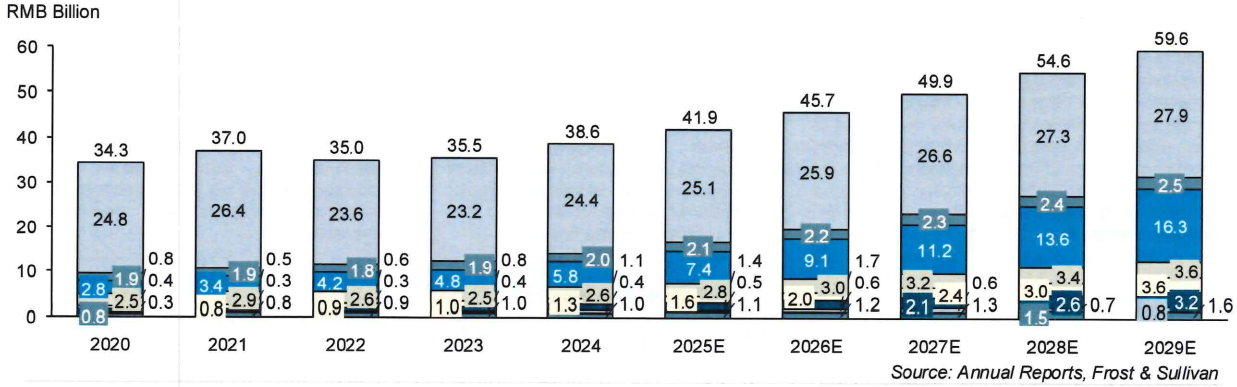
Overview of CMOS Image Sensor Market in the PRC

Market Size of CIS Market in the PRC

- From 2020 to 2024, the CIS market in the PRC maintained stable growth, with market size expanding from RMB34.3 billion to RMB38.6 billion, representing a CAGR of 3.1%. Consumer remained the largest application segment, although its share showed slight fluctuations over the period. The industrial imaging applications increasing from RMB0.8 billion to RMB1.3 billion at a CAGR of 14.4%. Scientific imaging CIS also demonstrated steady growth, rising from RMB0.3 billion to RMB0.4 billion, reflecting a CAGR of 11.7%.
- Looking ahead from 2025 to 2029, the PRC CIS market is expected to sustain its growth trajectory, expanding from RMB41.9 billion to RMB59.6 billion, with a projected CAGR of 9.2%. The industrial imaging applications are expected to expand from RMB1.6 billion to RMB3.6 billion at a CAGR of 22.5%. Scientific imaging applications are anticipated to reach RMB0.8 billion by 2029, with a CAGR of 14.2%, forming part of a rising cluster of high-value, professional-grade use cases.

Market Size of CIS Market in the PRC, Breakdown by Application, by Sales Revenue 2020-2029E

CAGR	Consumer	Prosumer	Automotive	Security	Industry Imaging	Medical Imaging	Scientific Imaging	Defence & Aerospace	Total
2020-2024	-0.4%	1.1%	19.6%	0.6%	14.4%	28.1%	11.7%	7.6%	3.1%
2025E-2029E	2.7%	5.1%	22.1%	6.7%	22.5%	23.6%	14.2%	8.2%	9.2%



Source: Annual Reports, Frost & Sullivan

Overview of CMOS Image Sensor Market in the PRC

Market Drivers

Market Drivers

Technology Innovation	• Technology innovation is a key driver of the CIS market, with advanced architectures and integration breakthroughs reshaping performance benchmarks. Backside-Illuminated CIS has become mainstream by repositioning the photodiode above the metal wiring layers, significantly boosting low-light sensitivity. Stacked CIS architectures go a step further, physically separating the pixel and logic layers to enable denser pixel arrays, enhanced image processing, lower noise, and faster data readout. At the packaging level, innovations in wafer-level packaging (WLP) and chip-scale packaging (CSP) allow for ultra-thin and compact sensor modules, which are ideal for next-gen applications like industrial internet of thing/miniaturized devices. Moreover, on-chip ISPs equipped with embedded AI now support real-time scene analysis, noise filtering, and HDR optimization directly at the sensor level, greatly improving image quality while optimizing energy efficiency. These continual innovations strengthen CIS competitiveness across consumer, automotive, and industrial imaging domains.
Rise of Application Demand	• The professional imaging sector in prosumer segment, including film production, news gathering, and broadcasting, continues to raise the bar for image clarity, color accuracy, and low-light performance. This trend is expanding the role of domestic CIS suppliers in high-end cameras and professional equipment. Security and surveillance systems also remain a critical source of demand, with China's "Skynet" program and smart-city initiatives deploying over 200 million networked cameras nationwide, where 4K and higher-resolution systems now account for the majority of new installations. These trends are driving demand for high-dynamic-range and low-power CIS devices that support real-time analytics and integration with edge AI workloads. In industrial automation and medical diagnostic imaging, critical machine vision tasks, such as precision electronics assembly lines and semiconductor wafer defect inspection, necessitate specialized sensors equipped with ultra-high frame rate operation, nanoscale signal linearity, and sub-millimeter resolution for microscopic anomaly identification. Meanwhile, minimally invasive endoscopic and surgical navigation systems demand increasingly compact and sensitive CIS modules, accelerating innovation in pixel architectures and packaging technologies.
Policy Support	• Chinese "domestic substitution" drive and 14th Five-Year Plan have unlocked substantial policy support: the national Integrated Circuit Industry Investment Fund ("Big Fund") has deployed over RMB 150 billion into key segments including CIS, while provincial governments offer land, power, and tax incentives to local champions to scale capacity and R&D. In medical sector, the 14th Five-Year Plan emphasizes the replacement of imported medical equipment. This has driven strong demand for secure, high-performance imaging components in endoscopes, surgical systems, and diagnostic devices, strengthening the position of domestic CIS suppliers. Moreover, strategic international collaborations and technology licensing agreements with global leaders are helping Chinese vendors narrow the gap on front-end lithography, back-end packaging, and IP design, speeding domestic mass production of advanced CIS devices for both local and export markets.

Source: Frost & Sullivan

Overview of CMOS Image Sensor Market in the PRC

Future Trends

Accelerated Domestic Substitution and Strengthened Self-Reliance

Through deep collaboration with domestic foundries, outsourcing and assembly test providers, and system integrators, Chinese players will building a self-reliant, highly responsive image sensor value chain. Unlike global competitors who often rely on fragmented and internationalized production models, Chinese image sensor companies are leveraging vertical integration and localized coordination to significantly reduce costs while improving customization speed and product adaptability. This approach is particularly effective in vertical markets such as industrial vision, medical imaging, and scientific imaging, where domestic players are beginning to establish a real competitive edge. Supported by strategic policies and industry funds, domestic firms are poised to make significant strides in mid-to-high-end sensors, narrowing the gap with global leaders. The rapid acceleration of domestic substitution will lead a combination of high-quality output, affordability, and responsiveness.

Intelligent Upgrades Driven by AI Integration

Chinese CIS vendors are rapidly integrating AI algorithms onto the sensor chip itself, enabling features such as automatic scene recognition, intelligent noise reduction, and dynamic range optimization, thereby enhancing image quality and efficiency at the source. Co-design of hardware and algorithms has become the norm, with sensor manufacturers collaborating with AI software firms to develop unified platforms that accelerate feature iteration and customization. For scenarios like smart surveillance and intelligent transportation, AI-driven edge-computing enables sensors to perform local object detection and behavior analysis, reducing reliance on the cloud and improving response times.

Ecosystem Collaboration and Platform-Based Evolution

The CIS industry in the PRC is shifting its strategic focus beyond standalone sensor specifications to encompass cross-disciplinary integration of algorithms, ISP chipsets, and AI accelerators across the semiconductor value chain. Progressive manufacturers are adopting a system-level platformisation approach, engineering modular sensor ecosystems optimized for diverse application scenarios spanning consumer electronics, automotive ADAS, and industrial automation sectors. Meanwhile, a more complete domestic supply chain from chip design to wafer fabrication, packaging, and module integration, which is emerging, fostering vertical collaboration. Standardization, open interfaces, and industry alliances will further enhance the ecosystem efficiency and innovation momentum.

Future Outlook

Source: Frost & Sullivan

Overview of CMOS Image Sensor Market in the PRC

Laws and Regulations

Regulations	Issue time	Issue department	Description
Guidelines for Industrial Structure Adjustment Directory (2024 Edition) （《产业结构调整指导目录（2024年本）》）	2024.02	The National Development and Reform Commission	Manufacturing of Doppler radar technology and equipment, medical electronics, health electronics, bioelectronics, automotive electronics, power electronics, financial electronics, aerospace instruments and meters electronics: Manufacturing of products such as image sensors, sensor electronics, etc. added to the encouraged category.
Implementation Opinions on Enhancing the Reliability of the Manufacturing Industry(《制造业可靠性提升实施意见》)	2023.06	Ministry of Industry and Information Technology Ministry of Education Ministry of Science and Technology State Administration for Market Regulation Ministry of Finance	The focus is on improving the reliability of electronic equipment and components, including high-end general-purpose chips such as 8C/CU/GPU, wide-bandgap power devices like gallium nitride and silicon carbide, precision optical components, optical communication devices, new sensitive components and sensors, high-adaptability sensor modules, Beidou chips and devices, chip-mounted passive components like resistors, capacitors, and inductors, high-speed connectors, high-end RF devices, high-end electromechanical components, and LBD chips.
Guiding Opinions on Promoting the Development of the Energy Electronics Industry (《关于推动能源电子产业发展的指导意见》)	2023.02	Ministry of Industry and Information Technology Ministry of Education Ministry of Science and Technology People's Bank of China, China Banking and Insurance Regulatory Commission National Energy Administration	Strengthen the development and application of key information technology products for the new energy sector, primarily including power electronics, flexible electronics, sensor networks, smart energy information systems, as well as related advanced computing, industrial software, transmission communication, industrial robots, and other adaptive technologies and product research. Focus on miniaturized, high-performance, high-efficiency, and highly reliable power semiconductor devices, sensor components, optoelectronic devices, and other basic electronic components, specialized equipment, and advanced processes. Support the construction of ultra-high voltage and other new energy supply and consumption systems.
Shenzhen 2022 Smart Sensor Policy (《深圳2022智能传感器政策》)	2022.03	Ministry of Industry and Information Technology	It proposes that by 2022, to meet the core manufacturing needs of smart sensor design companies such as pilot tests and mass production, the city will invest in and participate in project construction by increasing capital in municipal state-owned enterprises, with the investment ratio not exceeding 25% of the total project investment. This policy has greatly promoted the development of small and medium-sized enterprises in the CMOS image sensor manufacturing sector in China, providing significant potential and space for market demand in the CMOS image sensor industry.
The outline of the 14th Five-Year Plan (2021-2025) (《十四五规划和2035年远景目标纲要（全文）》)	2021.03	National People's Congress	Clarify the focus of concentrated resources to tackle key core technologies in the fields of emerging and sudden infectious diseases, biosafety risk prevention and control, pharmaceuticals and medical devices, key components and materials, and oil and gas exploration and development. This policy promotes the development of MEMS sensors in the medical field, closely aligning with the post-pandemic trends in the biotechnology and healthcare sectors, and aims to build an industrial cluster for key components.
Action Plan for the Development of the Basic Electronic Components Industry (2021-2023)(《基础电子元器件产业发展行动计划（2021-2023）》)	2021.01	Ministry of Industry and Information Technology	The plan focuses on the development of miniaturized, low-power, integrated, and highly sensitive components, as well as high-end sensors in categories such as temperature, gas, displacement, speed, optoelectronics, and biochemistry.

Source: Ministry of Industry and Information, Frost & Sullivan

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Competitive Landscape

Ranking of CIS Companies

Ranking of Global CIS Companies, by Market Share in terms of Revenue in Industrial Imaging CIS Market (2024)

Ranking	Company Name	Private/Public	Brief Introduction	Market Share by Revenue, 2024
1	Sony	Public	Founded in 1946 and headquartered in Japan, the company is listed on the Tokyo Stock Exchange and is a global leader in CMOS image sensors widely used in consumer, automotive imaging, security, and industrial imaging applications, with a revenue of approximately RMB604.5 billion in 2024.	33.6%
2	Onsemi	Public	Founded in 1999 and headquartered in the USA, the company is listed on the NASDAQ and provides high-performance CMOS image sensors for automotive and industrial imaging applications, with a revenue of approximately RMB50.6 billion in 2024.	18.2%
3	**The Company**	**Private**	**It is a China-based image sensor supplier specializing in high-resolution CMOS sensors for industrial imaging, medical, and scientific imaging applications.**	**15.2%**
4	Teledyne	Public	Founded in 1960 and headquartered in the USA, the company is listed on the NYSE and offers advanced CMOS and CCD image sensors for scientific, aerospace, and defense markets, with a revenue of approximately RMB40.6 billion in 2024.	10.9%
5	OmniVision	Public	Founded in 1995 and headquartered in Shanghai, it is listed on the Shanghai Stock Exchange and specializes in the design and sales of CMOS image sensors for consumer electronics, automotive, and industrial imaging applications, with a revenue of approximately RMB25.7 billion in 2024.	6.3%
			Top 5 Subtotal	**84.2%**

- In 2024, Sony led the industrial imaging CIS market in the PRC with a market share of 33.6%, followed by Onsemi (18.2%) and the company (15.2%). The top five companies, Sony, Onsemi, the company, Teledyne, and Omnivision, together accounted for 84.2% of the market by revenue, indicating a highly concentrated landscape dominated by a few global and regional leaders.
- The company, which ranked third with a 15.2% market share, has established a strong position in the global industrial imaging CIS segment.

Note: In terms of revenue in 2024, industrial imaging CIS market accounted for approximately 2.1% of the global CIS market.

Source: Annual Reports, Frost & Sullivan

Competitive Landscape

Ranking of CIS Companies

Ranking of Global CIS Companies, by Market Share in terms of Revenue in Scientific Imaging CIS Market (2024)

Ranking	Company Name	Private/Public	Brief Introduction	Market Share by Revenue, 2024
1	Teledyne	Public	Founded in 1960 and headquartered in the USA, the company is listed on the NYSE and offers advanced CMOS and CCD image sensors for scientific, aerospace, and defense markets, with a revenue of approximately RMB40.6 billion in 2024.	28.4%
2	Hamamatsu	Public	Founded in 1953 and headquartered in Japan, the company is listed on the Tokyo Stock Exchange and specializes in scientific-grade CMOS sensors for medical imaging, industrial imaging, and scientific imaging applications, with a revenue of approximately RMB9.9 billion in 2024.	17.6%
3	**The Company**	**Private**	**It is a China-based image sensor supplier specializing in high-resolution CMOS sensors for industrial imaging, medical, and scientific imaging applications.**	**16.3%**
4	Onsemi	Public	Founded in 1999 and headquartered in the USA, the company is listed on the NASDAQ and provides high-performance CMOS image sensors for automotive and industrial imaging applications, with a revenue of approximately RMB50.6 billion in 2024.	5.5%
5	Fairchild Imaging	Private	Founded in 2001 and headquartered in the United States, It is a CMOS sensor company specializing in medical imaging, industrial, and scientific imaging applications, with a revenue of approximately RMB95.4 million in 2024.	3.6%
			Top 5 Subtotal	**71.4%**

- In 2024, Teledyne held the leading position in the global scientific imaging CIS market with a 28.4% share, followed by Hamamatsu at 17.6% and the company at 16.3%. The combined market share of the top five reached 71.4%, indicating a strong presence of specialized vendors in this high-precision segment.
- The company, ranking third globally, has gained notable traction in scientific imaging by offering tailored CMOS sensor solutions that address the demanding requirements of research laboratories, advanced diagnostics, and analytical instrumentation.

Note: In terms of revenue in 2024, scientific imaging CIS market accounted for approximately 0.8% of the global CIS market.

Source: Annual Reports, Frost & Sullivan

Overview of CMOS Image Sensor Market

Entry Barriers

Research and Development Innovation Barrier

- In the CIS industry, research and development innovation has emerged as a critical barrier due to the extensive scientific and engineering challenges involved in image sensor development and commercialization. It requires multi-years of development cycles from concept to production, entailing mask sets, prototype wafer spins, and reliability testing. Advanced pixel architectures and circuitry architectures demand deep expertise in device semiconductor physics, optics, and mixed-signal integration. Modern CIS also integrates on-chip image signal processors for functions like HDR merging and noise reduction, necessitating co-development of hardware and algorithms. Furthermore, navigating a landscape rich in patented technologies adds legal
- complexity and licensing costs.

Talent & Capital Barrier

- In the CIS industry, the talent and capital barrier highlight the critical need for both specialized technical expertise and substantial financial resources. Leading-edge CIS development demands experienced multidisciplinary teams including device physicists, mixed-signal IC designers, process engineers, optics engineers, and image-algorithm specialists, recruiting such a team is often challenging due to the high demand, low supply. It is also important for such a team to work efficiently and keeping up with the tech trends. The facts that tech giants and startups compete for scientists and engineers sets high salary expectations. For fabless companies, the capital barrier is significant due to high costs associated with R&D employees, and costs associated with expensive process development, software, photomask sets, prototype wafer runs, etc. Long time-to-market, slow adoption, and scaling production capacity also require robust liquidity reserves to cover operational expenses, raw material procurement, and mask set iterations. For fab-lite or IDMs, building or expanding CIS manufacturing capabilities requires hundreds of millions to billions of dollars in capital expenditure for clean-room facilities and specialized equipment. Without a robust talent pool and resilient financial backing, new entrants and smaller firms cannot absorb the high burn rates or attract the niche experts essential for successful CIS innovation and production.

Supply Chain Integration Barrier

- The supply chain of CIS is highly dependent on the specialized semiconductor foundries, whose process can be customized for various pixel design performance with no compromise on analog, digital performance, quality, or reliability. The access to these foundries is dominated by giant companies, and normally associated with substantial upfront payment for process setup and fine-tune. CMOS image sensor wafers normally requires micro-lens array and color filters array which is processed on wafer level and handled by specialized color foundries. The finished wafers are then tested, packaged using methods such as WLCSP or ceramic packaging, which are normally handled by separated assembly facilities. The packaged sensors are then tested either in-house or outsourced to OSAT suppliers. Orchestrating this multi-tiered ecosystem demands robust logistics, quality control systems, and long-term contracts to ensure materials availability, yield consistency, and synchronized ramp-ups. New entrants lacking established relationships and coordination platforms struggle to secure timely supplies, negotiate favorable terms, and maintain
- end-to-end traceability, making supply-chain integration a formidable barrier.

Source: Frost & Sullivan

Overview of CMOS Image Sensor Market

Entry Barriers

Downstream Know-How Barrier

- The CIS industry stems from the deep domain expertise required to integrate image sensors into diverse end-use systems. Leading suppliers not only supply raw CIS but also provide comprehensive support including tailored optical designs, ISP parameter adjustments, precision autofocus algorithms, and full-system calibration services, expertise that has been cultivated through extensive collaboration with OEMs in the smartphone, automotive, surveillance, and industrial markets. For instance, achieving reliable HDR performance in low-light security cameras, or calibrating color fidelity for medical diagnostics, demands proprietary test procedures, software toolchains, and application-specific validation protocols. New entrants lacking this specialized know-how must build multidisciplinary teams of optics engineers, firmware developers, and application specialists, and invest in reference designs, validation labs, and long-term pilot projects with OEMs. Without these capabilities, even technically sound CIS may underperform in real-world products, making downstream expertise a critical barrier to market acceptance.

Brand Recognition Barrier

- The CIS industry is shaped by the long-standing reputations of established market leaders, whose sensor products have consistently demonstrated superior quality, reliability, and performance over decades of commercial deployment. OEMs and module makers prefer these established brands to minimize integration risks, ensure supply chain stability, and leverage proven support and firmware ecosystems. High-profile partnerships further reinforce customer trust, creating a virtuous cycle where brand strength drives broader adoption. New entrants face an uphill battle to gain credibility. They must invest heavily in marketing, secure pilot projects with marquee customers, and demonstrate long-term field reliability through rigorous certifications. Without recognized branding or customer endorsements, smaller or newer CIS suppliers struggle to penetrate design-in pipelines and achieve scale, making brand equity a critical barrier to entry.

Source: Frost & Sullivan

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- Customized solutions typically present a higher technological barrier.
- CIS is widely used in various applications, including consumer electronics (such as smartphones, tablets, and computers), prosumer electronics (like DSLR, DSC, and action cameras), automotive systems, security surveillance, industrial imaging, medical imaging, scientific imaging and defense and aerospace.
- In CIS market, there is a clear distinction in demand for products between consumer and non-consumer applications. Consumer CIS primarily targets mass-market electronics such as smartphones, computers, and tablets, characterized by high volume, strong price sensitivity, and short product cycles. Manufacturers compete through cost control and large-scale shipments, with customers focusing on price-performance ratios and rapid innovation. In contrast, non-consumer CIS serves specialized sectors such as industrial imaging, automotive sector, medical imaging, scientific imaging, etc. These applications demand for CIS products with higher unit prices, higher added value, and higher level of customization.
- According to Frost & Sullivan, the global market for professional photography and video solutions is expected to grow from RMB4.5 billion in 2024 to RMB5.9 billion in 2029, representing a CAGR of 5.6%.
- The company Released the second generation of charge-domain global shutter CMOS image sensors in GMAX series, featuring multiple pixel sizes such as 2.5μm, 3.2μm and 4.6μm, based on 65nm process, launched products including the world's smallest global shutter pixel of 2.5μm at that time.
- The company launched the world's first backside-illuminated scientific-grade CMOS image sensor at that time, GSENSE400BSI.
- The company Launched the global shutter CMOS image sensor GMAX32152 with a resolution of 152 MP, the highest resolution known for global shutter CMOS image sensors in the market at that time.
- The global CMOS image sensor market is experiencing modest growth, benefiting from a combination of growth drivers including (i) accelerated technological advancement, such as pixel size reduction, backside illumination, stacked architecture, HDR advancements, improvement of power efficiency and noise reduction; (ii) intelligent upgrades driven by AI integration enabling features such as automatic scene recognition, intelligent noise reduction and dynamic range optimization; and (iii) shift of strategic focus beyond standalone sensor specifications to encompass cross-disciplinary integration.
- It is in line with market practice to deal with trading companies in the CIS industry.
- It is not uncommon in CIS industry to have overlapping customers and suppliers.

Source: Frost & Sullivan

Appendix

- "ADC": analog-to-digital converter, a converter that changes analog signals into digital data.
- "APS-C": advanced photo system type-C, also known as advanced photo system-classic type, a specification for measuring the optical size of CMOS image sensors, which is generally 29.3mm when referring to the optical size of CMOS image sensors.
- "area array" or "area array sensor": a form of CMOS image sensors featuring pixels arranged in a two-dimensional matrix, which allows them to capture a complete 2D image in a single exposure
- "GDS": graphic database system, a file format for integrated circuit layouts
- "IC": or "integrated circuit" integrated circuit, a type of miniature electronic device or component, manufactured using semiconductor techniques, integrating all the necessary transistors, resistors, capacitors, inductors and their connecting wires for a circuit onto a small semiconductor wafer (such as a silicon chip or substrate), which is then soldered and encapsulated within a casing to form an electronic device with the desired circuit functions
- "IR": infrared, a type of electromagnetic radiation with wavelength just greater than that of the red end of the visible light spectrum but less than that of microwaves
- "LED": light-emitting diode, a semiconductor diode that emits light when voltage is applied
- "linear array" or "linear array sensor": a form of CMOS image sensors featuring pixels arranged in a single line and capturing 2D images by scanning objects moving at a constant speed perpendicular to the sensor's orientation
- "OLED": organic light-emitting diode, a LED technology used for flat panel displays, in which the emissive electroluminescent layer is a film of organic compounds which emit light in response to an electric current
- "photomask": an opaque plate used to replicate circuit layouts onto the wafer during the wafer manufacturing process
- "ToF": time-of-flight, a method for measuring the distance between a sensor and an object, based on the time difference between the emission of a signal and its return to the sensor, after being reflected by an object. ToF can be further categorized as direct time-of-flight ("dToF") and indirect time-of-flight ("iToF")
- "ultra-HD": ultra-high-definition, which includes 4K and 8K digital video formats

Source: Frost & Sullivan

Appendix

- The industry in which The Company operates is highly competitive worldwide and increasingly characterized by frequent introduction of new designs, short product life cycles, quick response to customers' preference and increasing demand for quality products and price sensitivity.
- The market in which The Company operates is highly competitive, characterized by rapidly changing technologies.
- The Company operates in a highly competitive market characterized by rapid technological evolution, swift changes in customer demands and preferences, frequent introduction of new products and services, and the constant emergence of new industry standards and practices.
- In light of The Company's strategic efforts to expand into international markets, The Company is increasingly exposed to global trade policy developments and geopolitical tensions.
- Since then, The Company has made substantial progress and have grown into a global leading provider of high-performance CMOS image sensors, focusing on the research and development of high-performance CMOS image sensors.
- This model also allows The Company to benefit from the advanced technologies and economies of scale that their suppliers bring to the table, ensuring that their high-performance CMOS image sensors remain competitive in a rapidly evolving market.
- In 2015, The Company successfully developed the world's first BSI sCMOS image sensor, subsequently expanding into industrial imaging, professional photography and video, and medical imaging sectors, where The Company has achieved multiple industry "firsts" and pioneering breakthroughs.
- The global CMOS image sensor industry in which we operate is highly competitive and concentrated. The principal competitive factors in our markets include technological expertise and innovative R&D capabilities, product development capabilities and supply chain partnerships.
- The Company primarily competes with a number of global and regional CMOS image sensor design companies and manufacturers.
- Industrial imaging: China's core industrial chains, including lithium battery and photovoltaic new energy, AI-powered collaborative robotics, and semiconductor manufacturing, are rapidly advancing toward high-end, intelligent, large-scale, and globalized development. Industrial inspection has become a critical foundation for manufacturing process upgrades, yield assurance, and production efficiency enhancement.
- Scientific Imaging: Supported by favorable policies, technological iteration, application expansion, and accelerated domestic substitution, global demand for high-precision, high-efficiency, and ultra-stable scientific instruments continues to grow, creating substantial market opportunities.
- Professional Photography and Video: Driven by AI algorithm advancements, 5G infrastructure development, 3D modeling breakthroughs, and precision optical component innovation, the global professional imaging market is experiencing substantial growth. This expansion stems from both the professionalization of film production and democratization of content creation driving equipment upgrades, as well as consumers' growing demand for professional-grade imaging quality and scenario-specific functionality.
- Medical Imaging: Globally, and particularly in China, healthcare infrastructure improvements and technological advancements have triggered explosive growth in medical imaging demand, including disposable endoscopes and X-ray detection systems, presenting tremendous market potential.
- Global shutter pixel technology is widely demanded in industrial imaging, intelligent transportation, high-speed imaging, and other applications.

Source: Frost & Sullivan

Appendix

- Industrial imaging: The increasing demand for automation in industries such as manufacturing and logistics is pushing demand for high-performance CMOS image sensors. These sensors enable defect detection, quality control, and robotics, contributing to the rise in demand for higher resolution and faster processing speeds in factory automation.
- Scientific imaging: The scientific imaging industry has growing demand due to advances in research and the increasing use of imaging in areas like microscopy, spectroscopy, and environmental monitoring. Higher resolution, improved sensitivity, and faster readout speeds are essential for capturing more detailed data, driving the growth of CMOS image sensors in this field.
- Professional photography and video: The rise of content creation, including photography, cinematography, and broadcasting, continues to boost CMOS image sensors demand. Professional-grade cameras require sensors with higher resolution, improved low-light performance, and enhanced dynamic range. The increasing use of CMOS image sensors in high-end cameras and filmmaking equipment drives steady demand for more advanced and precise sensors.
- Medical imaging: CMOS image sensors adoption is driven by the demand for diagnostic techniques and portable imaging devices. Medical applications such as endoscopy, ultrasound, and diagnostic cameras require high-resolution, low-noise sensors to ensure accurate results. The rising focus on patient care and the growing need for real-time, on-site diagnostics are pushing demand for CMOS image sensors in medical imaging technologies.
- In China, the CMOS image sensors industry is benefited from additional support by strategic government policies and industry funds for accelerated domestic substitution and strengthened self-reliance.
- Area array sensors feature pixels arranged in a two-dimensional matrix, allowing them to capture a complete 2D image in a single exposure. In contrast, linear array sensors have pixels arranged in a single line and capture 2D images by scanning objects moving at a constant speed perpendicular to the sensor's orientation.
- The Company has established long-term direct supply relationships with top-tier partners, including Tower and DB HiTek (the world's leading foundries), as well as Kyocera (the world's largest advanced ceramics supplier), ensuring both the security and cost efficiency of key material supplies.
- In recent years, OLED and micro-OLED represents a significant leap in display technology, particularly for VR and AR applications. Compared to traditional LED displays, the OLED display is becoming the preferred choice for portable VR/AR devices, because of several advantages:
  - — ultra-fast response time, which is critical for reducing motion blur; and
  - — higher pixel density, which is crucial for near eye clarity and immersive experience.
- The typical pixel size for OLED ranges from around 150 μm. for monitors/TV displays, 50–80 μm. for smartphones/tablets, to below 10 μm. for near-eye displays. As the pixel size shrinks, the manufacturing process requires higher precision, better dust particle and contamination control. In order to achieve reasonable yield and bring affordable displays to the market, ultra-high resolution inspection and metrology tools for the micro-OLED production lines are in urgent demand.

Source: Frost & Sullivan

Appendix

- **Industrial imaging**
- Industrial imaging is widely used in various manufacturing and production lines to automate, control, inspect, and analyze different industrial processes, such as dimensional measurement, component alignment, robotic guidance, object recognition and sorting, and defect inspection and detection. Industrial imaging enhances precision, throughput, efficiency, and quality control in various industries, such as photovoltaic, new energy, semiconductor, automotive, textile, printing, pharmaceutical, food and beverage industries. The typical applications of industrial imaging solutions include (i) factory automation; (ii) logistic and positioning; (iii) motion capture; and (iv) industrial inspection and metrology.
- Factory Automation: Vision-based systems are increasingly the go-to system for factory automation. From computer vision in robots to high-speed automated optical inspection and scanning barcodes, there are a wide range of camera systems, each with their own specific resolution and frame rate requirements. Our industrial portfolio offers a wide range of sensors to meet our customers' exacting requirements.
- Logistic and Positioning: Imaging technologies play an important role in modern logistics and positioning systems, enabling automation, real time tracking, and efficient handling of goods. Typical applications include automated guided vehicles, autonomous mobile robots, barcode/QR code scanning, conveyor belt and parcel sorting, etc. Logistics and positioning applications typically employ two main vision system devices: fixed camera systems and handheld devices. The fixed camera system is read at large working distance, so it requires high accuracy and high frame rate to achieve a large throughput, and it is usually necessary to use a global shutter to eliminate shutter artefacts. Smaller and lighter handheld devices are used at shorter distances, so they can use image sensors with lower resolution, rolling or global shutter, and are typically lower cost. Either area array or linear array sensors may be used. Our industrial GMAX and GL portfolios offer a wide range of sensors to meet our customers' exacting requirements.
- Motion Capture: Motion Capture refers to the technology of recording and processing the movements of people or other objects. It is widely used in entertainment, medicine, and robotics. Fast action shooting and the ability to synchronize multiple sensors are the key to this application. Our GMAX and GSPRINT product lines combine the characteristics of global shutter, high frame rate, and high resolution to meet the needs of this application.
- Industrial Inspection and Metrology: industrial inspection and metrology rely on high-performance image sensors as well as advanced optics, to ensure micron level accuracy defect detection and quality assurance in advanced manufacturing, such as semiconductor and electronics, flat panel displays, automotive, medical devices, and aerospace industry. We offer a wide selection of sensor size/optical formats in the industrial GMAX product line, as well as a large number of linear sensors in the GL product line.

Source: Frost & Sullivan