CMOS Camera Module Industry for Consumer & Automotive 2020

Market and Technology Report 2020
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Richard LIU

Richard Liu is a Technology and Market Analyst in the Photonics, Sensing & Display division at Yole Développement, part of Yole Group of Companies. Based in Shenzhen (China), Richard is dedicated on imaging activity (Monitors) as well as the development of technology & market reports

Prior to Yole, Richard was engaged in camera module design on image sensor, AF/OIS at Onsemi, before this, he worked as a customer-application-technologist in Micron/Aptina Imaging. Richard has over 12 years post graduate experience in both of imaging semiconductor and camera module industry, he has the successful track record in developing projects for the tier one smart phone and module makers, which brought him wide industry connection in the CMOS image sensor supply chain and ecosystem

Richard graduated from Wuhan University (China) and holds an Electronics Engineering Degree.

Contact: richard.lui@yole.fr

Pierre CAMBOU MSc, MBA

Pierre Cambou MSc, MBA, is a Principal analyst in the Photonic and Display Division at Yole Développement (Yole).

Pierre’s mission is dedicated to imaging related activities by providing market & technology analyses along with strategy consulting services to semiconductor companies. He is responsible for the CIS Quarterly Market Monitor while he has authored more than 15 Yole Market & Technology reports.

He has been deeply involved in the design of early mobile camera modules and the introduction of 3D semiconductor approaches to CMOS Image Sensors (CIS).

Known as an expert in the imaging industry, he is regularly interviewed and quoted by leading international media.

Pierre has an Engineering degree from Université de Technologie de Compiègne (France) and a Master of Science from Virginia Tech. (VA, USA), Pierre also graduated with an MBA from Grenoble Ecole de Management (France).

Contact: pierre.cambou@yole.fr
## YOLE DEVELOPPEMENT OFFERING

### Custom studies
- **Who**: Yole analysts
- **What**: Customer specific analysis
- **When**: One shot study
- **Why**: Customer request
  - Emerging needs
- **How**: Tailored study to customer demand
  - Workshops
  - Communication

### Market & Technology reports
- **Who**: Yole analysts
- **What**: Analysis of a main topic of the semiconductor & microtechnology industry
- **When**: Regular basis, 1 to 2 year
- **Why**: On the shelf
  - Growth markets
- **How**: Tailored to the strategic assessments of the topic, marketing wise, and technology wise

### Quaterly Monitor
- **Who**: Yole principal analysts
- **What**: Analysis of a major segment of the semiconductor & microtechnology industry
- **When**: Every Quarter
- **Why**: On the shelf
  - Growth markets
  - Large dynamic markets
  - Large ecosystem
- **How**: Tailored for investors, quarterly metrics showing the dynamics of the market and of its main players
WHAT DOES OUR ANALYSIS ACCOUNT FOR?

From sub-components to camera modules

**Minimum camera resolution:**
50 pixel x 50 pixel

---

Optics

AF & OIS Actuator

Module Assy

Sensor array

3D Sensor

3D Illuminator

Sub-components
Sensor, optics & illumination

Camera Modules

Systems

Wafers & raw material
courtesy of Sony
courtesy of Samsung
courtesy of Samsung
WHAT WE GOT RIGHT, WHAT WE GOT WRONG

Technology and market forecast challenge

Global Forecast:

• Overall camera module industry dynamics
• The rise of Chinese ecosystem

• CIS price hike end of 2019
• Accelerated adoption of multiple camera approach

Mobile trend:

• Imaging paradigm ask for multiple camera approach
• Sensing paradigm is bringing new type of sensors GS, iToF, dToF

• Accelerated adoption of under screen Optical Finger Print (OFP) technology
Yole has increased its forecast for CMOS camera modules (CCM) due to increased demand for smartphones and other main applications such as automotive.

Growth potential is maintained at a high level for the 2020-2025 period, mostly driven by the proliferation and diversification of cameras per end system.

WHAT WE GOT RIGHT, WHAT WE GOT WRONG

CCM forecast over the years
HOW IS A MOBILE CAMERA MODULE MADE?

Structure of a camera module

Once a relatively basic component, CCM has evolved into a complex microelectro-mechanical device.

Module assembly brings all these components together into a module
2019-2025 CMOS CAMERA MODULE MARKET FORECAST BY COMPONENT (IN $B)

- Camera module assembly
- CMOS Image sensor
- Lens set manufacturing
- Actuator (AF & OIS)

**2019**

- Camera module assembly: $9.5B
- CMOS Image sensors: $14.3B
- Lens set manufacturing: $4.8B
- Actuator: $2.7B

**CAGR 2019-2025**

- Camera module assembly: $19.5B, CAGR 19-25 +12.7%
- CMOS image sensors: $24.2B, CAGR 19-25 +9.1%
- Lens set manufacturing: $7.6B, CAGR 19-25 +8.1%
- Actuator: $5.7B, CAGR 19-25 +13.5%

**2025e**

- Camera module assembly: $57.0B
Combined revenue in the Mobile & Consumer and Automotive CCM industry reached $31.3B in 2019 and should reach $57.0B in 2025.

Today, the multiple, 3D and optical fingerprint camera approaches have maintained revenue growth momentum.

High resolution, large format CIS and the periscope lens will be the next wave of increasing module profits.
## 2019 Camera Module Assembly - Market Share (in %)

### Chinese module makers got the strong growth.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>2018 ($M)</th>
<th>2019 ($M)</th>
<th>YoY(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LG Innotek</td>
<td>4,107</td>
<td>4,341</td>
<td>5.7%</td>
</tr>
<tr>
<td>2</td>
<td>O-Film</td>
<td>3,390</td>
<td>4,119</td>
<td>21.5%</td>
</tr>
<tr>
<td>3</td>
<td>Sunny Optical</td>
<td>2,700</td>
<td>4,007</td>
<td>48.4%</td>
</tr>
<tr>
<td>4</td>
<td>Foxconn</td>
<td>3,130</td>
<td>3,095</td>
<td>-1.1%</td>
</tr>
<tr>
<td>5</td>
<td>Semco</td>
<td>2,517</td>
<td>2,640</td>
<td>4.9%</td>
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<tr>
<td>6</td>
<td>Q-Tech</td>
<td>1,040</td>
<td>1,462</td>
<td>40.6%</td>
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<tr>
<td>7</td>
<td>Luxvisions</td>
<td>1,009</td>
<td>1,345</td>
<td>33.3%</td>
</tr>
<tr>
<td>8</td>
<td>ams</td>
<td>724</td>
<td>957</td>
<td>32.2%</td>
</tr>
<tr>
<td>9</td>
<td>Chicony</td>
<td>700</td>
<td>867</td>
<td>23.9%</td>
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<tr>
<td>10</td>
<td>Truly</td>
<td>580</td>
<td>747</td>
<td>28.8%</td>
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<tr>
<td>11</td>
<td>Mcnex</td>
<td>570</td>
<td>724</td>
<td>27.0%</td>
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<tr>
<td>12</td>
<td>Cammsys</td>
<td>535</td>
<td>561</td>
<td>4.9%</td>
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<td>Next 5</td>
<td>1,874</td>
<td>1,998</td>
<td>6.6%</td>
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<tr>
<td></td>
<td>Other</td>
<td>3,791</td>
<td>4,445</td>
<td>14.6%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$26,667</strong></td>
<td><strong>$31,308</strong></td>
<td><strong>17.0%</strong></td>
<td></td>
</tr>
</tbody>
</table>

### 2019 Camera Module Market Share by Players (in %)

- **LG Innotek**: 17%
- **O-Film**: 4%
- **Luxvisions (Liteon)**: 5%
- **Q-Tech**: 6%
- **Sunny Optical**: 11%
- **Foxconn (Sharp)**: 12%
- **Semco**: 11%
- **Chicony**: 3%
- **Truly**: 3%
- **Mcnex**: 3%
- **Cammsys**: 2%
- **ams**: 4%
- **Other**: 6.6%

2018: $26.7B

2019: $31.3B
GLOBAL MARKET OUTLOOK

The smartphone market disruption

Smartphones have provided an alternative to digital cameras.

Historical sales for main categories in consumer electronics (in M units)

- Personal Computers
- Digital Cameras
- Smartphones

- When the smartphone volume reached saturation – the computing segment stopped its decline, not the digital cameras.
- When the smartphone volume crossed the personal computer line – it was the end of growth for the later.
The average cameras per smartphone is higher than car by 2025.

There are roughly ~1,300M smartphones produced each year, and ~80M light vehicles.

The main factor governing the number of cameras produced worldwide is the average number of cameras per end-product - mainly in smartphones and light vehicles.

In 2025, it is expected that mobile markets will have an average number of « cameras per end-product » around 5.0, while automotive will go beyond 3.0.
MOBILE CAMERA MARKET TREND

More cameras, probably different types

If the current trend continues, we are heading towards 8 cameras per smartphone!
MOBILE MARKET TREND

Proliferation of cameras in mobile – historical timeline

Module size & cost

20 x 10mm²
$20
10 x 10mm²
$10
5 x 5mm²
$5
1 x 1mm²
$1

Camera phones: Innovation from Sharp in June 2000

Smartphones: Main camera size stops shrinking, and a front-facing camera is added

Dual & triple rear: improved photography zoom and wide-angle lenses

The “selfie trend”: front-facing camera size increases

Sensing module: 3D front & rear – under display FP

Market size

Rear camera modules
$20B

Front camera module
$10B

Sensing module
$5B

2x $5B market

$10B market

$30B market

$1B

MOBILE CAMERA MARKET TREND

“Front-side cameras & sensors” conundrum

Android phones have been the most aggressive push to develop a full screen and have already released the concept phone.

Screen-to-body ratio

Notch

Bars

Pop-up/slide-up/hole

Under-display

Today the main stream is hole-punch camera in front

Front’s appearance remains a key differentiator between main producers
MOBILE MARKET TREND – APPLE FRONT SETUP SCENARIO

Apple notch will be halved

<table>
<thead>
<tr>
<th>Camera Type</th>
<th>Resolution</th>
<th>Pixel Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIR GS camera</td>
<td>1.5Mp</td>
<td>2.8µm</td>
</tr>
<tr>
<td>RGB camera</td>
<td>8Mp</td>
<td>1µm</td>
</tr>
<tr>
<td>NIR GS</td>
<td>2.0Mp</td>
<td>2.2µm</td>
</tr>
<tr>
<td>RGB AF + OIS</td>
<td>12Mp</td>
<td></td>
</tr>
</tbody>
</table>

3D structured light approach will shrink down

All players remain, but silicon content may shrink
CAMERA MODULE TECHNOLOGY TREND

General Module Structure - Example

All camera modules have a similar structure except Apple which uses a ceramic substrate and a flexible substrate on all these camera modules as well as an assembly of the CIS in flip chip configuration.

The detailed structure is:

Apple rear camera

Android rear camera
MOBILE MARKET TREND – DISRUPTION IS LOOMING

Which path towards “always-on” video-based context awareness?

Large-bandwith data gathering regular cameras
Large-data streaming: 5G connectivity
Computation requirement: cloud computing

Low-density data gathering neuromorphic sensing
Low-density data streaming: 4G, IoT
Computation need: edge computing

Differentiator: 5G tech
Pros: cost over power & privacy
Low-end approach
Smart devices, buildings, cities

Differentiator: neuromorphic tech
Pros: power & privacy over cost
High-end approach
High-end mobile & automotive

From voice to video-based AI devices

Edge vs. Cloud AI devices

Embedded intelligence

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Status of the CMOS Image Sensor Industry 2019

CMOS Image Sensor Quarterly Market Monitor

3D Imaging & Sensing 2020
Smartphone Camera Module Comparison 2020 Volume 1

Apple iPad Pro LiDAR Module
CONTACTS

Western US & Canada
Steve Laferriere - steve.laferriere@yole.fr
+ 1 310 600 8267

Eastern US & Canada
Chris Youman - chris.youman@yole.fr
+1 919 607 9839

Europe and RoW
Lizzie Levenez - lizzie.levenez@yole.fr
+49 15 123 544 182

Benelux, UK & Spain
Marine Wybranietz - marine.wybranietz@yole.fr
+49 69 96 21 76 78

FINANCIAL SERVICES
› Jean-Christophe Eloy - eloy@yole.fr
  +33 4 72 83 01 80
› Ivan Donaldson - ivan.donaldson@yole.fr
  +1 208 850 3914

CUSTOM PROJECT SERVICES
› Jérome Azémar, Yole Développement - jerome.azemar@yole.fr
  +33 6 27 68 69 33
› Julie Coulon, System Plus Consulting - jcoulon@systemplus.fr
  +33 2 72 17 89 85

REPORTS, MONITORS & TRACKS
India and RoA
Takashi Onozawa - takashi.onozawa@yole.fr
+81 80 4371 4887

Greater China
Mavis Wang - mavis.wang@yole.fr
+886 979 336 809 +86 136 6156 6824

Korea
Peter Ok - peter.ok@yole.fr
+82 10 4089 0233

Japan
Miho Ohtake - mihaohtake@yole.fr
+81 34 4059 204

Japan and Singapore
Itsuyo Oshiba - itsuyo.oshiba@yole.fr
+81 80 3577 3042

Japan
Toru Hosaka - toru.hosaka@yole.fr
+81 90 1775 3866

Follow us on

GENERAL
› Camille Veyrier, Marketing & Communication
camille.veyrier@yole.fr - +33 472 83 01 01
› Sandrine Leroy, Public Relations
sandrine.leroy@yole.fr - +33 4 72 83 01 89
› General inquiries: info@yole.fr - +33 4 72 83 01 80

About Yole Développement | www.yole.fr | ©2020