The Challenges for a Commercial Design House to Design Astronomical CIS

Jan, 2011  Sergi Lin

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恆景科技股份有限公司
Outlines

- Commercial CIS industry brief update
- Brief introduction to Himax Imaging
- Drives and challenges to design astronomical CIS
Global Semiconductor and Imaging Market

2010 Global Semiconductor
$300+ B

Memory
Processor
Imager $7.4 B
Other
CCD 38%
CMOS 62%
(89% unit volume)

Source: iSuppli

2014 Global Semiconductor
$370+ B

Memory
Processor
Imager ~$9.3 B
Other
CCD 16%
CMOS 84%
(95% unit volume)

Image sensor is No. 3 & keeps growing rapidly

Himax Imaging Proprietary & Confidential
Image Sensor Application Breakdown

Larger part of the market remains in consumer-electronic domain
Catalysts for CIS Technology Improvements

- Fast-growing market applications and large market size enables significant improvement
  - Improved Quantum Efficiency
  - Improved Dark Current level
  - Improved noise level

- CIS process is partly tuned for sensors, yet compatible with logic
  - Highly integrated system
Sensitivity Improvement Progress

- ↑ QE & ↓ Crosstalk
  - QE > 60% (Silicon) reported
  - Optimized Microlens
  - Lower stack height
  - Light pipe
  - Optimized photodiode
  - Back Side Illumination (BSI)

- Reduction in noise
  - Pixel device optimization
  - Single-digit electron noise level is typical, sub-electron is possible

![SNR 10 (Normalized to 1.75µm Pixel)](chart.png)
Dark Current Reduction Progress

- Pinned photodiode (charge transfer) resulted in reduction by a factor of 100
- BSI may increase the dark current slightly (some researches report otherwise)
Pixel Size Reduction Trend in 3Cs Products

- To fit in more pixels in small module (1/4” is key)
- Sizing down speed is slowing down
  - Hitting the performance bottom line (SNR10 < 70 lux)
  - Approaching physical limit – higher cost & bigger effort necessary
- BSI will bring us down to 1.4um, & further?

- Innovative ways necessary for further reduction
HII Capabilities & Designs Extending Pixel Performance

- Advance Sensor Design
- BrightSense™
- ClearView™
- Color Filter Array
- Water Level Optics
- Sensor Design
- Sensor Solution
- Characterization
- Process Optimization

25cm distance

Standard readout
QE & Xtalk improvement

- 1.75 um pixel process improvement within 3 years
- QE improved by ~ 30%, Xtalk reduced by 30%, over the 1st Gen

Graph removed for confidentiality
Hot Pixel Reduction

- Significant hot pixel improvement by process development

Graph removed for confidentiality
Flicker Noise Improvement

- PTN of 0.1% survival plot improved from ~36e to ~13e
- Pixel w/ PTN > 10e reduced from 6% to 0.6%

Graph removed for confidentiality
Image Quality & Noise Improvement

Older Generation

Newer Generation
BrightSense™ True Pixel Level Binning = \[ \uparrow \text{Sensitivity} \quad \downarrow \text{Noise} \]

1.75\( \mu \), 15FPS @ 5lux  
1.75\( \mu \), 30FPS @ 5lux
Himax Imaging ClearView™ Technology

Optical Restoration Engine integrated in Himax Imaging sensors
Restores sharpness degraded by inexpensive plastic lens
ClearView™ Qualified Lens List (QLL) ensures restoration optimization
MTF Compensation

MTF

- Diffraction Limit
- Pure Optics
- w/ ClearView

Lower Half of the Nyquist Band

Pure Optics

w/ ClearView
ClearSense™ Enhanced Dynamic Range

- Provides highlight and lowlight details in COLOR
- Low system cost – no additional memory, 10bit data output
## Consumer Design House’s Future in Scientific Sensor

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<th>Drivers</th>
<th>Challenges</th>
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<tr>
<td>▪ Stable revenue stream</td>
<td>▪ Lack of understanding to scientific sensor requirements</td>
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<tr>
<td>▪ Develop technical depth</td>
<td>▪ New development and reengineering of current consumer sensor technologies for scientific sensor requirements</td>
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<td>▪ Access and recruitment of talents in the field</td>
<td>▪ Unfamiliarity to supply chain and specialty services unique to scientific sensor requirements</td>
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<td>▪ Have fun – we are technical people too!</td>
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<th>Next Steps</th>
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<tr>
<td>▪ Deeper collaboration</td>
<td>▪ Fast turn-around, chip-level system integration, flexible sensor operation, post-capture image processing, and more</td>
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<td>▪ Combine design house strengths and innovative solutions</td>
<td>▪ Leverage consumer volume to drive specialty vendors</td>
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<td>▪  ◦ Maybe we can start something from here!</td>
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Drive for better vision