Development of Solid State Lighting Industry And Standardization in China

China Solid-State Lighting Alliance(CSA)

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Jun 19, 2017  Hangzhou
• SSL opened the door of joint development of Si and 3rd generation Semiconductors

• The materials (GaN and SiC) and core process are essential for power electronics, communication, ICT, security, etc.
SSL Open the New Era of Next Generation Semiconductor

New Generation of information highway

5G Era

Visible light communication

Position service

Massive optical storage

Chips light interconnection

On-demand lighting, Beyond lighting

Medical and agricultural applications

Wide-band-gap Semiconductor

High Voltage Transformer

Smart home smart society

Mobile Internet, wearable

Small, lightweight
Milestones of China SSL

- **2003**: The Establishment of CSA
- **2004**: Beijing Olympic Demonstrations
- **2006**: The 11th Five-Year Plan “863 Plan” SSL Project
- **2008**: Launching “10K 10Cities” by MOST
- **2009**: Six ministries “Opinions on SSL Energy-Saving Industry”
- **2010**: Output 200 billion RMB
- **2012**: Output exceeded 100 billion RMB
- **2013**: Industry output > 257.6B RMB
- **2014**: Chip localization rate 75%
- **2015**: 100lm/W
- **2016**: Industry output > 356.7 B RMB
- **2017**: 160 lm/W
- **2018**: >30000 patents/year
- **2019**: >50 listed companies with LED as core business
- **2020**: Chip localization rate 75%
Industrial output keeps growing

- **2016**, industrial output: RMB **521.6 Billion**, GROSP **22.8%**; **2015**, RMB **424.5 Billion**, the past 10 years average annual growth rate exceeded 30%.

  - **Epi & chip** Output value 18.2 B RMB, growth rate 20%
  - **Packaging** Output value 74.8 B RMB, growth rate 21.5%
  - **Applications** Output value 428.6 B RMB, growth rate 23%  

- **LED general lighting** remains the main driving force of the market development

2016 Application areas of LED products (Output value)
Revenue of listed companies grows rapidly

- Market demand of downstream drive chip and packaging prices up
- 2016 Operation revenue of LED listed companies grow by 30%
  - Operation revenue of 26 listed LED companies: 45.1B RMB
  - Operation revenue growth rated No.2 in 28 different industries

<table>
<thead>
<tr>
<th>NO.</th>
<th>Company</th>
<th>Revenue</th>
<th>Growth</th>
<th>NO.</th>
<th>Company</th>
<th>Profit</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aoto Electronics</td>
<td>15029.38</td>
<td>180.17%</td>
<td>1</td>
<td>CHANGELIGHT</td>
<td>4157.3</td>
<td>7598.90%</td>
</tr>
<tr>
<td>2</td>
<td>Mason Technology</td>
<td>46691.92</td>
<td>147.58%</td>
<td>2</td>
<td>HC Semitek</td>
<td>8078.01</td>
<td>681.13%</td>
</tr>
<tr>
<td>3</td>
<td>Everfine</td>
<td>10448.43</td>
<td>122.81%</td>
<td>3</td>
<td>Nata</td>
<td>250.41</td>
<td>283.68%</td>
</tr>
<tr>
<td>4</td>
<td>HC Semitek</td>
<td>50641.48</td>
<td>110.71%</td>
<td>4</td>
<td>Aoto Electronics</td>
<td>909.82</td>
<td>238.00%</td>
</tr>
<tr>
<td>5</td>
<td>LianTronics</td>
<td>70364.86</td>
<td>90.33%</td>
<td>5</td>
<td>Mason Technology</td>
<td>2636.57</td>
<td>217.84%</td>
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<tr>
<td>6</td>
<td>MLS</td>
<td>153580.19</td>
<td>87.36%</td>
<td>6</td>
<td>MLS</td>
<td>13256.89</td>
<td>162.70%</td>
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<tr>
<td>7</td>
<td>San an</td>
<td>198993.49</td>
<td>68.90%</td>
<td>7</td>
<td>Unilumin</td>
<td>4968.88</td>
<td>146.42%</td>
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<tr>
<td>8</td>
<td>JIAWEI</td>
<td>67787.71</td>
<td>68.30%</td>
<td>8</td>
<td>JIAWEI</td>
<td>9806.95</td>
<td>111.48%</td>
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<tr>
<td>9</td>
<td>HONGLIZHIHUI</td>
<td>69210.79</td>
<td>57.14%</td>
<td>9</td>
<td>Leyard</td>
<td>17246.92</td>
<td>110.59%</td>
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<tr>
<td>10</td>
<td>RE-FOND</td>
<td>35073.82</td>
<td>52.97%</td>
<td>10</td>
<td>Everfine</td>
<td>2452.06</td>
<td>91.02%</td>
</tr>
</tbody>
</table>

2017 Q1 Operation profit ratio top 10 of LED companies
Top10 companies average income: **2B RMB**

Big companies with core competence grow stronger

Small companies rely on low cost and homogeneity competition struggling to survive

**2016 Top10 LED companies in China**

<table>
<thead>
<tr>
<th>Gross profit rate (% )</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LED industry</strong></td>
<td>27.8</td>
<td>28.8</td>
<td>27.7</td>
<td>31.9</td>
</tr>
<tr>
<td>upstream</td>
<td>28.6</td>
<td>33.7</td>
<td>30.1</td>
<td>25.4</td>
</tr>
<tr>
<td>Midstream</td>
<td>26.7</td>
<td>24.7</td>
<td>23.0</td>
<td>23.2</td>
</tr>
<tr>
<td>Downstream</td>
<td>22.2</td>
<td>23.5</td>
<td>23.6</td>
<td>26.3</td>
</tr>
<tr>
<td><strong>LED display</strong></td>
<td>32.3</td>
<td>35.2</td>
<td>37.4</td>
<td>36.7</td>
</tr>
</tbody>
</table>

Source: CSA Research
M&A speeds up industry consolidation

- In 2016, 40 major M&As, (worth >22B RMB ), covering whole chain & locations
- Break technical and patent barriers through M&A, enlarge scale
- 14 Cross-border M&A during 2015-2016

<table>
<thead>
<tr>
<th>Date</th>
<th>Acquirer</th>
<th>The acquired party</th>
<th>Transaction amount</th>
<th>Transferee equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016.1</td>
<td>Feilo videos</td>
<td>Sylvania</td>
<td>1400 million euros</td>
<td></td>
</tr>
<tr>
<td>2016.6</td>
<td>MLS</td>
<td>LEDVANCE</td>
<td>400 million euros</td>
<td>100%</td>
</tr>
</tbody>
</table>
In 2016, exports > USD 10.5 Billion, decrease 2.4%

EU and USA are the major export markets

Market to middle east region grows rate: 27%
Contents

1. Status of China SSL Industry
2. Standardization of CSA
3. The 13th Five Year Plan
CSA: Who are we

- Established in 2004; 2014 Legally Registered in Zhong Guancun
- 578 Members, 87% are Manufactory companies, cover 70% China SSL Output
- 2014, First batch of Pilot Alliance of S&T service industry Supported by MOST and MOF
Efforts made by CSA

- Promote the Industry by Technology Innovation, Industry Service and International Cooperation
- Bring S&T innovation to standardization

- Establishment
  - 46 members
  - 2004

- 6 ministries: SSL development guidance
  - 2008

- CSAS
  - State Key Laboratory
  - 2009

- Pilot organizations on S&T service industry
  - 2012

- International SSL Alliance
  - 2010

- ISO/TC274
  - 2013

- 578 members
- National Standardization Innovation Award
  - 2014

- Lighting “the Belt and Road” program
  - Industrial investment fund
  - 2015

- 2016

- Lighting “the Belt and Road” program
- Industrial investment fund
- 2016

- CSA

- 2016

- Lighting “the Belt and Road” program
- Industrial investment fund
- 2016
Opportunity of Consortium standards

- Reform of national standardization
- Add Consortium standards to the national standards system

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015.3</td>
<td>The State Council: Reform on National Standardization Works</td>
</tr>
<tr>
<td>2015.5</td>
<td>Standardization Administration of China: Recommend pilot organizations on Consortium standards, CSA is one of the pilot organizations</td>
</tr>
<tr>
<td>2016.3</td>
<td>Standardization Administration of China, General Administration of Quality Supervision, Inspection and Quarantine of China: Consortium standards development guidance</td>
</tr>
<tr>
<td>2016.4</td>
<td>GB/T 20004.1-2016 Consortium standards is published</td>
</tr>
</tbody>
</table>
Demanding for Alliance Standard

- Former standard system: organized by the government
- **Long cycle** for standards development by the government; Small and private enterprises, R&D expenses is insufficient and dispersed
- Alliance standard is part of Consortium standards: **Joint participation**, **Collaborative innovation**
- **Short developing cycle**, rapid response to market, combined relatively and flexibly with intellectual property; As cooperation organizations of industry, university and institute, alliance can exert **innovation capability with advantages**; **Close to the industry**, reflecting the advanced technology, improve international competitiveness
- Technology and standardization trends: normalized products, reliability test and evaluation, intelligent lighting, OLED, etc.
• 2007, CSA SSL standardization promoting workgroup founded
• 2012, Establishment of CSA Standardization Committee (CSAS) supported by SAC
• 2015, The Sate Council released standardization reform proposal:
  cultivate and develop consortium standards

CSA standardization committee

Openness
Transparency
Consensus
Improving Market Environment

● Promoting Standard, Testing System Construction
  • BY now, 47 National Standards (term definition testing, safety, etc.), 35 Industry Standards
  • CSAS: Featuring short cycles, quick market responses and combining with IPRs; 41 Alliance Standards, 10 National Standards, and 5 International Standards
  • Publish quality inspection reports regularly from CSAS

● Launching Product Quality Certification
  • ELI (Efficient Lighting Initiative), focusing on product quality and efficiency
  • In 2014-2015, “TOP-RUNNER” according to CSA standards, cultivating leading brands
Part of standards

- CSA 041-201X Smart Home Lighting Function Attribute Specification
- CSA 040-201X Smart Home Lighting Communication Module Interface Specification
- CSA/TR 004-201X Technical report of control protocol for LED smart home connected lighting
- CSA/TR 003-201X Architecture of smart home lighting system and interconnection technology
- CSA 018-2013 Application layer communication protocols for the interface in intelligent public LED lighting systems
- CSA 016-2015 Application and interface requirements for LED lighting – Street/tunnel light consisting of non-integral LED module (V02.00)
- CSA/TR 001-2014 Overview on standardization of the LED lighting control system
- CSA 035 LED lighting product visual health and comfort test
CSA016  Street light consisting of non-integral LED module

- The core competitiveness of products support the industrial development
- Market regulation, Large-scale Production, Cost reduction
- The interface specification for the optical, electrical, thermal and mechanical
- Joint-design with enterprises
- 20%-30% of LED Street light sales are using CSA016 in 2016,
- >500,000 LED street lighting and tunnel lighting products, >4,000,000 LED modules using CSA016
- >100 LED street lighting companies developed products according to CSA016

Companies using CSA016

Products using CSA016

CSA016 has become National Standard
Based on CSA standards, develop ISA recommendations and standards, 6 CSA standards (CSA020, CSA016, CSA005, CSA035, CSA017, CSA032) have been translated into ISA Recommendations by Dec. 2016.

International standardization cooperation through ISA

- "ISA Recommendations on Accelerating Depreciation Test Method for LED Lighting Products" (ISATCS-90012014, based on CSA 020), the research cooperation with Russia and India had been initiated. This has also been recommended to VLA of Vietnam.

- "ISA Recommendations on Interface Requirements for Application of LED Lighting Street Light" (ISATCS-SN-90022014, based on CSA016) has already been recommended to BIS and BEE of India, ILMA of Iran.

- "ISA Recommendation on Human Factor Testing on the Index of Healthy and Comfortable Lighting: Terms and Definitions" (ISATCS-SN-70012016, based on CSA035) has been recommended to CIE.
ISO/TC274 light and lighting: concerning vision, photometry and colorimetry, involving natural and man-made radiation over the UV, the visible and the IR regions of the spectrum, and application subjects covering all usage of light, indoors and outdoors, energy performance, including environmental, non-visual biological and health effects.

- CSA is the working group leader of China, build bridges between China industry and ISO/TC274, support the development of standardization.
- Organize WG2, Chinese representative is the working group convenor.
The New Demand of China Society

- **Demand driven**: Low carbon and intelligence
  - Energy-saving and environment protection has become the mainstream in 21st century
  - The era of big data need more efficient, personalized, intelligent

- **Application driven**: new type industrialization, new urbanization, ageing problem

New type industrialization  New type urbanization  Medical care
From Functional Lighting to Beyond Lighting

**Ecological lighting source with the advantage of cost performance**

**On-demand lighting**

- To improve lighting quality and meet the needs in people’s safety, physiology and psychology
- To create a more healthy, comfortable and smarter “light environment”

**Beyond lighting**

- Agricultural applications
- Medical applications
- Visible light communications , location-based services, etc.

Past 10 Years | 2015 | Next 10 Years
The 13th Five-Year Plan of China LED Industry

Main Tasks

- Key technological breakthroughs
  Demonstration projects
- Supply-side structural Reform
- International and Regional Cooperation
- Market Regulation
- Demand-driven Green lighting Promotion
Main Targets of China LED Industry

- Leading in innovative application
  - Industrial output 500BY
  - Cost down: 50%
  - Lighting market share rate: 30%
  - Energy saving: 100B KWh

- Become a world LED power
  - Industrial output 1000BY
  - Lighting market share rate: 70%
  - Energy saving: 340B KWh
  - Wide spread applications
The 13th Five-Year Plan SSL R&D Strategy

1 Innovation Chain
• From fundamental research, frontier technology, system integration to the demonstration system deployment

2 Platforms
• Open innovation platform for the whole industry chain
• A network service platform for eco-system optimization

3 Focuses
• Efficient, high quality and comfort lighting sources for various applications
• Smart lighting systems and service
• “More than Illuminations”
The 13th Five-Year Plan SSL Research Areas

- High quality Full spectrum LED
- UV LED
- LED Agriculture lighting
- Intelligent lighting visible optical communication
- SiC GaN
Standardization of technological achievements

- Healthy lighting, intelligent lighting, agricultural lighting, UV LED

### Standardization Plan in National R&D Program (2016-2020)

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Subtasks</th>
<th>Number of standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High quality, full spectrum inorganic semiconductor lighting materials, devices, lamps and lanterns industrialization manufacturing technology</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Key technology and production demonstration of high efficiency large area OLED lighting</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>Third-generation semiconductor materials and semiconductor lighting</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>New form multi-function intelligent lighting and visible light communication critical technology and system integration</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Semiconductor lighting and biological mechanisms and systems integration techniques and applications for health care and agriculture</td>
<td>The study of biological mechanism for healthy illumination</td>
<td>&gt;5</td>
</tr>
<tr>
<td></td>
<td>Research and development of the mechanism of health and medical care</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Research and application demonstration of LED key technologies for facility agriculture production</td>
<td>&gt;5</td>
</tr>
<tr>
<td></td>
<td>Research and application demonstration of LED key technologies for poultry and aquaculture</td>
<td>&gt;3</td>
</tr>
</tbody>
</table>
Jointly promote the standard system with opening minds

- Explore a way to incorporate technological achievements into standards, serve the industry's technology and market demand.
- Exchange and cooperate with domestic and foreign organizations and enterprises, coordinate and improve development of industrial standard.
- Explore an approach to make alliance standards into national standards or international standards, improve collaboration capabilities of alliance standards platform.
- In the light and lighting scope, build bridges between China industry and ISO/TC274, support the development of standardization.
Thanks for Your Attention!