LED 조명 애플리케이션과 사업화 동향

손 원 국
2009. 11. 17

I. Seoul Semiconductor
II. Lighting & LED
III. Market review
I. Seoul Semiconductor

Global Production Platform & Sales Network

- 3 corporate locations
- 30 sales offices
- 114 distribution sites

* SH = SSC + Huga

History

Continuous growth for 17 years

(Unit: Billion Won)

<table>
<thead>
<tr>
<th>Item</th>
<th>CAGR 05~07</th>
<th>CAGR 08~11</th>
<th>CAGR 66%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>8.9%</td>
<td>19.5%</td>
<td></td>
</tr>
<tr>
<td>Seoul Semiconductor</td>
<td>30.4%</td>
<td>66.0%</td>
<td></td>
</tr>
</tbody>
</table>

World Leading Manufacturer

Korea No. 1, Global Top 4

(Market Share : %) (Unit : $ million)

Our goal is to be Top 3 with 1,300 billion won in 2011 year

Awards

2009.05 Seoul Semiconductor got the Order of Industrial Service Merit for 44th Anniversary of Invention day from Korea Government

2008.12 Acridge awarded in Newtech Korea 2008


2007.12 Acridge, named as “Hot 100 products of 2007” by US electronic component magazine EDN

2007.03 Acridge has been named “Product of the Year” of 2006 by Elektronik

2006.11 Named as one of Asia’s 100 Hot Growth Companies by BusinessWeek

2006.10 Forbes named SSC as one of Asia’s Annual Best 200 companies Under a Billion
Strategic Vertical Integration

- Vertical Integration: LED chip, PKG, Module
- Strategic production system with joint-ventured Huga for increasing demand
- Continuous increase in capacity of Seoul Semiconductor (500M packages per month)

Competitive Strategies

1. From chip to package/module
   
   Growth > Fabrication > Packaging > Custom Module

2. Cost competitiveness
   
   Volume production (0.5 Billion Chips per Month), Effective management (Slim Org.), Global sourcing (USA, China, Korea)

3. Broad Product Portfolio
   
   Acriche, Z- Power LED, Side View LED, Top View LED, Lamp LED, Chip LED, High Flux LED, Dot Matrix, Custom Display, Deep UV, Near UV

4. Worldwide production capabilities
   
   Technology Centers and Factories in USA, Korea and China
World Class Products

1) Acriche Series
   ✴ Acriche is **AC-driven** semiconductor light source without additional Secondary components

   **A4 Series : 0.76W of high efficiency AC-driven LED**
   . World best luminous efficacy among warm white LED in mass production
   . 65~75lm/W & over 85 Ra of Warm white LED

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A4</td>
<td>0.76</td>
<td>50 (65lm/W)</td>
<td>20mA@55V</td>
<td>3000</td>
<td>85</td>
</tr>
</tbody>
</table>

   **A3 Series**
   Direct driven at 100/110V with 40mA & 220V/230V with 20mA
   215 lm of pure white & 145 lm of warm white available

2) DC LED

   **Z1 : Ultra Slim LED for Lighting**
   1.2 thickness : Z-Power LED Z1
   Excellent color uniformity (Pure white : 120lm , Warm white : 95lm )

   **728 series : High CRI Top View LED**
   CRI 80~90 : Top View LED 728 series
   High CRI values close to natural light

   **LCW100Z1 : Chip LED with high luminous efficacy**
   Global Top-class luminous efficacy, Chip LED with 120 lm/W
   Available luminous flux : 7.8lm@20mA, 14.3lm@40mA

   **P5-II : Full Color Power LED**
   R, G, B Full color 6 Pin : P5-II
   High power & Full color, Excellent uniformity

   **P7 : Super Bright Power LED**
   Max 900lm : Power LED P7(10W)
   Excellent color uniformity
**Patents Portfolio**

Global Leading with over 5,000 patents

**R&D Strategy:** 10% of sales revenue invested in R&D and strategic cooperation
Maintain the top position securing patents and developing applications

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**“Acriche”, the World First Semiconductor Light Source**

1) Features

**Not an LED, Semiconductor light source made of integrated circuit**
A plug-in & eco-friendly light source, connected directly to AC 110V or 220V outlets without additional converters

- Put dozens of light emitting cells on one die
  - Patent registered
  - Inner integrated circuit
  - AC direct connection (110V, 220V)
  - Compact components
  - No power supply needed
  - Long Life
  - Environment-friendly

---

 bild: 600x800

bild: 600x800
### Acriche VS DC LED

<table>
<thead>
<tr>
<th>Components</th>
<th>Acriche</th>
<th>DC - LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>. Acriche is only component</td>
<td><img src="image1" alt="Acriche AC power source" /></td>
<td><img src="image2" alt="DC-LED AC/DC Converter" /></td>
</tr>
<tr>
<td>Cost</td>
<td>. 35,000 hrs of lifetime not reduced by converter</td>
<td><img src="image3" alt="DC-LED LED" /></td>
</tr>
<tr>
<td>Lifetime</td>
<td>. 35,000 hrs of lifetime not reduced by converter</td>
<td><img src="image2" alt="DC-LED AC/DC Converter" /></td>
</tr>
<tr>
<td>Efficiency</td>
<td>. No conversion loss</td>
<td><img src="image3" alt="DC-LED LED" /></td>
</tr>
<tr>
<td>Others</td>
<td>. No fire hazard . Electrical safety guarantee</td>
<td><img src="image2" alt="DC-LED AC/DC Converter" /></td>
</tr>
<tr>
<td></td>
<td>. Environmental pollution caused by converter . Additional space needed for converter . Fire hazard and low reliability caused by heat emission and converter</td>
<td><img src="image4" alt="DC-LED Converter" /></td>
</tr>
</tbody>
</table>

### Lighting Fixture Structure by LED Type

**DC LED type**
- Optic
- LED
- Driver
- Heat Sink (with Fan)
- Body(with Base)

**Acriche type**
- ![X Mark](image5)
Lighting Applications (Fixtures)

- Region: KOREA
  Part No.: Acriche (AW221.4)

- Region: EUROPE
  Part No.: Acriche (AW322.1)

Lighting Applications (Fixtures)

- Region: EUROPE
  Part No.: Acriche (AW322.1)

- Region: KOREA
  Part No.: Acriche (AW221.4)
Lighting Applications (Fixtures)

<table>
<thead>
<tr>
<th>Region</th>
<th>Part No.</th>
<th>CRI</th>
<th>CCT</th>
<th>Watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUROPE</td>
<td>Acriche (AW3221)</td>
<td>70</td>
<td>6,500</td>
<td>4</td>
</tr>
<tr>
<td>KOREA</td>
<td>Acriche (AW2228)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lighting Applications (Fixtures)

<table>
<thead>
<tr>
<th>Region</th>
<th>Part No.</th>
<th>CRI</th>
<th>CCT</th>
<th>Watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>KOREA</td>
<td>Acriche (AW3221, AN3221)</td>
<td>70</td>
<td>8,500 / 3,000</td>
<td></td>
</tr>
<tr>
<td>JAPAN</td>
<td>Acriche (AN3201)</td>
<td>70</td>
<td>3,000</td>
<td>20</td>
</tr>
</tbody>
</table>
Lighting Applications (Fixtures)

Region: Korea (National Palace Museum of Korea)
Part No.: Acriche (AW3220)
CRI: 70
CCT: 6,500

Lighting Applications (Fixtures)

Region: Europe
Part No.: Acriche (AW3220)
CRI: 70
CCT: 6,500
# Seoul Semiconductor's LED Products

<table>
<thead>
<tr>
<th>Acriche</th>
<th>Side View LED</th>
<th>Dot Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z-Power LED</td>
<td>Chip LED</td>
<td>Custom Display</td>
</tr>
<tr>
<td>Top View LED</td>
<td>Lamp LED</td>
<td>Deep UV</td>
</tr>
<tr>
<td></td>
<td>High Flux LED</td>
<td>Near UV</td>
</tr>
</tbody>
</table>

## Interior lighting
- [Japan](#)
- [Europe](#)
- [Europe](#)
- [Europe](#)

## Exterior lighting
- [Europe](#)
- [Korea](#)
- [Europe](#)
- [Europe](#)
- [Korea](#)
- [Korea](#)
Applications with Seoul Semiconductor's LEDs

SSC is penetrating into new markets all over the world.

II. Lighting & LED

Energy & Environments

Source: U.S. Census Bureau, International Data Base, June 2001 Update.
World Lighting Electricity

Consumption shares by sector in 2005

- Residential, 31%
- Commercial, 43%
- Industrial, 18%
- Stationary, 8%
- Outdoor

<Source from: Strategies in light 2009>

Lighting Industry Segmentation
Lighting Industry Classification (By Product type)

Major Lighting Company (Lamp & Fixture)

- Lamp
- Driver
- Housing
- Controller
- Etc (Simulation...)

Lighting Material Company

- Driver
- Components
- Lamp
- Control

Design included

General Lighting Fixture Company (Middle level/Low level)

- Assemble
- All parts
- Design
- ?(Special Technique)

Light Source Classification

Light Source

- Solid matter lamps
  - Luminescence radiators
    - Laser
    - LED
    - Laser LED
    - Photo luminescence
    - Bio luminescence
    - Etc

- Thermal radiators

- Discharge lamps
  - Glow discharge
  - Arc discharge
  - High-pressure Discharge lamps
    - Mercury vapour lamps
    - Metal halide lamps
    - High-pressure Sodium lamps
    - Low-pressure Sodium lamps
  - Low-pressure Discharge lamps
    - Fluorescent lamps
    - Compact fluorescent lamps
### Typical Efficacies and Lifetimes of Lamps

<table>
<thead>
<tr>
<th>Current Technology</th>
<th>Efficacy (Lumens/Watt)</th>
<th>Typical Rated Lifetime (Hours)</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent</td>
<td>10–19</td>
<td>750–2,500</td>
<td>97</td>
</tr>
<tr>
<td>Halogen</td>
<td>14–20</td>
<td>2,000–3,500</td>
<td>99</td>
</tr>
<tr>
<td>Fluorescent – T5</td>
<td>25–56</td>
<td>6,000–7,500</td>
<td>52–76</td>
</tr>
<tr>
<td>Fluorescent – T8</td>
<td>35–87</td>
<td>7,500–20,000</td>
<td>52–90</td>
</tr>
<tr>
<td>Fluorescent – T12</td>
<td>35–92</td>
<td>7,500–20,000</td>
<td>50–92</td>
</tr>
<tr>
<td>Compact Fluorescent</td>
<td>40–70</td>
<td>10,000</td>
<td>82</td>
</tr>
<tr>
<td>Mercury Vapor</td>
<td>25–50</td>
<td>29,000</td>
<td>15–50</td>
</tr>
<tr>
<td>Metal Halide</td>
<td>50–115</td>
<td>3,000–20,000</td>
<td>65–70</td>
</tr>
<tr>
<td>High-Pressure Sodium</td>
<td>50–124</td>
<td>29,000</td>
<td>22</td>
</tr>
<tr>
<td>Low-Pressure Sodium</td>
<td>18–180</td>
<td>18,000</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: DOE.

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### Light Source Technology Level

*<Source from: Strategies unlimited 2009>*

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LED Package Type

- **5mm Lamp**
  - IF = 20 mA
  - Heat

- **Super Flux**
  - IF = 70 mA

- **TOP LED**
  - IF = 50 - 150 mA

- **High Power LED**
  - IF = 350 ~ 1000 mA

Thermal Condition by LED Package

- **5mm Lamp**
  - IF = 30 mA
  - Θe = 240 °C/W

- **High Flux**
  - IF = 70 mA
  - Θe = 120 °C/W

- **Z LED**
  - IF = 350 ~ 1000 mA
  - Θe = 7 °C/W
HB LED Type

Input power (W)

- Low power
- Drive Current: 20mA
- Middle power
- Drive Current: 50~150mA
- High power
- Drive Current: 150~1,000mA

White Color Method

- R+G+B LED
- Blue LED + Yellow Phosphor
- UV LED + R/G/B Phosphor
LED Lighting Fixture

LED Lighting Fixture = LEDs + Power Supply (driver) + Thermal Management + Optics

LED Fixture Design Process

Fixtures Function
- Task light, decorative, outdoor, wet environment...

Technical Features
- Light output, color...

Regulatory Requirements
- UL, IES, Energy Star, Title 24...

Esthetics

LED Light Engine

Thermal Management
- Optics
- Drivers

Fixture Design

Testing Fixture Efficacy

Source from: Strategies unlimited 2009

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LED Lighting Roadmap

System efficiency ~54% → 70% improving

Light Source by LED

Glass, Fragile, Short life-time

Metallic, Strong, Long life-time
## Lighting Fixture by LED

- Big size, Low efficacy, High-Maintenance
- Slim, High efficacy, Money saving

## Future Lighting System

- LED Lighting + Optimal Design + Solar Energy → Future Lighting System
LED Lighting Contest Prizewinner (Lighting for tomorrow 2009)

- IES
  “Get it right”
  Seeks to promote energy efficiency and quality lighting by highlighting product

- IALD

- DOE
  Market-ready luminaires & emerging products categories

LED Packages for Lighting

P5-II series RGB Full color
P9 series 0.5W
P4 series
Acriche A2
The World's Brightest White LED 115lm (Pure, MAX) If=350mA 1 die
Acriche A3
Super Bright
World Highest Brightness Power LED
P7 series
-Z1 series
Ultra Slim High Brightness Power LED 120lm/W
Unbeatable Lumen per dollar
Acriche A4

<Seoul Semiconductor Power LED series>
Price Allocation (Down light)

- **Incandescent Down light**
  - Lamp Mfg’s 13%
  - Ballast 0%
  - Socket 1%
  - Optics 21%
  - Fix Assy 65%
  - Total 100%

- **CFL Down light**
  - Lamp Mfg’s 15%
  - Ballast 21%
  - Socket 1%
  - Optics 15%
  - Fix Assy 48%
  - Total 100%

- **LED Down light**
  - Die 15%
  - Pkg 12%
  - Driver 3~15%
  - PCB 15%
  - Optics 12%
  - Fix Assy 35%
  - Total 100%

LED Lighting Price Target

- **Cost of LED Lighting**
- **Incandescent**
- **CFL**
- **LED**

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# LED Business Support by Country 1

<table>
<thead>
<tr>
<th>국가</th>
<th>상세 지원 방안</th>
</tr>
</thead>
</table>
| EU  | - EU 집행위원회는 2012년 9월까지 백열전구를 상품에 진열하는 것을 법으로 금지하는 에너지 절감 지침을 승인  
   - EU내 일반 전구 판매가 2009년 9월 1일부터 점차 중단될 예정  
     (100W 이상: 이 시기부터 판매 금지, 75W: 2010년 9월, 60W: 2011년,  
      10W: 2012년 판매 중단 → 2016년 부터 에너지 효율 B등급 이상 제품만 판매가 지속될 예정)  
   - 백열전구 교체로 가구당 연간 50유로(9만3천원)씩 100억유로의 에너지 절약을  
     에너지 효율 B등급 이상 제품을 사용할 경우 15% 세금 환급 |
| 영국 | - ECA(Enhanced Capital Allowance) 정책 발표하여 소비자가 LED 제품 구매시 15% 세금 환급 |
| 스페인 | - 1인 1 energy saving bulb 보급 project 일환으로 2010년 보급 제품에  
   LED 사용 예정 (Valencia 주는 모든 가로등 LED로 순서적 교체 결정) |

# LED Business Support by Country 2

<table>
<thead>
<tr>
<th>국가</th>
<th>상세 지원 방안</th>
</tr>
</thead>
</table>
| DOE(Department Of Energy) Plan 확정  
- 다년간의 LED 관련 R/D plan 을 실행, Solid State Lighting을 지원함  
- 13개 업체를 선정하여 정부 차원의 조명 관련 지원함(지원 금액 $20M)  
- DOE 등록된 LED 관련 PJT는 Cree 및 각 대학교와 연계되어 진행됨  
- 향후 20년안에 LED는 급속도로 조명을 대체할 것이며, 기존 조명사용  
  전력의 62%를 줄이고, 133개의 발전소 건설비용을 줄이며, $2800억 이상의 절약효과를 가져올 것으로 예상 |
| 미국 | - 정부 차원의 친환경 에너지 고효율 정책으로 LED 수요 높아짐  
   - Obama 정부는 Bush 정부와 달리 친환경재생에너지 정책을 적극적으로 펼  
   - LASF는 'Clinton Foundation'의 '클린턴 기후 이니셔티브'와 파트너십을  
      맺고 온실가스 방출을 줄이는 등 LA를 친환경도시로 만들기 위해 가로등  
      LED로 교체하는 Project 를 적극 추진  
   - '09년, '10년, '11년, '13년에 가로등전체에  
      90%의 LED 전구로 교체하였음(4년, 1년, 2년, 3년, 4년, 5년)  
   → LED 가로등 교체작업 통해 연간 1000만 달러의 전기료 절감 기대 |
### LED Business Support by Country 3

<table>
<thead>
<tr>
<th>Country</th>
<th>Sales Support Options</th>
</tr>
</thead>
</table>
| **중국** | □ 중국 정부 4조원 투자 경기 부양책  
- 세부 내용  
  - 내수 확대를 위해 2010년까지 4조위안(5860억달러 약 775조원)을 투입  
    - 대규모 경기 부양책을 중국 국무원이 최종 승인<신화통신 보도>  
  - 투입자금 용도  
    - 저소득층을 위한 주택건설 및 사회간접자본 확충  
    - 농촌지역 기반시설 마련: 수도, 전기, 교통 및 공공시설 확대  
    - 환경보존, 기술혁신, 재난지역 재건 등 10개 부문에 사용  
  - 08년 4분기 건설부문 1천억RMB투자, 09년/지진피해재건을 위한 200억 RMB 투자  
- 당사 파급 효과  
  - 자체 기술력은 있으나 자본금이 부족한 도로등/터널등 제조업체의 융행,  
    - 에너지 공사의 자금지원을 통해 빠르게 대응 것으로 추정  
| □ 북경 정부의 1조 계획(기존 백색등을 절전형광등으로 교체)  
- 세부내용  
  - 절전형광등을 기존가격의 10% 가격으로 공급, 90%예산을 정부가 부담  
  - 북경내 4개 구에 50만개의 절전 형광등 공급  
  - 전체 투입예산은 09년 4천만RMB, 09년 5천만RMB 예정,  
    - 절전전력량 2억KW/년, 예산절약비용 2억RMB/년 |

### LED Business Support by Country 4

<table>
<thead>
<tr>
<th>Country</th>
<th>Sales Support Options</th>
</tr>
</thead>
</table>
| **일본** | □ 세제 혜택 및 비용 지원  
  - LED 조명 장치를 고효율 에너지 절약 설비로 지정  
  - 에너지 수급 구조 개혁 촉진 세제 개정  
  - 설비 취득 가격의 30% 특별 전면  
  - 중소 기업의 경우 취득 가격의 7% 세금 공제 추진  
| □ Light for the 21st Century Project 추진  
  - 2010년 까지 조명 에너지 20% 절감을 목표로 백색  
  - LED를 이용한 반도체 조명 개발 수립(목표 120lm/W) |
| **호주** | □ 차세대 광전 기술 개발 및 보급 전략 추진  
  - 정부 주도하에 향후 4개년 계획 수립하여 시행중  
  - '09년 정부 산하 기관 백열 전구 사용 금지  
  - '10년 백열 전구 생산 금지  
  - '12년 전구 사용 금지 |
III. Market review

HB LED Market Breakout (1999~2008)

1999
- Lighting: 2%
- Other: 22%
- Signals: 2%
- Mobile Appliances: 16%
- Signs/Displays: 25%

Total: $0.82 Billion

2008
- Lighting: 9%
- Other: 16%
- Signals: 1%
- Mobile Appliances: 43%
- Automotive: 19%
- Signs/Displays: 17%

Total: $5.1 Billion

<Source from: Strategies in light 2009>

Average Growth Rate for Applications (1999~2008)

Total Market 22.5%

- Other
- Lighting
- Signals
- Automotive
- Signs/Displays
- Mobile Appliances

CAGR

<Source from: Strategies in light 2009>

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LED Industry Growth Extension

LED Lighting Market in 2007

<Source from: Strategies in light 2009>
**World Lighting Market**

- **Global lighting market**
  - About 109 Bil [US $]

- **Lamps Lighting** (62.4%)
  - Incandescent/Halogen/Sodium etc
  - 67.5 Bil [US $]

- **Fluorescent Lighting** (34.5%)
  - 37.5 Bil [US $]

- **LED Lighting** (3.1%)
  - 4 Bil [US $]

*Source from: Strategies Unlimited 2008*

**LED Lighting Examples 1**

Images of various LED lighting examples are shown.
LED Lighting Examples 2

LED Lighting Examples 3
LED Lighting Examples 4

LED Lighting Examples 5
LED Lighting Examples 5-1

LED Lighting Examples 6
LED Lighting Examples 7

LED Lighting Examples 8
Future LED Lighting Market

- Need for high-efficiency fixtures
- Development of performance, testing, and labeling standards
- Shortage of LED fixture designers
- Education for consumers and technicians
- Fast-growing CFL market share and mind share
- Growth of LEDs in illumination is dependent on energy prices
- End of life issues
- Changing the lighting paradigm
- Improvements in HB LED price/performance

Thanks for Listening

Edison for past 100 years, Acriche for the next 1,000 years