

A photograph of a modern LED light bulb with a white dome and a silver heat sink, positioned in the upper right corner. The background is a view of the Earth from space, showing the blue horizon and black sky. A faint grid pattern is visible on the left side of the image.

Silicon-Based GaN High-Power LED

Sonny Wu
Chairman & CEO

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SEMICON[®]
West2010



Creating the best LED light bulb for the World !

- World's only GaN/Si-based LED production company
- Disruptive silicon technology
 - Managing the challenges in GaN/Si
 - Scaling to 6-inch wafers and larger to drive down costs
 - Leveraging low-cost semiconductor IC standard tools for manufacturing
- Vertically integrated for scale and lighting solutions



Solving GaN-on-Silicon Challenge



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Sapphire

- Mature technology
- High material quality
- Dominates LED business

SIC

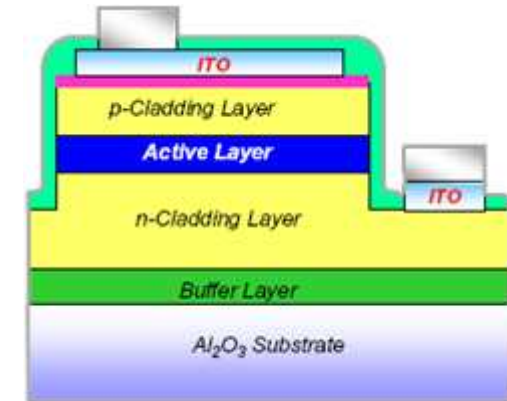
- Mature technology
- High material quality

Silicon

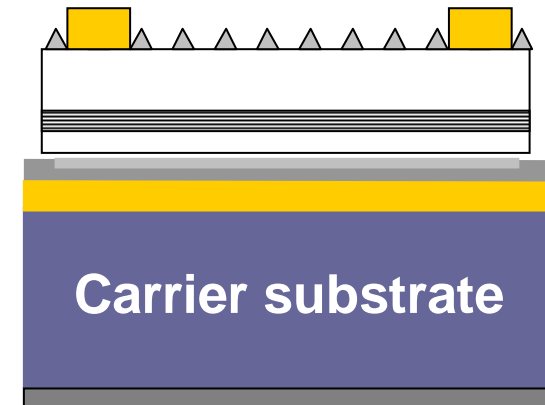
- Easy to go to 6–12 inch
- Less expensive
- Easy substrate lift-off for thin film (TF) process
- Can take advantage of low-cost IC manufacturing

Challenges

- **Substrate lift-off is difficult**
- **More difficult to go to 6–12 inch**
- **Expensive**
- **More difficult to go to 6–12 inch**
- **Lower material quality**
- **Tensile strain can cause film cracking**



TS: Transparent Substrate

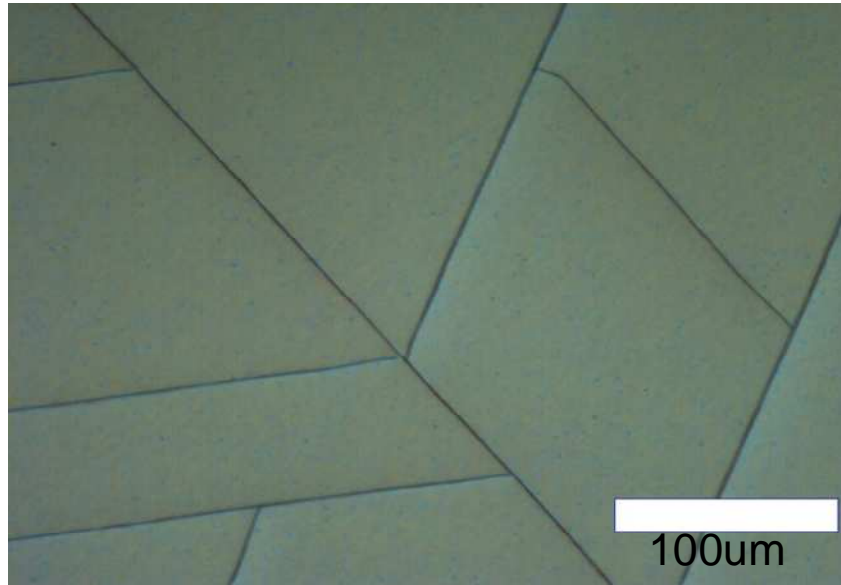


TF: Thin Film

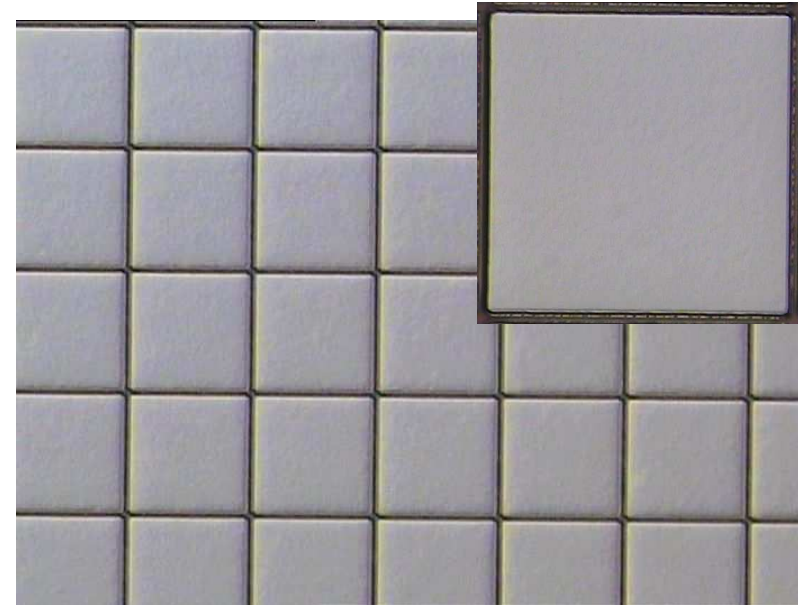
Managing the Stress in GaN/Si



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- Lattice constant mismatch
- Thermal expansion mismatch
- High tensile strain
- Cracking everywhere



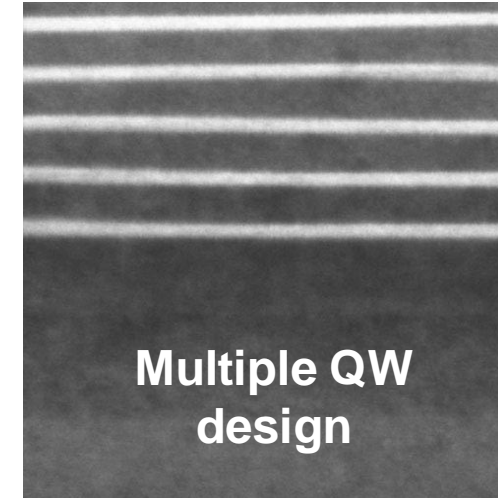
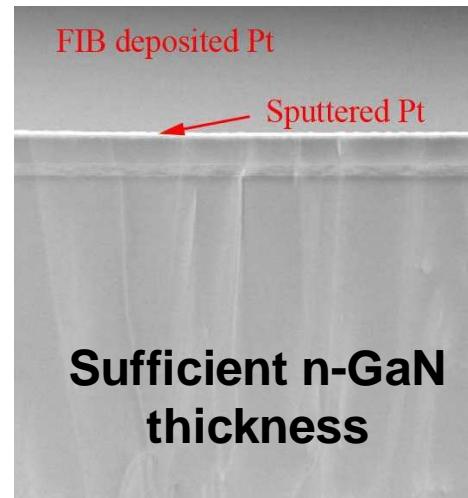
- Pre-patterned substrate
- Proprietary multiple-layer buffer design
- $<5E18$ dislocation density
- **High material quality**

Optimizing epi and Device

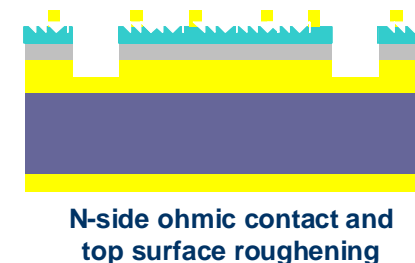
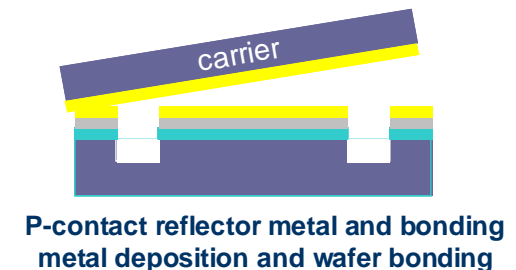


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- High-quality thick n-GaN layer to minimize defects
- Multiple QW design to maximize internal quantum efficiency
- **High-efficiency epi**



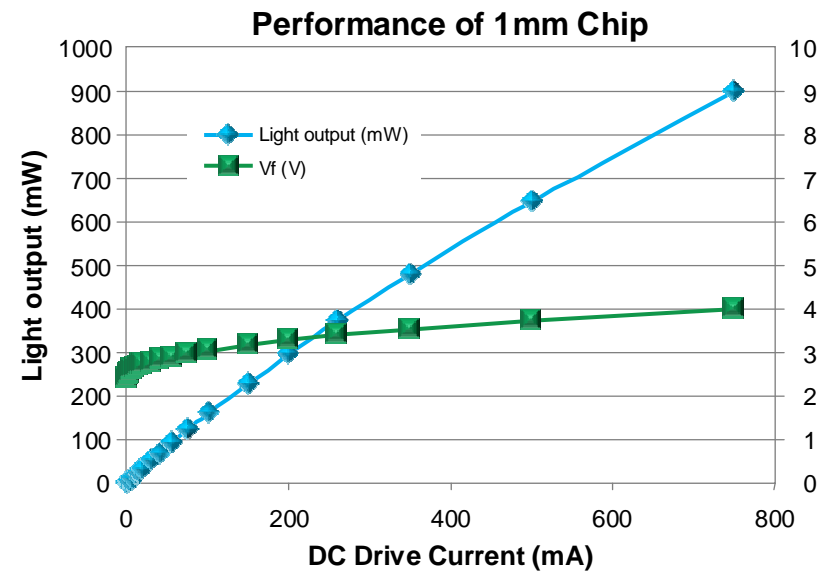
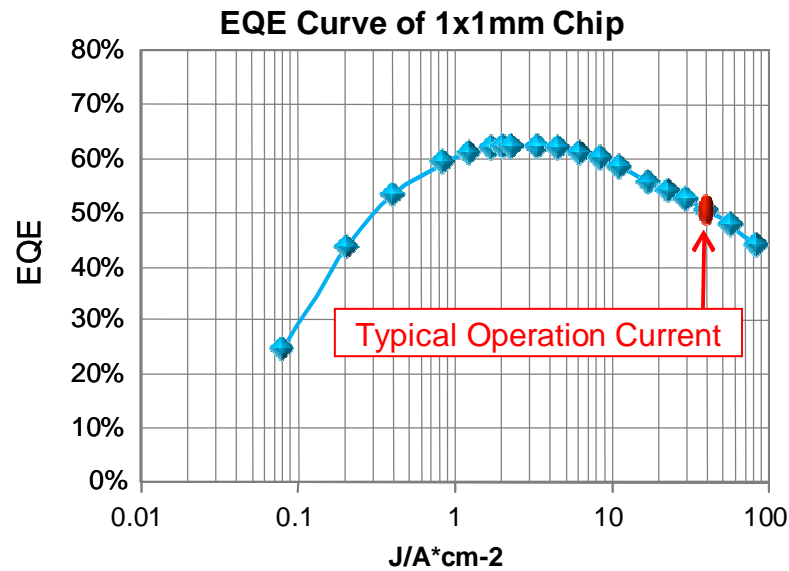
- Thin film structure with proprietary process to maximize the light extraction
- **High-performance device**



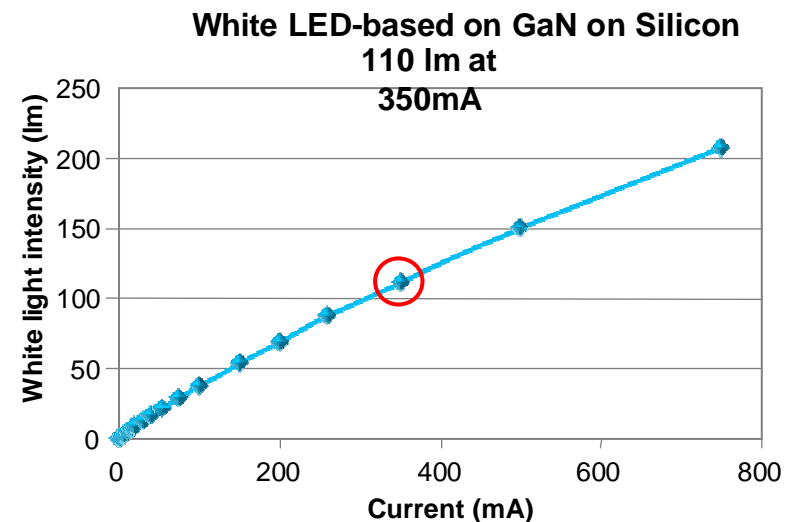
Achieving High Performance



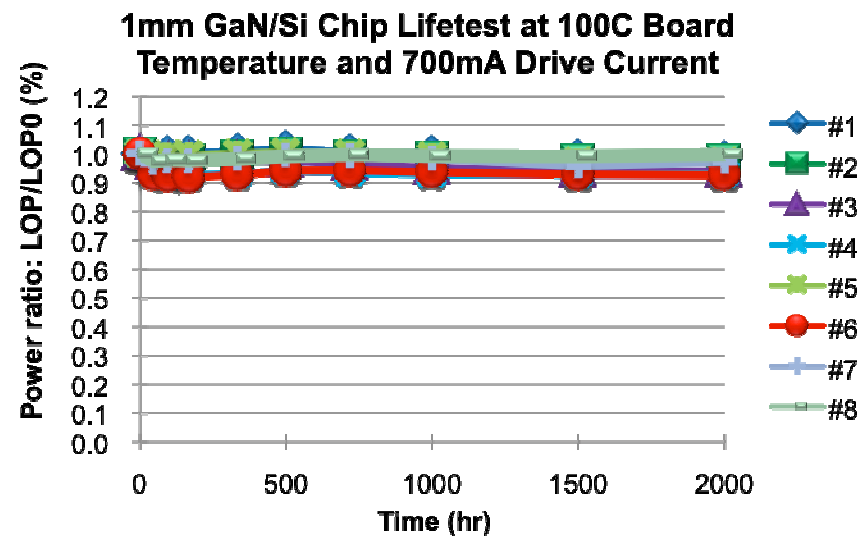
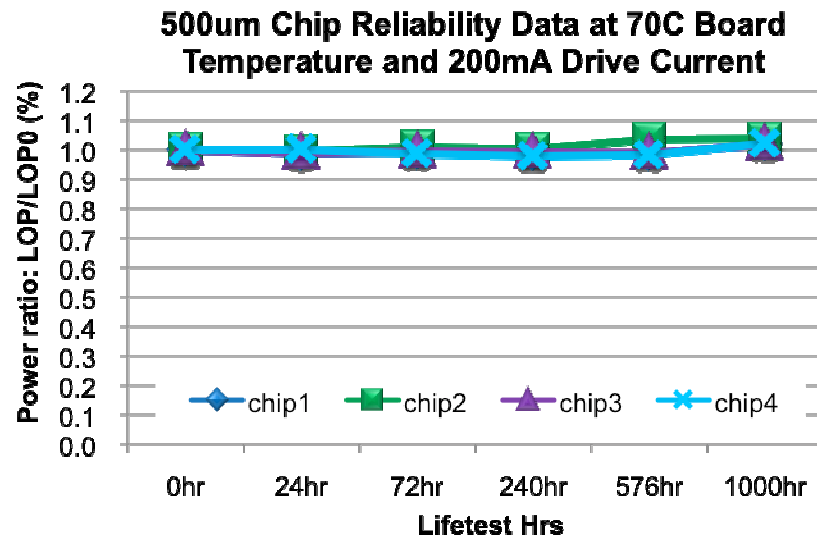
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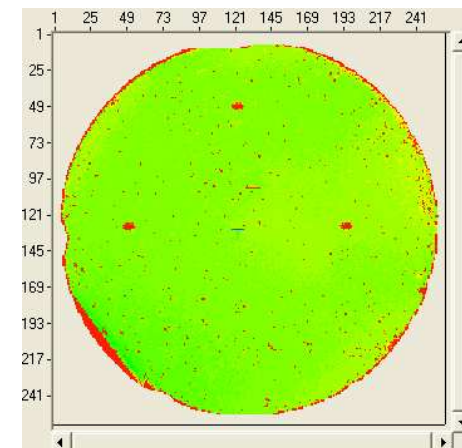
- >50% EQE at operating current, on par with sapphire-based LEDs
- Low operation voltage of 3.1–3.4V
- 110 lm at 350mA white (5000K CCT, 65 CRI)



Proving Reliability and Manufacturability



- Highly stressed lifetest at 3x normal operating current and 110–120 junction temperature
- Reliability similar to LEDs made on sapphire
- Silicon-based LED manufacturing process control; yield similar to sapphire-based LEDs



LatticePower's LED Light Bulb



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Specifications

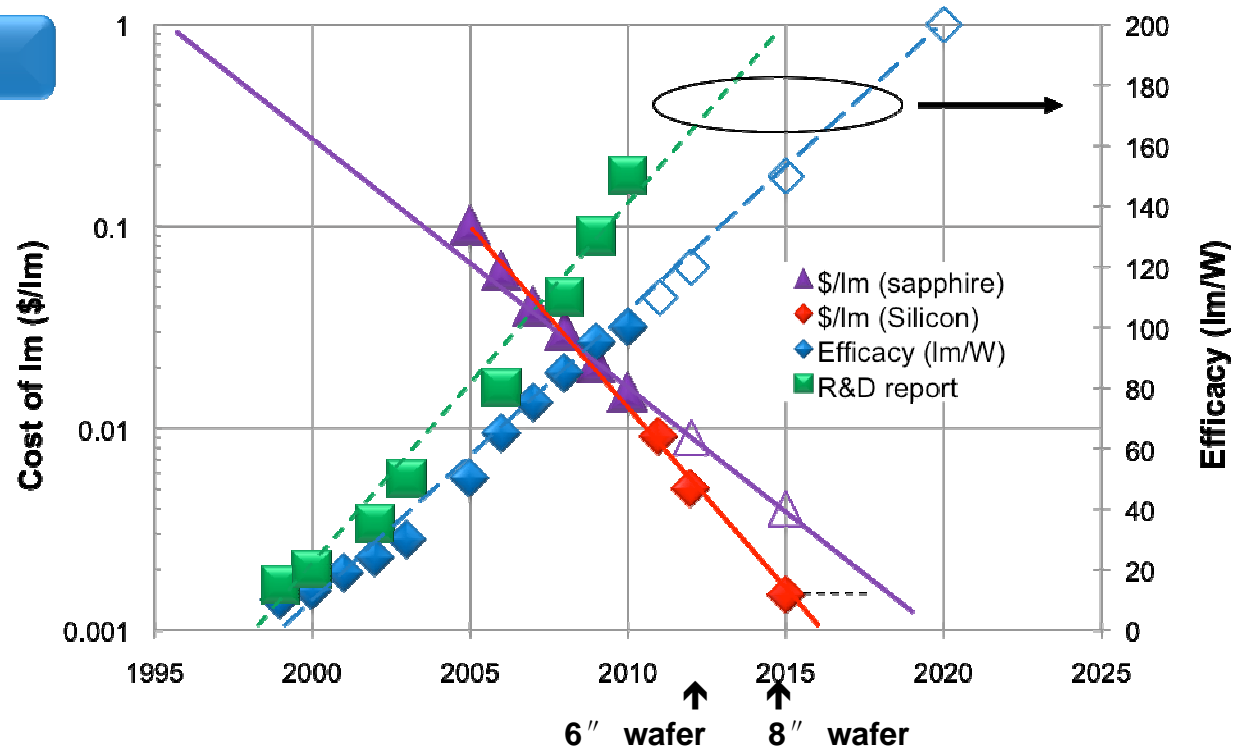
Product name	Snowcone
Voltage (V)	110 VAC
Power consumption	7W +/-10%
Power factor	0.95
Luminous flux (lm)	700 lm (neutral white), 480 lm (warm white)
Efficacy	92 lm/W (neutral white), 66 lm/W (warm white)
Color temperature	5000k +/-10% (neutral), 3000k +/-10% (warm white)
CRI	67 (neutral white), 80 (warm white)
Lifetime	40,000 hr
Weight & dimension	170g, 60mm x 122mm
Price	\$8 @ minimum 1 million order



LatticePower's Ambition



Haitz's Law



**6-inch-diameter and larger silicon wafer technology:
Impact of falling cost on Haitz's law**

Timeline	Today	2012	2015
Efficacy	100 lm/W	120 lm/W	150+ lm/W
Cost	Base	-50%	-80%

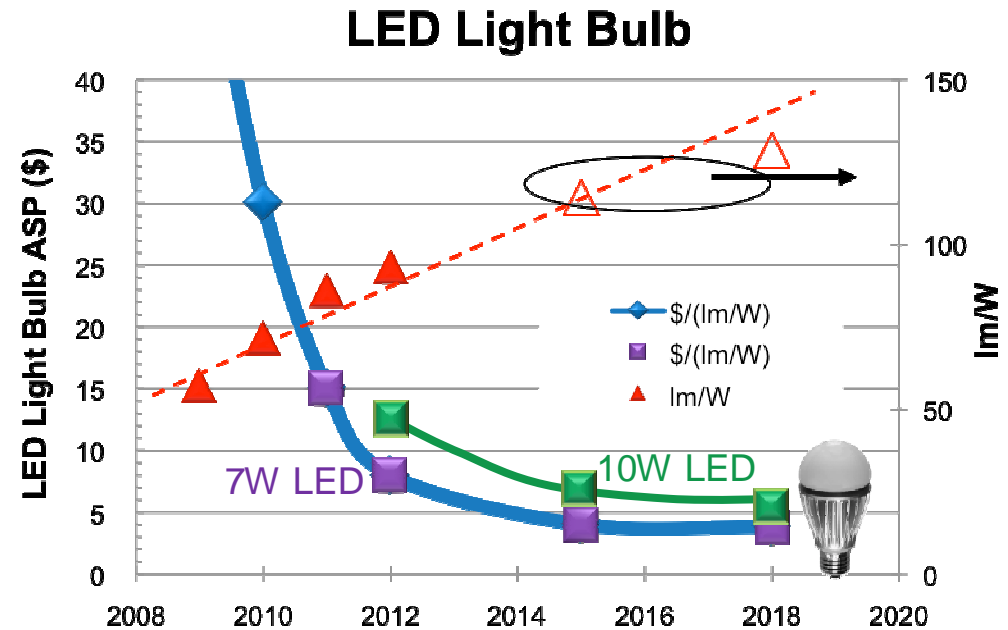
LED Light Bulb Adoption



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Key Factors for Lower Cost

- Silicon-based LED chips
- High-efficiency LED driver
- Scale and low-cost manufacturing capability



Timeline	Today	2012	2015
Efficacy	70 lm/W	90 lm/W	120 lm/W
7W/45W ASP	\$30	\$8	\$4
10W/60W ASP	-	\$12	\$6
Si wafer size	50mm/2"	150mm/6"	200mm/8"



Acknowledgements

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Thank You!

LatticePower (晶能光电)

www.latticepower.com

Contact: blu@latticepower.com

