Development of Advanced Manufacturing Methods for Warm-White LEDs for General Lighting

DOE Project # DE-EE0003232

Project update at the SSL Manufacturing workshop in San Jose, CA
13th-14th June 2012

Team at GE Lighting Solutions
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Advisory role – Anant Setlur, William Beers
Background for the project

**Vio™**  Designed for performance, ease of manufacturing and scalability

**Vio Nomenclature**

**Data Sheet**

**Electrical and Optical Performance**

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3 second pulse 850 nm at 2°C, 40% RH.

- Established product with a range of different SKUs (1W-7W)
- Potential for manufact. cost reduction and performance improvement

**BOM Costs Plotted in Arbitrary Currency Units for 1W Vio™ Product After task 5 (comparison with baseline)**

**imagination at work**

DOE SSL Manufacturing Workshop
13th-14th June 2012
Project Plan

PHASE I

Task 1
Overall Program Management

Task 2
Evaluate “Remote” Phosphor Manufacturing methods
Deliverables:
• Downselected process approach
• Performance and reliability criteria met

Task 3
Pilot downselected “Remote” Phosphor Manufacturing method
Deliverables:
• Acceptable color variation established
• Performance and reliability criteria met
• Cost targets met

Task 4
Design & pilot high-speed characterization techniques
Deliverables:
• Establish measurement system capability
• Pilot measurement system with satisfactory GR&R

PHASE II

Task 5
Design of Volume Production Line
Deliverables:
• Detailed large-scale manufacturing plan.
• Performance and reliability criteria met
• Cost targets met
Task-2

Phosphor molding

Milestone # 1

Based on early reliability / performance / cost savings potential
- Phosphor Molding selected as the preferred path

OR

Slurry Coating

• Eliminate phosphor waste in current process
• Reduce part to part color variation

Task 2

Evaluate "Remote" Phosphor Manufacturing methods
Deliverables:
• Downselected process approach
• Performance and reliability criteria met

imagination at work
**Task-2**
Phosphor molding

**Task-3**
Reliability testing

OR

Milestone # 1
Phosphor molding selected

Slurry Coating

**OR**

Milestone # 2
Adaptation into manuf. line

**Reliability testing**

**Scale up**

**HTOL**

**RTOL**

**LM-80 Testing**

Long term reliability tests and manufacturing scale up of Phosphor Molding

**Task 3**

Pilot downselected “Remote” Phosphor Manufacturing method

Deliverables:
- Acceptable color variation established
- Performance and reliability criteria met
- Cost targets met

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13th-14th June 2012
Task-4

Machine concepts finalized, build started in 2011

Machine build complete in 2012

Task 4
Design & pilot high-speed characterization techniques
Deliverables:
- Establish measurement system capability
- Pilot measurement system with satisfactory GR&R

DOE SSL Manufacturing Workshop
13th-14th June 2012
Task-5

**Design** for large scale manufacturing line for Vio™

Go from a batch, manual process to a high speed line manufacturing process

Currently manual

Currently semi automated

Currently semi automated

Currently semi automated

Currently semi automated

Currently semi automated

Design created for future possible expansion

Task 5

Design of Volume Production Line
Deliverables:
- Detailed large-scale manufacturing plan.
- Performance and reliability criteria met.
- Cost targets met.
Summary / Results

Less than 2 step MacAdam ellipse color shift after 6K hrs

Less than 4 step MacAdam ellipse color distribution in manuf.

Projected L70 of greater than 50K hrs

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<th>I(mA)</th>
<th>VF</th>
<th>Iv (Lm)</th>
<th>CCX</th>
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Able to achieve 90+ LPW in remote phosphor config. (using Blue LEDs)

Manuf. costs reduction target met