Maximizing Cost Efficiencies and Productivity for AMOLED Backplane Manufacturing

Elvino da Silveira
Agenda

**Introductions & Trends**
- Consumer products driving AMOLED Adoption!

**Lithography Challenges**
- Devices performance increase lithography requirements
- Innovative solutions to meet demanding cost targets!

**Meeting the Challenges**
- Beyond lithography, process control!
Vice president of business development at Rudolph Technologies, with responsibilities to identify new markets and develop strategies to prosecute the opportunities. Until the Rudolph acquisition in December 2012, he served as president and operations manager of Azores since its inception in March 1999. Prior to forming the company, he was employed by MRS Technology, Inc., as the vice president of operations and worldwide customer support. da Silveira has also held engineering and customer support roles at Hampshire Instruments from 1991 to 1993 and GCA/General Signal from 1984 to 1991. Mr. da Silveira holds a B.S. in Mechanical Engineering from Northeastern University.
About Rudolph

Process solutions across the semiconductor industry

INSPECT
- Macro Defects Silicon to Die
- Dicing and Chipping Detection
- Interconnect Metrology
- 3D/2D Inspection
- Residue Detection

MEASURE
- On Product and In-die
- Multi-layer Film Stacks
- UBM, RDL, PR, PI, Dielectrics
- Structure CD

IMAGE
- Lithography down to 2µm
- Fan-out and Cu Pillar
- Wafer and Panel

ANALYZE
- Process Analysis
- Process Control
- Tool-centric and Fabwide

RUDOLPH SOLUTIONS APPLY ACROSS THE SEMICONDUCTOR VALUE CHAIN

CORE COMPETENCIES

FRONT-END
- SILICON

BACK-END
- RUDOLPH SOLUTIONS APPLY ACROSS THE SEMICONDUCTOR VALUE CHAIN

TEST
AMOLED Trends

Increased Mobility & Function Driving New Technology Adoption

Adoption of AMOLED

Products driving more adoption

New Form Factors

Next generation products

OLED Materials

Flexible Substrates

Higher pixel per inch (PPI)

Trends Mandate Changes in Display Production Equipment

Source: IHS
AMOLED Display Overview

Backplane common to all displays

Increasing number of transistors and electrical requirements
Drive stringent lithography to meet AMOLED backplanes
Building Up the Model

AMOLED cost drives

Operations Cost

Backplane

Lithography

System Price

Yield Loss
Lithography Solution  Based on innovation

Technology

- METROLOGY
- LARGE FIELD LENS
- SCALABLE STAGE

Software Capability

- PARALLEL EXPOSURE
- SOFTWARE SUITES

AMOLED Solution

- G6 LITHOGRAPHY

Leveraging Technology and Software
# Tolling Cost

## GEN 6 MASK SIZE COMPARISON GRAPHIC
- **Glass Size:** 177.6 mm x 177.6 mm
- **Cost:** USD $2-3k per mask
- **Magnification:** 1.25x (enlarger)
- **Number of Masks per exposure:** 2

## GEN 6 COST COMPARISON
- **Glass Size:** 850 mm x 1200 mm
- **Cost:** USD >$30k per mask
- **Magnification:** 1:1
- **Number of Masks per Exposure:** 1

<table>
<thead>
<tr>
<th>Size</th>
<th>Dimensions</th>
<th>Individual Mask Cost</th>
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<tbody>
<tr>
<td>Size A</td>
<td>850*1200</td>
<td>$60,000</td>
</tr>
<tr>
<td>Size B</td>
<td>800*920</td>
<td>$50,000</td>
</tr>
<tr>
<td>Size C</td>
<td>177.6*177.6mm</td>
<td>$40,000</td>
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</tbody>
</table>

**Rudolph**
- **Size C:** 177.6*177.6mm
Reduce Costs and Improve Utilization

**Reduces Consumables Costs**
No lamp replacement (est. 79K savings/year)

**Reduces Operation Costs**
> 21000 KW/mo and 500 CFM cleanroom air

**Improves Performance**
Better dose control

**Increases Throughput**
No shutter delays

**Higher System Utilization**
No machine down to replace lamp

**Improved Reliability**
No moving parts
Lithography Cost Differentiation

Equal Performance
22% Lower ASP

LED Light Source
No High Power Hg Lamp
>70% Lower Consumable Cost

Lower Mask Cost
Results >5X savings per layer

Superior Value of Ownership
Addressing Quality in the Display Industry

Increased complexity

Higher unit counts and I/O

Strict quality-control metrics

Digital Threading enabled for rapid product diagnostics

APPLE ON THE IMPORTANCE OF QUALITY

“We started off with a very idealistic perspective—that doing something with the highest quality, doing it right the first time, would really be cheaper than have to go back and do it again”
Software Expanding Rudolph Value

Innovative software solutions contributing to Rudolph growth

Genesis™ Software

• Fast/flexible connection
• Integrated DB-many data
• Handling large data set

RUDOLPH/OEM Integration

INTELLIGENT DIAGNOSTICS

Expanding across the Enterprise

ACTIONABLE INTELLIGENCE

Connected Data
End to End Analytics

MINIMIZING RISK
CREATING VALUE
Summary

Comprehensive Solution

Accelerated Adoption of AMOLED in Mobility Products
Increased unit counts and AMOLED Adoption
Driving need for comprehensive cost containment solutions

Integrated Solutions Address
Factory Wide Monitoring and Diagnostics,
Capability to Expand into Enterprise
Thank You!

감사합니다

danke

merci

 obrigado

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