Defining a new photomask quality standard

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The Journey
Mycronic in short

>40 years of experience in innovation

>1,100 employees in ten countries

>50 Mycronic is represented in more than 50 countries

>500 patents prove the power of innovation.

>12,000 production systems at more than 3,000 customers

>98% of consolidated net sales are outside Sweden
Two business areas serving the electronics industry

Business Area Pattern Generators (PG)
Advanced mask writers indispensable for the production of the world’s displays as well as a broad aftermarket offering

Business Area Assembly Solutions (AS)
Leading production solutions for the electronics assembly industry
Mycronic’s Pattern Generator solutions
Indispensable for the display industry

- Prexison-80 & Prexision-800
- Prexision-8 & Prexision-10
- Prexision-MMS

- FPS8100
- FPS6100 & FPS6100E

- Upgrades and modifications to improve mask quality
FPD Technology driver, OLED displays

Demand increase in OLED display for premium consumer electronics

**OLED adoption in premium products**

- OLED, prerequisite for foldable display
- 14 out of 16 major TV manufacturers introduce OLED TV on their premium product

**Impact in lithography technologies**

- OLED complexity 2 ~ 3 times compare to LCD
- To support transition LCD ➔ AMOLED
  a new aligner generation with higher resolution has been introduced
- Better photomasks will be needed to utilize their full capability

Source: LG OLED TV @ Youtube

New aligner generation

Prexision-800
The mask quality of Semiconductor “350nm node” requirements are now required at Display.

More holistic way of working was introduced in Semiconductor industry:
- Driven by mask user to overcome the challenges.

Similar development seen for display:
- Tighter collaboration through supply chain.
- Technologies transfer from Semiconductor to Display.
- High-end photomask becomes critical and seen as strategical importance.
Prexision-800

Key concepts and highlights to meet future requirements

- Improved lenses & mirrors
- New final lens with higher NA
- New modulator: 11 → 15 Beams
- Based on field proven P-80 platform
- New SW and functions to enhance performance
- New dampening solution to minimize vibration
Prexision-800, Key benefits

Will deliver photomasks which will define a completely new standard

**New resolution standard**
- P800 resolves L/S to 550nm
- ~25% smaller L/S than P80 & P8/10

→ Will enable writing around ~250nm smaller features with maintained linearity

**Superior pattern fidelity**
- High fidelity on OPC structures
- Larger process window than P80 & P8/10

→ Photomasks with SRAF and OPC structures small enough to effectively push the aligner resolution

**Outstanding CD control**
- ~2X better CDU than P80
- ~4X better CDU than P8/10

→ Photomasks that secures uniform electrical properties of the transistors

**Improved Mura level**
- P800 has ~50% lower edge roughness than P80
- The ER is distributed on more frequencies

→ Higher yielding production for both photomasks and the final displays
New resolution standard
Enable small OPC structures

• Prexision-800 CD linearity almost flat down to 1µm

• Improved pattern fidelity and CD Uniformity on smaller features

• Enables mask designs with will maximize the capability of the new aligner generation
New resolution standard

Enable small OPC structures

- 500nm L/S (X&Y)
- 1µm circle
- 1.2µm C/H with 0.6µm serifs
- Isolated lines (X/Y - 500nm, 750nm, 1µm)
- 1.1µm OPC
Outstanding CD control

Further improvement in CDU by SW function BPIO

- Composite CD-uniformity:
  - “Worst case” CD-uniformity
  - Evaluated by measure all possible beam combination
  - Samples all over the micro-sweep including overlap
  - Evaluated in three different position of the stage

→ Composite CDU (3σ)
  X = 16nm
  Y = 13nm

→ ~2X better than typical P-80 performance
Improve Mura level

State of art optical components give less Mura

- Prexision-800 has around 50% lower edge roughness ➔ Reduced Mura
- The edge roughness is also distributed on more frequencies ➔ Reduced Mura

$3\sigma = 20\text{nm}$

$3\sigma = 11\text{nm}$
Summary

- Display photomask has entered the really advanced requirement space
  - Driven by increasing adoption of OLED displays in premium products
- To meet industry requirements and enable efficient production of advanced display a new mask writer has been developed, the Prexision-800
  - Increased resolution matching the new aligner generation
  - Large improvement in CDU
  - Mura level will be superior
  - All improvements implemented without compromising productivity
- Two Prexision-800 sold and One in production to support display innovation

➔ Prexision-800 will define the new mask quality standards for future generation displays
Thank you

Watch Mycronic video clip “The Journey”

https://www.youtube.com/watch?v=OLSxOJEs1N8