Qualification Management and Its Impact on Capacity Optimization

Mehdi Rowshannahad, Stéphane Dauzère-Pérès, and Bernard Cassini

INTRODUCTION
Semiconductor manufacturing:
- Complex industrial environment
- Dynamic business and production environment
- Flexibility and Agility
- Expensive manufacturing equipment
- Optimum Capacity Utilization

Studied problem:
- Recipe-to-machine Qualification Configuration

QUALIFICATION MANAGEMENT
Recipe: Machine instructions to obtain the desired process
Qualification: Capability of processing a recipe (products) on a tool
Impact on Production Planning and Scheduling

Toolset Flexibility: Combination of different flexibility measures

System Flexibility: Combination of different flexibility measures

F_{System}^\text{(Recipe)} = a \cdot F_{Recipe}^\text{(Recipe)} + (1 - a) \cdot F_{WP}^{\text{Recipe}}

F_{Recipe}^\text{(Recipe)} = a \cdot F_{Recipe}^\text{(Recipe)} + (1 - a) \cdot F_{WP}^{\text{Recipe}}

“NEW” and “NOT PREVIOUSLY QUALIFIED” RECIPES
- New Products: Never qualified
- Not Previously Qualified Recipes: Completely disqualified

WP and Time Flexibility:
1. Proposes qualifications for the not previously qualified recipes (NQR)
2. Once all the NQRs are qualified, suggest further qualifications for “normal” recipes.

WIP Flexibility: Workload balance in terms of production volume
- Increases machine utilization (capacity) and avoid bottleneck

Time Flexibility: Workload balance in terms of processing time
- Increases flexibility for production scheduling

Toolset Flexibility: Guarantee against machine breakdown

Production Volume Per Recipe

F_{WP} = \sum_{i=1}^{m} \frac{WIP_i \cdot P_i}{m}

WIP Flexibility: Workload balance in terms of production volume

F_{WP} = \sum_{i=1}^{m} \frac{WIP_i \cdot P_i}{m}

Excel-based application

Data Extractor

Input File Creator

QUALIFICATION MANAGEMENT DECISION SUPPORT SYSTEM
Best Qualification
Optimized Capacity
Optimized WP Distribution

QUALIFICATION MANAGEMENT
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Toolset Qualification

Recipe Flexibility: Combination of different flexibility measures

Industrial Experiments

Thermal Treatment Toolset (22 machines of 4 different types)

INDUSTRIAL EXPERIMENTS

Fig. 1: Current workload balancing (in hours) for production volumes of one week

Fig. 2: Flexibility gains with one not previously qualified recipe (NQR): “Recipe 3”

Fig. 3: New workload balancing after 1st qualification

Fig. 4: New flexibility gains after 1st qualification

Fig. 5: Workload balancing after best qualification: “Recipe 7” on “Machine 19”

Fig. 6: Optimal WIP distribution after best qualification: “Recipe 7” on “Machine 19”

REFERENCES

CONTACT INFORMATION
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CONCLUSION AND FURTHER RESEARCH

Benefits of Qualification Management DSS:
- Warnings of a loss of flexibility,
- Increases capacity utilization,
- Avoids machines to become overloaded,
- Increases flexibility for production scheduling,
- Avoids costly unnecessary and urgent qualifications,
- Reduces downtimes caused by too many qualifications,
- Supports the acquisition of new machines,
- Supports the introduction of new products.

Further Research:
- Considering batch sizes in workload balancing algorithms,
- Including maximum capacity of each machine in flexibility measures.

REFERENCES

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Investigation of an on Product High-k / Metal Metrology Methodology Using an In-line, High Throughput XPS Measurement Technique

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Abstract
In this paper, we investigated a novel and unique, high throughput, in-line XPS technique for thin film (< 100 Å) measurements, such as SiON and HfO. In-line XPS measurement capability was evaluated using four separate techniques: offline SIMS, offline XPS, in-line ellipsometry, and offline micro-X-ray fluorescence (XRF). A nitrogen sensitivity test determined that the detection limit was on the order of 5 × 10^14 atoms/cm^2 in a thin SiON layer. The success of achieving the thickness of the bilayer HfO/SiON film was demonstrated. Long-term dynamic precision and short-term repeatability for high film measurements are also discussed for both thickness and composition. These values were determined to be less than 1% of the nominal value (±1%) for the film thickness.

XPS Fundamentals

Experiment

4a. Single Layer SiON Film

Experiment

Analysis and Results

Conclusions

The key advantages of the in-line XPS technique are the ability to measure thickness and composition of high film layers simultaneously and to achieve high throughput. The XPS technique is capable of measuring the thickness and composition of high film layers with a precision of ±1% of the nominal value.