

Point of View

IT Solution Approach for Photomask Procurement

by Nikhil Ankalikar

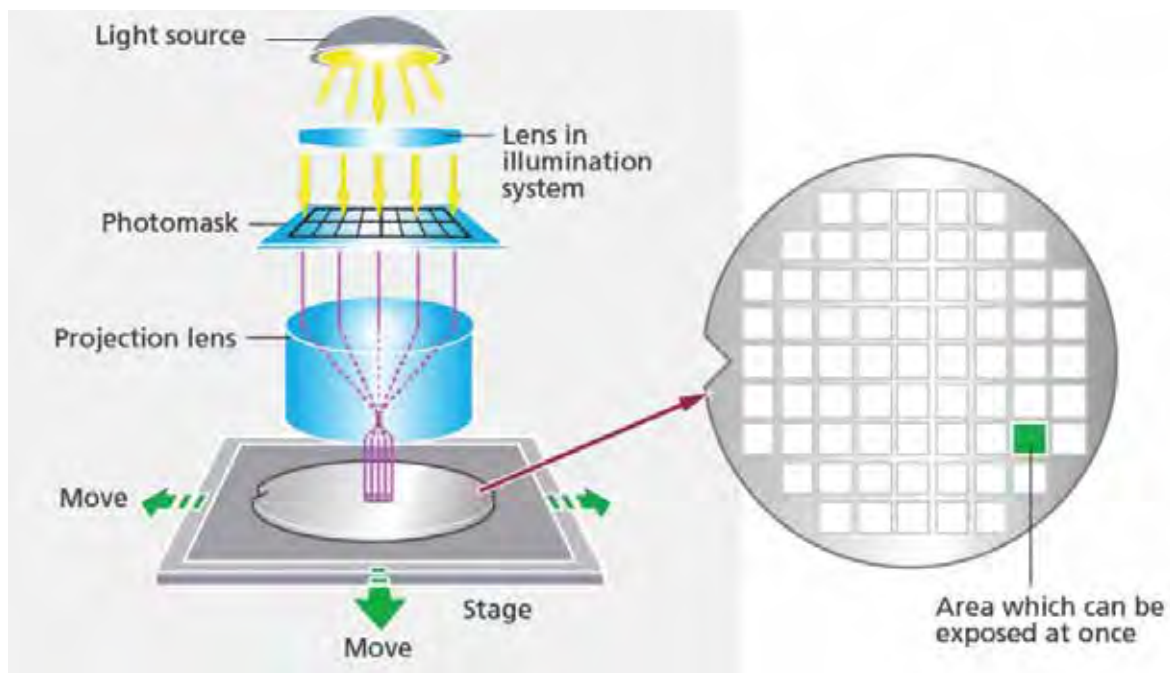
Scenario

One of the companies from the semiconductor industry was implementing ERP solution to their business. Project team was testing the implementation with real-time business cases. For front-end sites, photomask procurement process was not working as expected. War-room was set to check for any quick-fixes to resolve the issues or work-around possible to execute the process. Can the system go-live functionally with acceptable bugs/ workarounds or without implementing business process? Project team decided to defer go-live date for front-end sites. So, what is photomask and why photomask process has so much importance?

What is photomask?

Photomasks are used for optical lithography in silicon wafer processing and contain the pattern of the integrated circuits. Optical lithography is a photographic process by which a light-sensitive polymer, called a photoresist, is exposed to light source, and developed to form 3D relief images on the substrate.

For understanding purpose, photomask is a kind of template which replicates chip circuit design. It is quartz or glass substrate coated with an opaque film.



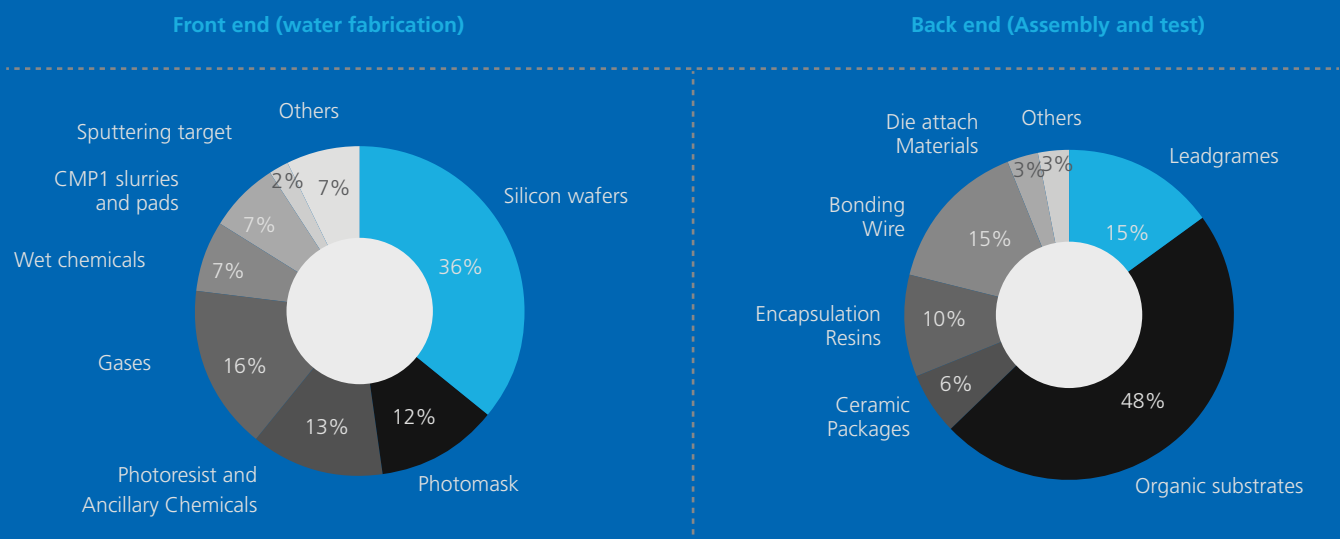
SEMI (Semiconductor Equipment and Material International) predicted photomask revenues to increase from USD 4.4B in 2020 to USD 4.8B in 2021^[1]

Importance of Photomask in Semiconductor manufacturing

Photomask is one of the main front-end manufacturing materials, along with materials like silicon wafers, gases, wet chemicals, photoresist. In one of the papers submitted by semiconductor industry association in April 2021^[2], they have given the breakdown of market size of semiconductor manufacturing materials. As per data of 2019, photomask market share contributes to 12% of front-end materials.

Exhibit 9 | Semiconductor production uses hundreds of unique materials and specialty chemicals

Breakdown of market size of semiconductor manufacturing materials, 2019 (% of \$ Billion)



1. Chemical mechanical planarization | Source: BCG analysis based on data from SEMI, IHS and HSBC

Silent features of photomasks

Photomask technology is always ahead of the semiconductor technology

Photomasks are unique in nature. This uniqueness makes 'planning in advance' difficult

In general, photomasks are ordered 'Just in Time'. Photomasks are ordered in sets. One photomask set generally contains more than one photomask layer

Shortage of photomask has severe impact on front-end site operations, and theoretically can lead to shutdown of the front-end site in extreme cases

Challenges in Photomask production and procurement process

Business Challenges

- ▶ As transistors have become smaller and smaller, photomasks have also become more complex in order to accurately transfer increasingly complex patterns onto the silicon wafers
- ▶ Rise in the economic pressure (due to high capital cost from supplier side and expectation of cost reduction from customer side)
- ▶ There is a need for high yield (less rejections) and rapid turn-around
- ▶ Minimizing lead time of procurement

IT Challenges

- ▶ **Data security:** Photomask set/ layer design results into semiconductor chip design. Depending upon the usage of chips in various application, sensitivity of the photomask technical data varies. In general, photomask attributes and photomask drawings must be stored securely with access to authorized persons only.
- ▶ **Uniqueness of data:** Each photomask is unique in nature due to combinations of technical attributes like critical dimensions, defect control, technology data, and commercial data. Hence reusability of photomask data is restricted.
- ▶ **Linkage between photomask technical data and commercial data:** Photomasks are produced based on 'Make to order' basis. Along with other parameters, photomask pricing is driven by complexities in the design and production of the photomask. There are no business rules to link commercial data and technical attributes of photomasks.
- ▶ **Time criticality in photomask procurement process:** As mentioned earlier, photomask procurements can't be planned in advance due to uniqueness. Photomask supply chain is always under time pressure to make the masks available for production. IT systems need to support photomask buyers to achieve their KPIs of cycle time reduction, supplier performance, zero defect orders.

Expectations from IT systems

Simplification in the business process execution

Enhanced user experience

Reporting and monitoring of photomask orders

Adopt industry best practices to the extent possible

Success factors for IT solution for photomask procurement

1. Focus on the business KPIs

Each business process has unique KPIs. In case of photomask procurement, time criticality and data security are key areas to be focused.

a. Time criticality – Reduction in procurement cycle time

- Select correct solution components while implementing IT solutions. Wrong selection of solution components may lead to higher administrative times in process execution and can also increase complexity of the process execution. Example – creating material master/ part master/ item master for each photomask is not a good idea considering uniqueness of photomask.
- Analyze the potential for process automation to reduce number of keyboard strokes and mouse clicks. It will not only reduce the cycle time but will also achieve quality documentation.

b. Data security

Various countries have already established data protection regulations to secure the data. Photomask designs can be considered as IPs of the organization. Any misuse/ leakage of the data can lead to business risks and financial losses.

- Security teams should provide only relevant data access to individual roles within photomask procurement. Encryption/decryption techniques in the data flow provides additional security to data.
- Optimize data footprint – ERP implementation teams should avoid duplicating the data of photomask drawings, technical attributes and commercial data. During IT solution implementation, there is an inclination to store all the data at one place to ease the reporting and hence replication of data is preferred in case of multitenant IT implementations. The inclination should be avoided.

2. Solution scalability and flexibility

Digital technology is growing with lightning speed. Artificial Intelligence, Machine Learning, IoT are driving the world and are already part of day-to-day life. Due to increasing applications, chip and photomask designs are changing and are getting more and more complex. Considering the possibility of change in the number of attributes that describes the photomask, IT solution should be scalable and flexible enough to accommodate these changes in the photomask attributes.

3. Solution maintenance

Selection of 'best fit' system components helps to come out quickly from situations like system maintenance, system upgrades. This is especially important for photomask underlining time criticality of the business process.

Illustration of system components for photomask procurement, considering SAP system as system of records and reporting:

Process	Data Maintenance	Requisitioning	Ordering	B2B Communication	Receiving	Invoicing
SAP Components available for the solution	<ul style="list-style-type: none"> • Generic Material Master for group of photomasking • Business Partner • Purchase Info-records condition Records for pricing • Document Management System + Classification system for photomask technical attributes 	Manual Purchase Requisition	<ul style="list-style-type: none"> • Purchase Contracts • Ad-hoc purchase Orders/ call-off Purchase Orders • Pricing based on PIR, Condition Records 	<ul style="list-style-type: none"> • EDI Communication • Using middleware like Web-methods, XI/PI 	<ul style="list-style-type: none"> • Goods Receipt using Purchase Order • Goods Receipt using inbound deliveries 	<ul style="list-style-type: none"> • Paper Invoicing • E-invoicing • ARIBA invoicing

Summary

ERP implementation for photomask procurement process deserves special attention while mapping the process. Implementation teams should ensure that IT systems are not introducing delays in this 'time critical' process. Selecting right system components, keeping data security aspects in design and designing future-ready solution are keys to photomask procurement process implementation in IT systems.

References

^[1] <https://semiengineering.com/semiconductor-photomask-revenues-predicted-to-increase-in-2021/>

^[2] <https://www.semiconductors.org/wp-content/uploads/2021/04/4.5.21-SIA-supply-chain-submission.pdf>



Nikhil Ankalikar has 19+ years of industry experience including 17 years of SAP consulting experience across globe. Nikhil has specialization in sourcing and procurement, inventory management and warehouse management. He has delivered SAP solutions for industries namely manufacturing, construction, process, FMCG, trading and semiconductor. In last 7 years, he is designing SAP solutions for semiconductor industry.

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