PRESENTATION 1- Eitan Oppenhaim

Slide [1]

Thank you, Miri, and thank you all for joining us. My name is Eitan Oppenhaim, the CEO and President of Nova and I will host this event today.

Last year we met virtually, and it worked very well for many of you, so we have decided to do it again this year. Yet, I recently had the great pleasure of meeting many of you again in person and will continue doing that in the next conferences as well.

Slide [2]

During the session today we will share with you the recent developments and changes in the company, including our new strategic plan, financial framework and guidelines, the market's current and future dynamic ecosystem, and the company's exciting technology directions.

With me today, I have Dror David, our CFO, Zohar Gil, our CMO, and Shay Wolfing, our CTO. Together, we will aim to cover everything you may be interested in, including Q&A time at the end of the last session.

Slide [3]

Following our results for the first half of 2022, and the released guidance for the third quarter, 2022 is shaping out to be another strong year for Nova, demonstrating the company's bold innovation, forward momentum, increasing resilience and most significantly – our growing relevancy to our customers in the most advance technology nodes.

Our industry has seen accelerated growth this year, against the backdrop of a challenging supply chain, dynamic geo-political and economic uncertainties. Despite these headwinds, Nova continued to outperform in 2022 due to our ability to execute a clear long-term strategic plan which we put forth over the past five years. We built this plan on pillars of technology differentiation, organic and inorganic growth engines, and revenue diversification. With the 3rd quarter guidance in place, 2022 is shaping out to be our best year ever.

Slide [4]

In 2022 we reached several significant milestones and charted a course forward.

- Over the past 4 quarters (Q3 21 to Q2 22) the company revenues exceeded 500 million dollars in revenue, realizing the Nova 500 plan and cementing the fundamentals for our future growth. With nearly half a billion dollars in our cash reserves post the recent ancosys acquisition, and almost a third of our overall R&D investment going into innovative technologies, we are ready for the next phase in our journey.

- Our strive to outperform continues this year as our reported results for the 2nd quarter represent a 50% revenue growth in H1 22 over the same period last year.
- Another milestone we reached this year as part of our Nova 500 plan was the acquisition of ancosys which reflects our expanding presence in the materials arena, which we expect to grow significantly in the next few years.
- With this acquisition, we can now offer a broader solution to our customers, that offers dimensional, materials and chemical metrology insights under one umbrella. This acquisition will also set us a good entry point to the growing advanced packaging market, which is getting closer to the FE standards.
- With the integration of ancosys, Nova now operates with 3 full P&L divisions – Dimensional, Materials, and Chemical metrology.
- There is no doubt that supply chain and production capacity are becoming major items to handle in this environment. We have not missed a beat in our deliveries during the last 3 years and we are currently in the advanced stages of building additional production capacity to support our next growth milestone. In this current global political uncertainty, Nova decided to distribute its manufacturing over 3 sites (US, Germany, and Israel) to maintain benefits and avoid potential restrictions.
- **Slide [5]**
- If we take a brief look at our performance in the last few years, we have been meeting our expectations to double the company revenues every 4 to 5 years on average. We could do so by leveraging the company's solid technical fundamentals, and strong culture, which is centralized around the people, religiously sticking to our strategic goals and executing them well.

- Our ability to outperform the industry growth pace, and achieve annual records and high CAGRs in the last few years, is the result of several elements beyond pure market share that is growing as well:

    1. The first one is the expansion of our portfolio beyond traditional OCD to other growing areas like materials and chemical analytics. By that we don't only increase the total available markets but also increase Nova's overall value to its customers.
    2. The second is our ability to focus only on differentiated technology that can set us apart from the competition. By now all our products, including the traditional ones have a differentiation factor.
    3. The 3rd one is our innovative approach to come up with new metrology solutions that have not existed inline before. We did that with Prism, Elipson and Metrion. All of these are organic engines developed in house.

4. The final is what we have been preaching for the past 5 years - the diversification of our revenue mix. By now we have succeeded in diversifying our markets, customers, geographies, and technology. We believe that a well-diversified company is better positioned to grow and overcome cyclicality in the market.

Slide [6]

So what does our portfolio look like after the ancosys acquisition?

You already know that Nova's main goal is to deliver process control solutions, which means we provide highly accurate dimensional and materials measurements through the fabrication of advanced chips constructed on silicon wafers. Our technology supports the measurement of small devices in a sub-Angstrom environment, in other words, less than one ten-billionth of a meter.

We approach process control from two different angles. On the one hand, we shine light or X-ray beam onto a wafer and, using the reflection, as well as smart, highly advanced physical and mathematical models, measure the dimensional and materials properties of the transistor. On the other hand, we also employ chemical analysis methods to analyze the advanced materials our customers are using today, to ensure that the materials components behave according to the design.

All of our 3 main product lines are using our advanced SW to combine physical modeling with machine learning schemes to extract better results from the Hardware and predict the range of the next measurement..

Why is it becoming so difficult in our industry?

Three small examples for what is happening to semiconductors devices.

- In vertical NAND we see growth from 64 layers just a few years ago to more than six times as much in the near future.
- The bump pitch in advanced packaging decreased thirty-fold
- and in Logic, we saw a growth of one-hundred times more transistors on a chip, in just a few years.

Slide [7]

Before speaking about the industry drivers and its relations to Nova, I would like to spend few minutes on the technical engines that increase metrology intensity and attach rate beyond the overall chip demand.

Back in the days of Moore's law, architecture was a key player in driving changes in device structure when scaling. Although today this is not the only method to improve performance, changes in architectures always drive metrology intensity to new heights. Looking across the semiconductor segments, all 3 types of devices (Logic, NAND and DRAM) continuously undergo intensive architecture changes to improve performance. Each of these complicated technical

transition increases the demand for metrology, driving metrology intensity higher in every new node.

In Logic, and specifically now after the adoption of EUV, we expect that scaling will continue to sub nanometer devices. While new challenges continue to emerge in FinFET, we also start dealing with the highly complicated various forms of nanowire.

In NAND, we're seeing a dazzling number of layers in VNAND moving from one deck to triple-deck structure, combining thinner layers and different materials.

And in DRAM we continue to see aggressive scaling in the sub 16nm with plans to move to 3D devices.

At the end of day, it is a simple equation: The more complex chips and transistors become, the higher the demand for dimensional metrology.

Slide [8]

- On the materials side, things are becoming just as complicated. Changes in scaling and architecture can improve performance to a limit. The next element emerging to improve performance is the introduction of new materials and compositions, which are less stable than traditional ones. This means adding more process steps, new critical applications, and demand for tighter process control.
- Therefore, we're witnessing exponential growth in the number of applications utilizing materials metrology. We now see three to four times as many applications running on our tools as we did just five years ago.
- As a result, Nova's materials metrology solutions are moving from in fab (meaning a couple of tools in a FAB) to a complete inline, high volume manufacturing process control tools.

Slide [9]

As we turn to packaging, we see clear indications that manufacturers are beginning to view advanced packaging as part of the Front End wafer fabrication process. As a result, the demand for stability, yield and quality is growing and the utilization of metrology tools is increasing.

- In the advanced packaging domain, we're moving the evolution from Fan-out to 3D designs, creating numerous combinations and new substrate materials. This creates more variations of chemistries than ever before.
- Feature size and device complexity lead to more process steps raising the number of interconnect layers from 8 in a Planar logic device to 17 in Gate All Around. Every layer has its own platers, baths, and cleaners – and as a result, requires more chemical control.

- All this leads to a constant need to monitor bath purity and solution stability.

The result is a growing need for inline monitoring of the various chemistries in both Front End and BackEnd, and for more frequent monitoring to meet the tighter specifications.

- **Slide [10]**

With that we can focus now on the overall demand environment.

We are carefully monitoring the market dynamic which is now driven not only by supply and demand schemes but also by some trade restrictions and financial sensitivity in the markets. Although we should expect some volatility in the demand scheme through the next few quarters (mainly by the weakness of the traditional drivers like PC and mobile which impact memory supply and prices), we still believe in the industry's secular growth and strong long-term structural demand drivers.

The First one (as charted on the left) relates to the demand driven by the accelerated digital transformation, which boosts several drivers, that will continue growing in the next few years, like IOT, Automotive, AI, High performance computing and data management infrastructure.

Second, are structural changes in industry fundamentals.

1. In each application, from car to mobile to a server, the content of semiconductors is growing and most of that can be supplied by the trailing nodes which are also experiencing growth.
2. The investment in technology transitions in the transistor size and shape in all 3 segments is imperative to improving performance and must take place a few years before reaching high volume manufacturing. The investment in these R&D lines is significant.
3. The EUV adoption can compensate for some limitations of MOORE's law and accelerate scaling in Logic as the cost per transistor is reduced.
4. Following the issues in supply chain, countries and continents are looking differently at semiconductor infrastructure and invest heavily in programs that stimulate local investment and independence. AS a result, there is a growing amount of new fabs globally to set this infrastructure.
5. And finally, adjacent markets to the front end are starting to improve their technology and therefore invest in metrology and not just in inspection anymore.

The third driver family includes the growing use of materials process control inline right next to the process tools. We expect that this area will grow more than the average CAGR of process control.

Slide [11]

Everything I reviewed so far explains the foundations we laid and our confidence in the company's growth. If we carefully review the milestones we reached in 2022, we can say safely that the Nova500 plan has been achieved and materialized through the last 4 quarters.

- In the last twelve months, we exceeded 500 million dollars in revenue, while meeting our financial model.
- Executing our organic growth plans, we introduced three new technologies to the market, all highly innovative and differentiated.
- Leveraging our expanding portfolio, we were also able to increase our overall market share, securing larger deals and providing a full portfolio of solutions to new fabs.
- We diversified our revenue mix with balanced geography, customers, segments and product contribution.
- We also executed on our in-organic growth path, acquiring ancosys and already reaching accretive value.

And now, we are ready for the next challenge.

Slide [12]

So what is our new strategic model? Our new target is to reach one billion dollars in revenues by the end of 2027.

We believe that the strong fundamentals we built over the last few years can support our aggressive target. The plan includes several pillars.

- Our new technologies' adoption and proliferation rates in the coming years.
- Introducing new technologies we're currently working on.
- Growth in our chemical analysis business.
- Our materials metrology leading portfolio that matches the market growing challenges.
- The continued diversification of our markets into BE.
- and further M&A activities.

Dror will elaborate more about the financial model to support this plan and Shay will discuss further technology avenues in our core organic capabilities.

- **Slide [13]**

- A key component in our ability to outperform our industry and peers, and to keep up with the pace of the market, despite supply chain issues, has been the constant growth in our production capacity.
- Smart supply chain management coupled with efficient and automated production, allowed us to more than double our capacity in the past five years, and to double it yet again in the

coming 5 to support our plan to reach 1 Billion in revenues, which means growth in all product lines.

- Since we have this investor day virtually, I would like to take you on a short tour of our global production manufacturing facilities.

Slide 14:

Now that we're back, let's talk about the two main elements of our growth engines - organic and inorganic. The next two slides show the pillars of our strategic plans in these two areas.

The first one is organic growth, where we still believe that the drivers have not changed and include the following.

The first one is our Differentiated technology. Nova is the only company that has materials, chemical and dimensional metrology solutions as part of its metrology portfolio. We continue searching all the time to expand this offering.

The second is the combination of physical and machine learning software capabilities to enhance hardware capabilities and provide an artificial intelligence-based way to reduce time to solution and increase yield.

The third one is our service revenues. By leveraging our growing installed base and offering value-added services to our customers to improve productivity, utilization, and metrology capabilities. We increase the utilization of our installed base

And the last one is the continuous demand for improving lab capabilities and transferring them to inline tools.

Slide [15]

Regarding the inorganic engine, *we* remain aggressive in our M&A plans and we continue screening multiple relevant targets and industries.

Our criteria for finding the right acquisition remain true :

The first one is early access to lab technology that we can convert into inline and in fab capabilities as we have done with XPS, ELIPSON and METRION.

The second is enhancing our materials metrology, to continue our leadership in this segment.

The third is expanding our software machine learning capabilities to stretch and enhance our hardware performance.

And finally, to keep looking at the semiconductor adjacent market like advanced packaging and compound semi.

As we work towards our next acquisition, we're already seeing the fruits of our recent one. ancosys, our new chemical metrology division, has secured a record quarter in Q2 and is well on its way towards a record year. The synergies we identified are happening faster than initially

expected. We are in the advanced stages of integrating ancosys into Nova, and as we quickly understand the challenges, we're already able to solve some of them, leveraging Nova's Front-End sales channels to expand ancosys reach into these customers as well.

These slides conclude my part. And with that, I would like to invite Dror David to discuss Nova's financial performance and future directions. Dror?

PRESENTATION 2- Dror David

Slide [1]

Thanks, Eitan.

Good day everyone and thank you all for joining our analyst and investor day.

Slide [2]

My name is Dror David, and I am the Chief Financial Officer of Nova.

I joined Nova in 1998, just before its initial public offering on the Nasdaq in the year 2000, and I have served as the CFO of the company since 2005.

Since my appointment in 2005, Nova has grown its annual revenues by 20 times, and its market cap has grown, more than 50 fold.

I hope and believe, that the Nova 1B plan we are sharing with you today, will reveal another step function in Nova's performance and shareholders value, in years to come.

Slide [3]

In my presentation today, I would like to demonstrate how the company realized the previous strategic plan of Nova 500, and what are the fundamentals, and the expected financial performance, moving into the Nova 1 Billion plan.

Slide [4]

So first, let's look at Nova's execution of the 500 strategic plan.

Slide [5]

Several years ago, we illustrated our financial targets, in all relevant elements, including revenues, profitability, and earnings per share, for the Nova 500 strategic plan.

During the execution of this plan, the company demonstrated a balanced operational and financial execution, coupled with continued investment for growth, in all elements of infrastructure, technology and customer relations.

I am happy to announce, that the company was able to meet or exceed, all of the communicated targets.

Slide [6]

Nova's performance in the last 12 trailing months, marks the final implementation of the Nova 500 plan. The company presented a record revenue level of 510 million dollars; gross margins of 58%, within the target model; operating margins of 33%, well above the target model; operating income of 166 million dollars; and, earnings per share of 4 dollars and 78 cents, meeting the anticipated earnings per share power, of more than 1 dollar per quarter.

In addition, through the execution of the plan, the company was able to increase its services revenues, from only 60 million two years ago, to an expected level of more than 100 million in 2022.

All in all, we can clearly see the company's ability to execute its stated targets, in all operational and financial aspects.

Slide [7]

Furthermore, looking at Nova's performance in the first half of 2022, as we exit the Nova 500 plan, we can clearly see that the company's profitable growth trend continues.

Revenues in the first half of 2022 grew approximately 50% over the same period last year, and we believe this represents one of the fastest growing results, for a wafer fab equipment company, in the first half of 2022.

Moreover, across the same period, profitability grew at a faster pace, with operating income growing by approximately 70%, and earnings per share growing by approximately 60%, to more than 2.5 dollars per diluted share, in the last 6 months.

Slide [8]

In parallel to executing the product roadmap, and customer penetration plans, the company also invested in the following areas, over the past several years:

- We invested approximately 50M in capital assets, including a new corporate office and lab facility in Israel, and a new facility for our US operations
- We invested approximately 50M in working capital, including building inventories through the covid 19 pandemic to ensure customer delivery.
- And, we invested approximately 100M in the acquisition of ancosys, including its post-merger integration into Nova

In parallel to these important investments, which will serve us in the coming years, we raised 200M in convertible debt due 2025, bearing zero interest rate, and repurchased company shares in the amount of approximately 30M.

As of today, the company's gross cash reserves grew to approximately 500M, enabling us to continue and build aggressive plans, for future growth and investments.

Slide [9]

It is clear, that the company is concluding the Nova 500 plan in a much stronger and more diversified position, so let's move on to discuss the fundamentals of our 1 Billion strategic plan.

Slide [10]

In recent years, we have repeatedly mentioned, the diversification and wide reach of the company's revenues sources, spanning a broad spectrum of customers, regions and applications.

Given the current wide verticals of demand in semiconductors, as well as the tectonic changes in semiconductor manufacturing, including the trade wars, local chip acts, and geopolitical uncertainties, we believe this widespread exposure, provides Nova with a significant advantage.

As a result of this broad presence, we can capitalize on various demand cycles, different applications, and multiple manufacturing shifts across customers and territories.

For example, in 2022, we saw and expect to continue and see, a strong demand in logic and foundry, coupled with some softness in memory investments. Consequently, Nova's revenue distribution, was approximately 70% from logic and foundry, in the first half of 2022, relative to 50% a few years ago, when memory investments were stronger.

In parallel, we see an extensive demand for advanced technology nodes in high-end applications, such as autonomous cars and AI on the one hand, and simultaneously a strong demand for trailing edge technologies and devices, on the other hand. Our wide position across the different customers serving these different markets, allows us to capitalize on both trends.

And, most importantly, especially given the on-going trade war, and increasing government involvement in semiconductor manufacturing incentives, including the recently announced chip acts in the US and Europe, Nova's revenue distribution is also balanced across all key territories.

It is important to note, that the company's revenue stream from the U.S. is on the rise. The company has a manufacturing and research site for X-RAY applications in California, and plans to open a new innovation center, and several service and sales offices, across the US, closer to customers manufacturing sites. This widespread presence and position in the US, is especially important, given the significant plans by three major customers, to open new leading edge manufacturing sites in the US, starting in 2023.

Slide [11]

In addition to the overall market segments and geography exposure, we see new green field front end fabs and customers in China.

We see additional US and European customers, which were dormant for a few years in terms of capital investments, starting to invest in trailing edge applications.

And, we increased our exposure to the backend customer base, which is highly diversified, through the acquisition of ancosys, a market leader in providing chemical metrology, to semiconductor backend processes.

As a result of these trends, the company spending customer base, has recently increased significantly, from 20 to 30 spending customers in recent years, to approximately 50 spending customers in 2022, including new backend customers related to ancosys acquisition.

Most of these additional spending customers are obviously small, with a potential contribution of less than 5% of total annual revenues. However, they contribute to the company's diversification, allowing the company to expand and offer additional existing and new solutions for a broader customer base.

Slide [12]

Another important revenue growth engine, that is fundamental for the Nova 1B plan, is the service business.

Service revenue growth has accelerated in recent years, in parallel to the company's installed base growth.

In 2022, we expect service revenues, to cross the 100M revenue mark, presenting more than 25% growth over each of the last two years.

In parallel, we expect the installed base to cross 5,000 systems, within the next 18 months.

As a result of this high number of installed systems, combined with expected high semiconductor manufacturing utilization rates, and our plans to introduce additional value-added services and packages, we expect the service business to continue and present, double digit growth in the coming years, and to represent approximately 20% of the company's total business.

Slide [13]

As you all know, the company has several new product lines, which only recently started their market adoption phase. Such adoption involves a complex transition of technology from lab to fab, and a long process of customer-by-customer evaluation and education.

The potential volume impact of such transition, materializes when customers move to near line and in line usage of such technologies.

For Metrion and Elipson, we expect this transition, to happen gradually over the strategic horizon of the Nova 1 Billion plan.

Slide [14]

Overall, as Eitan previously discussed, and Zohar will elaborate later on, Nova is riding several business tailwinds, which are part of the Nova 1B fundamentals.

These tailwinds include:

The overall semiconductor market and TAM growth in the strategic horizon.

Nova's unique and differentiated product portfolio, including software, enables the company to win market share in its core markets.

The high value of the new technologies, which further expands the company's addressable markets and customer value creation.

And, the leveraging of the company's active installed base, and presence at more than 200 manufacturing sites globally.

Slide [15]

However, on another current of these positive business tailwinds, we face known challenges in the company's cost structure. These challenges involve macroeconomic trends beyond our control, which nevertheless significantly impact our cost of doing business.

We see continued supply chain constraints, and higher inflation rates on a global basis, impacting the cost of raw materials, cost of employment, and cost of travel.

Slide [16]

Combining all these elements, we believe the company will be able to reach the 1 Billion revenue mark during the next 5 years, through organic and non-organic growth. If, or once, we execute this growth plan, we will be able to continue the company's growth trajectory in the past 2 decades, during which Nova generally doubled its revenues every 5 years.

Slide [17]

The combination of significantly wider technology and product base, together with expected cost pressures, dictates the following targeted financial model, for the Nova 1B plan, organically.

On the gross margin front, we believe that the company's continued expected revenue growth, coupled with an expanded offering of high value and high gross margin products, such as software and new technologies, will enable the company to target gross margins between 57% and 59%.

Considering operating expenses, given our growth plans, we will obviously need to continue to invest in R&D & SG&A. Our model assumes that R&D can range between 15% and 18%, and SG&A can range between 13% and 15%.

As such, at the 1 Billion revenue level, we are targeting operating margins of 27% to 31%. This operating model does not include the impact of new acquisitions, which are yet to be examined and determined.

On the tax front, under current tax rules in Israel, US and Germany, we expect the effective tax rate to be approximately 14%.

The Share count for diluted earnings per share, is expected to remain at approximately 32 million, as we continue to execute the announced 100 million dollars shares repurchase plan, which will offset the impact, of fluent stock-based compensation plans.

All in all, we believe that this plan presents a balanced approach, of combining investment for growth, in parallel to increasing shareholders value, and can lead to an annual earning power of more than 7 dollars per diluted share, on a non-gaap basis.

Slide [18]

To execute this aggressive plan, we will continue our investments in global infrastructure, including offices, innovation centers, clean rooms and manufacturing spaces .

Given the need for effective communication and information management tools between the different sites, and given the rising cost of prevention and protection related to cyber security, we also expect to increase our investments in information technology, on a global basis.

Most of these projects are already undergoing, expected to conclude within the next 2 years, and are important building blocks, to our ability to execute the Nova 1 Billion plan.

Slide [19]

From gross capital allocation and investment for growth perspective, through the execution of the Nova 1 Billion plan and over 5 years, we expect to invest approximately 20% of the revenue growth in working capital, which is approximately 100M.

We expect to invest approximately 100M in capital assets.

And, we expect to continue and execute the previously announced 100M share repurchase program.

Considering all these elements together, including the expected fluent operating cash flow of the company, we expect to be able to use approximately 700M for future inorganic opportunities, through the Nova 1 Billion strategic plan, and we expect to invest approximately 500M, in R&D expenditures.

These ventures accumulate to a significant 1.5 Billion dollars of gross investments for growth, over a 5 year period, which is a significant step function, relative to the comparable 0.5 Billion investment, in the past 5 years.

Slide [20]

Before I conclude my presentation, I would like to refer to Nova's inorganic approach and screening elements.

As Eitan mentioned, our main goal for M&A is to accelerate growth. We are searching for a complementary combination of end markets and customer outreach, such as backend and frontend, as in the case of ancosys acquisition.

We are searching for complementary technologies, such as the combination of know-how between x-ray and optics, which can enhance the company's product portfolio and holistic approach for advanced customers.

And, we look for businesses that can be accretive within the first year of acquisition closing, and can improve earnings per share, and enhance shareholders' value.

Given the size of the company, and its cash reserves and market position, we believe the company will now be able to screen and execute, both incremental and transformational acquisitions in parallel.

With this I conclude my presentation, and I will now move the discussion to Zohar Gil, Nova's Chief Marketing Officer.

Zohar Gil

Slide [1] Presentation title

Slide [2] Bio

- Good day – I'm Zohar Gil, and I've been with Nova for 11 years.
- In my role, I focus on the company's corporate marketing, corporate strategy and portfolio strategy activities.
- Before joining Nova, I worked for 15 years in global high-tech companies.
- I have an academic background in engineering and business.

Slide [3] Framework

In my talk today I will discuss the framework that supports the Nova 1 billion strategic plan, focusing on market trends and Nova's product portfolio aspects.
I will start with a review of the engines that will drive secular growth of the semiconductor market in the coming years.
Then I will discuss the key drivers and factors for continued intensified investment in capital equipment.
In the last part of my talk, I will review Nova's portfolio in the key segments of dimensions, materials, and recently added chemical metrology, explain the product strategy, and link it to the market growth drivers.
My talk will focus more on the trends influencing the next 4-5 years that correlate with the Nova 1 billion strategic plan and less on the shorter-term trends influenced by the geopolitical and economic uncertainties.
So let's start with the semiconductor market review…

Slide [4] Market Demand Catalysts

Looking ahead, as our world is increasingly becoming connected, digitized, and intelligent, the demand for semiconductors is driven by trillion of "things", compared to millions and billions of devices in previous decades. And there are multiple vertical markets and applications requiring semiconductors that are expected to grow at double digit figures in the next 5 years and serve as the catalysts for growth. As a result, the semiconductors market is expected to reach almost $800 billion in 2026. In the next slides want to focus on several examples. Starting with the automotive semiconductor segment…

Slide [5] Automotive

The automotive industry represents a major growth engine for semiconductor in the next 5-10 years, driven by the transition to electrical and autonomous vehicles. This growth stems from the shift to advanced driver-assistance systems (ADAS) that instantly process critical data and require multiple interconnections within the vehicle, high-performance chips, and more sensors, cameras, lasers, LiDAR, and other computer-electronics devices.

Semiconductors' content value will increase 6 times in the transition from non-automated to highly and fully automated vehicles. As a result, the automotive semiconductor market is forecast to reach over 16% CAGR in the next 4-5 years and approximately $100 billion.

As the automotive industry transitions to a higher level of automation, high performance chips will account for a more significant proportion of autonomous-chip revenues than sensors, driving increased demand for leading edge semiconductor technology.

The next segment is artificial intelligence…

Slide [6] Artificial Intelligence

Artificial Intelligence functionality is a requirement for many new products and represents a major growth engine for semiconductor revenue in the next 5 years. Artificial Intelligence semiconductor revenue relates to devices designed specifically to execute the algorithms associated with deep neural networks (DNNs) used in AI. This primarily includes application, graphic and micro processors.

The key trends influencing the growth in AI semiconductors in the next 5 years are 4-5 times increase in usage of AI enabled GPUs and processors deployed in Data Centers and the growing adoption of AI functionality used in consumer electronic devices. For example, by 2026, 50% of basic smartphones will utilize application processors with integrated AI functionality, up from 15% in 2020.

As a result AI semiconductor revenue will grow by over 50 billion dollars in the next 5 years, representing a CAGR of 26% from 2020.

Slide [7] Cloud

The 3rd growth engine is cloud semiconductors, which is the backbone of the data-based world. Cloud related data is exploding, with the increase in IoT connected devices and cloud based applications across multiple vertical markets. The total amount of data created, captured, and consumed globally is forecast to rapidly increase, from 64.2 zettabytes in 2020 to over 180 zettabytes by 2025. In line with the strong growth of the data volume, the storage capacity is forecast to increase, growing at double digit CAGR in the next 5 year.

As a result, cloud semiconductor revenue will grow at 11% CAGR in the next 5 years and reach over 140 billion dollars by 2026.

Slide [8] Summary of Semi Market

Summarizing the trends for the semiconductor market in the next 4-5 years, the total semiconductor market is expected to grow at CAGR of 5.6% and reach $780 billion dollars. Although the current uncertainty and potential headwinds in world-wide economy can influence the market in the short term, we see multiple growth engines on the horizon of the Nova 1 billion strategic plan that will drive semiconductor revenue and investment in advanced technology forward.

Slide [9] Transition slide

Next I want to discuss the trends impacting the investment in Capital Equipment for semiconductor chip manufacturing and packaging on the horizon of the Nova 1 billion plan

Slide [10] Wafer Capacity increase

First, let's look at the impact of increasing chip sizes of advanced processors on wafer capacity demand in leading edge nodes.

The transition to multi core processor architectures required for enhanced performance, has significantly increased the die sizes of these advanced chips. In the past 5 years CPU die sizes have doubled and GPU dies sizes increased by 50%. As a results data center processors are 2-3 times larger. This phenomenon also impacs Personal Computing processor chips, resulting in 2-3 times increase in chip size due to multi-core, GPU and neural engines, designs as illustrated in the diagram at the bottom. This means that wafer capacity demand will grow proportionally in order to produce the same amount of chips, increasing the demand for leading edge wafer capacity.

Slide [11] More Process Steps

Second is the number of process steps in advanced logic and 3D memory nodes. In logic, since the transition to 14nm FinFET transistors, there has been a sharp increase in the number of process steps due to growing process complexity. This growth is expected to continue with the transition to gate all around and future transistor technologies, which Shay will expand on in his presentation.

In memory, the number of process steps almost doubled in the transition to 3D architecture and continues to increase by about 10% as 3D-NAND chips evolve from single deck to multi and triple deck architectures. We know that future DRAM designs are heading towards 3D architecture, which will have a similar impact.

Slide [12] Capital Investment

As a result of the rising complexity in advanced logic and 3D memory manufacturing processes, the capital investment per wafer has increased dramatically, as observed in the diagram on the right, driving an increase in wafer fab equipment investments.

The diagram on the left shows the incremental annual growth , over a period of 11 years , taking 2010 as the base year. We can see that wafer fab equipment's CAGR was 10.2%, while critical dimensions and films' optical metrology CAGR was 13.6%. The increased capital intensity for metrology emphasizes its growing importance and value for advanced semiconductor manufacturing. We expect this trend to continue in the future.

Moreover, Nova products CAGR over the same 11 year period was 15.1%, outperforming the optical metrology market and increasing our market share.

Slide [13] Investment in trailing edge

The next point is related to capital investment in trailing edge nodes.

Historically, investments in Semiconductor manufacturing capacity were driven primarily by demand for leading edge logic and advanced memory chips. However, in the last few years the capital investment for trailing node foundry capacity has increased by 2-3 times compared to the previous 4-year average. In 2021, TSMC invested 20% of its total CAPEX in specialty technologies compared to 10% in previous years.
This trend is driven by the growing demand for IoT and sensors that do not require leading edge technologies and is expected to continue in coming years with the transition to 4th tectonic shift in computing, resulting with 10's of billions of IoT devices made with chips on trailing nodes.

Slide [14] Advanced Packaging

Moving to the packaging space we are seeing the evolution to High-End Performance Packaging technologies including flip chip, fan out and 3D packaging with higher I/O density, smaller pitch and enhanced performance.

The use of hybrid bonding and chiplet technologies will enable near monolithic performance and further increase demand for trailing edge nodes.

Advanced packaging revenue is expected to reach $57 billion in 2027 with CAGR of 10% for the entire packaging market and 19% for High-End Performance Packaging.

Capital investment for High-End Performance Packaging represents 70% of total CAPEX and is shifting from OSATs to Integrated Device Manufacturers and Foundries as the production and process control requirements are becoming similar to Front-End Fabs.

These trends are increasing the TAM for process control and metrology solutions that Nova delivers to the packaging market.

Slide [15] Deglobalization

On top the of trends in leading edge, trailing edge and packaging markets, the growing importance of deglobalization and Semiconductor Nationalization is expected to drive Higher CAPEX in the coming years.

Summing the global incentives such as the chip acts, 2030 Digital compass, made in China 2025, and more, governments incentives to support their local semiconductor industries amount to an annual value of 84 billion dollars for the next 5 years.

With the announcement of government incentives and subsidies around the globe, semiconductor manufacturers have increased their investments, announcing approximately 109 billion dollars of annualized CapEx over next 10 years.

Slide [16] Transition

After discussing the key trends for continued intensified capital equipment spending, In the last part of my talk, I will present Nova's portfolio and the product strategy that support the Nova 1 billion plan. Later, Shay will discuss the technologies and use cases in further detail.

Slide [17] Nova portfolio

Since our meeting last year we have expanded our portfolio both organically and inorganically, with the acquisition of ancosys. Our offering to customers now includes dimensional, materials and chemical metrology solutions that are enhanced by cutting-edge algorithms and big data fleet management solutions.

- In the dimensional metrology space, we continue to be the market leader for integrated metrology and offer the unique Prism stand-alone metrology solution, utilizing spectral interferometry technology.
- In the material metrology space, we introduced the Nova METRION, which is the industry's 1st fully-automated SIMS process control solution, targeted for in-line compositional profiling.
- Our portfolio now includes the market-leading and well-established inline XPS solution as well as two new disruptive and innovative material metrology platforms utilizing SIMS and RAMAN technologies.
- In the recently added chemical metrology solutions, we offer the most comprehensive and modular chemical analysis, process control and replenishment solutions targeted for the packaging and interconnect metallization processes.
- Our software algorithmic suite combines physical and machine learning schemes that improve the metrology performance across all our product lines and shorten the time to solution.
- Lastly, our fleet management solutions utilize big data technology and improve the operational efficiency and maintainability of our large fleets in complex high-volume production environments.
-

Slide [18] Product Strategy

In terms of product strategy:

- In dimensional metrology, we plan to sustain our market leadership in the integrated metrology space, expand the adoption of our unique Prism standalone platform and penetrate new segments such as advanced packaging
- In XPS materials metrology, we continuously increase the application space with our most advanced generation of VerFlex, extend the adoption in high-volume production fabs by all our key customers and penetrate new segments such as mixed-signal and advanced packaging.
- In the new materials segment of SIMS and RAMAN, we plan to broaden customer adoption, develop new applications and drive the adoption from R&D to inline and HVM.
- And lastly in the chemical metrology space, we plan to maintain our leadership in the packaging space with growing capital investments, expanding adoption in damascene interconnect and penetrating new segments that require high-performance chemical metrology solutions.

Across all our solutions, we plan to continue high levels R&D investment in both hardware and software solutions and focus on differentiation and innovation to support our ability to outperform the market going forward, as we did in the last decade.

Slide [19] Summary

To summarize my talk on the market drivers and growth engines for Nova 1 billion plan:

We see a healthy market on the horizon of our strategic plan and expect secular semiconductor market growth in the next 4-5 years, driven by multiple demand catalysts as our world evolves to be more digital, intelligent and connected.

In terms of capital investment, we expect the demand for leading-edge capacity to grow, driving an increase in metrology intensity and investment.
The investment in trialing edge and advanced packaging will continuously increase, driven by the growing demand for IoT and sensors and the need for high-performance packaging solutions.
Semi deglobalization will further increase overall capital investment with government incentives to support local semiconductor industries.

Our unique portfolio, continuous investment in differentiated capabilities and development of new technologies will drive our growth in our established markets, empower diversification to new industry segments and enable us to outperform the market as we did in the past 10 years.

This concludes my part. And with that, I would like to invite Shay Wolfling to discuss Nova's unique technology for exponential growth. Shay?

Dr. Shay Wolfling

Slide [2] - Bio

Thanks, Zohar.

Good day – I'm Shay Wolfling, responsible for Nova's technology development for the past 11 years.

Before joining Nova, I was at KLA, to which I joined via 2 acquisitions.

I had my own startup company, with innovative 3D technology, which was acquired by ICOS, a Nasdaq traded company in Belgium.

Then, 2 years after I moved to Belgium, ICOS was acquired by KLA.

I have a PhD in physics from Hebrew University.

Slide [3] - Outline

Following Zohar's review of the drivers for exponential growth, I will start with an overview of some of the technological trends and upcoming inflections, and the key challenges they create.

I will then focus on some of Nova's Technologies and solutions to enable this growth.

Slide [4]

First, let me expand on the technological trends we observe in semiconductors.

Slide [5] – Key Trends

{Click}

One of the key technological trends we see is the significant growth in data generation. This has multiple implications:

- As you can see in the graph the computational needs for Artificial Intelligence are growing like never before.
- In addition, the increased level of automation is driving high-performance IoT devices in a smaller volume and power.
- The breaking of data siloes, integrating data across platforms and users, with built-in analytics, is another driver for growth in data generation.

Before we will talk about some of the leading-edge architecture it is important to note that today there are multiple paths and technologies going forward.

There is an increasing diversity of development tracks and variants – in this chart you can see an example of the leading edge from the world's largest foundry.

But this is true not just for the leading edge as we see here with multiple FinFET variants, Nanosheets, material optimization etc' but also for the trailing edge nodes, as Zohar also mentioned.

The move to Chiplets and Advanced packaging also enables having each part of the complex chip in a technology optimized for it.

Finally, a significant path forward is coming from overall system integration, the so called DTCO.

Slide [6] – Scaling gets a boost

Scaling has been playing a key role in constantly reducing the cost per transistor from node-to-node, by both traditional scaling and new architectures. This is the well-known "Moore's law".

However, we need more than that to keep reducing cost and increasing density.

More than Moore means new types of integrations, new materials innovations, and full 3D both on the device level and as part of full 3D packaging.

Slide [7] – Technology Inflections

In many of the process steps there are new solutions and technology inflections to drive forward the PPAC – Power, Performance, Area (or density) and Cost of the devices:

- In patterning the most significant driver is the implementation of EUV (now also with next generation of increased aperture), but there is also growth in methods where you "add" material in the desired pattern rather than etch it away.
- In Logic There is clear architecture evolution from Nanosheet to Forksheet, CFET and even initial developments of 2D materials.
- In the BEOL or interconnect – there are also new architectures of moving the top metal layers to the bottom (called Buried Power Rail) and using new materials such as Cobalt and Ruthenium.
- On the Memory front 3DNAND continues to rise high with Multiple decks and over 400 tiers, as well as with the Logic part built under or over the Memory array. To further increase the memory density, in addition to more "Tiers", manufacturers are pushing the number of bits for each memory cell – going from 3 or 4 bits per cell to 6 bits per cell.
- In DRAM, even with EUV adoption, the 2D scaling is no longer sufficient, and we already see on the horizon a 3D DRAM, with DRAM going vertical, taking a similar path to the one taken by NAND years ago.
- Finally, Advanced packaging plays a significant role in continuing to drive the PPAC forward, by various types of new integrations and by system-level and not just chip-level optimization.

In the next part of my review, I will dive deeper into the 5 highlighted inflections in Memory, Logic, Interconnect and Packaging.

Slide [8] – Dimensional & Material implications

Before diving deeper, I want to emphasize that each of the reviewed architecture and device solutions has significant process challenges with dimensional and material implications.

You may recall an earlier version of this slide, but I want to highlight a new aspect of Material optimization which is enabled by Chemical Metrology.

With the acquisition of ancosys earlier this year we added Chemical metrology to our portfolio as well as a significant presence in the growing market segment of advanced packaging.

Slide [9] – Chemical Metrology

So, what is Chemical Metrology?

In a typical plating process, the wafer is submerged in a rather complex solution of materials, and it gets plated by a metal excited by an electrical current.

In case there is any problem with the materials or the plating process, there will be issues with the resulting metal layers (voids, non-uniformity etc'). When this is detected on the wafer, it is already too late.

To ensure a stable process, it is essential to constantly monitor and control the components in the chemical plating solution already in the bath, BEFORE it gets plated on the wafer.

We monitor for multiple "main components" which have a role in the process, and secondary components which may be generated as a result of the plating.

Such monitoring is constantly done in FEOL Fabs in the Copper Damascene process and on multiple processes with multiple materials in advanced packaging.

I will show some of the technologies and use cases involved later in the presentation, but it was essential to have this introduction before continuing to dive into the key process challenges.

Slide [10]

I will now focus on the dimensional and material challenges in 5 key inflections.

Slide [11] – 3DNAND

Starting from Memory:

The 3DNAND flash Memory continues to rise high, where we are now seeing devices with over 400 "tiers" of oxide and nitride, reaching a total thickness of over 20um.

- In addition to the thickness of each tier, manufacturers must control the full dimensional profile of such high aspect ratio structures (such as the holes and the slit) and monitor key parameters at the bottom of the stack.
- To enable such a high stack with an extreme aspect ratio, the process must be "split" into several tiers, creating "decks" of layers. Each "deck" has its own tilt, and overlay shifts between the decks that need to be controlled.
- Furthermore, to shrink the devices even further the logic part is manufactured either under or over the memory array.

From Material perspective:

- Multiple dielectric films in the channel must be tightly controlled.
- Before filling the channel, the thickness (and conformality) of the deposition on the sidewall is critical.
- Once filled, the quality of the Poly Silicon in the channel is critical for device performance, so the crystallinity and grain size should be controlled.
- To mitigate some of the metal process issues (such as voids, residues, and stress), new types of metals are now being evaluated.

Slide [12] – 3D DRAM

As DRAM continues to scale and shrink, with higher implementation of EUV, we already see that this is insufficient to keep up with the required density and cost.

Thus, like the NAND Flash 3D revolution, manufacturers will slowly move from 2D DRAM to 3D DRAM.

Simply put, you can think about it as taking the current architecture and "rotating it" so now we can pack many more bits into a smaller area.

Such 3D DRAM creates various new process challenges – The structure possesses a higher aspect ratio, challenging bottom parameters, and lateral etches making thinner capacitors.

Also on the Material front, dielectric control is critical, and residues can kill the device.

Slide [13]- Logic Architecture

In the world of logic, there is an architecture evolution with a clear path in the coming years, with growing dimensional and material complexity.

We already see adoption of Nanosheets or Gate-all-Around in many customers as part of the next generation technology-node, which is a much more complex 3D architecture compared to FinFET. The complexity increases as the architecture evolves to Forksheet (adding a dielectric wall

between the N and P transistors) and to CFET, with another 3D complexity of having the NFet nanosheets transistor manufactured on top of the PFet Nanosheets. At the technological horizon we already see works on atomic channel of 2D materials, which will create a huge set of new challenges.

The manufacturing process of this logic architecture is accompanied by key dimensional and material challenges:

- Multiple nanosheets (from 3 to 6 or 7 in CFET) one of top of the other, which must be fully and individually characterized.
- Each Nanosheet has thin layers of dielectrics surrounding it, which need to be tightly controlled.

From a material perspective, there are multiple material properties that are critically impacting the end-device performance:

- The quality of the Silicon and Silicon Germanium forming the nanosheet is critical.
- The stress and strain of both the Nanosheet and the source/drain are critical to ensure device performance.
- SiGe residues and doping control are two additional properties customers want to control inline.

Slide [14] - Interconnect

As the technology nodes continue to evolve, new architectures are also being adapted in the Back-End or interconnect of wafer manufacturing.

In addition to adopting Nanosheets in the transistor level, the top metal layers (as you see on the left drawing) are moving to the bottom of the device for power delivery and top signal routing– this is called “backside Power Delivery”.

Connections to the device layers are done by wafer-to-wafer bonding and nano-TSVs – narrow nanometer size Cu vias (the “yellow” lines in the zoom image).

These architecture changes support further scaling, increase routing efficiency, and have performance and power benefits.

Again, such changes are accompanied by increasing process challenges:

- Manufacturing the High-Aspect-Ratio Cu TSVs is dimensionally challenging to etch and to plate without any voids.
- To bond two wafers together the topography and surface roughness must be tightly controlled.
- There are also significant challenges to control the chemistry to a tight window to enable Copper, Ruthenium and Cobalt plating.

Slide [15] - Packaging

As Zohar also mentioned in his talk, we see significant growth in process challenges when the process is post wafer, in the advanced packaging stages.

The optimization and evolution of advanced packaging, in multiple possible directions such as Fan-Out-Level-Packaging or 3D Integrated Circuits, in a critical part of the More-Than-Moore path.

This enables true 3D architecture of the entire device as well as the concept of "Chiplets" where each functionality can be manufactured in a different technology node, and they are then packaged together.

In addition to the dimensional challenges arising from the 3D complexity, we see tighter requirements on the chemistry to enable a stable robust process:

- Optimal plating of copper throughout the lifecycle of the bath, even when a bath gets highly saturated, includes monitoring for various process by-products.
- Contaminants and photoresist in the bath can be killers to the process and must be controlled.
- In general, quality control of wet chemicals to prevent contaminants and particles is a significant challenge.

Slide [16] – Metrology Challenges

In addition to the many process-challenges I mentioned, as one last take, I want to focus on some key metrology challenges in a variety of different axes:

- Because time to yield is critical, the time to develop a certified metrology solution keeps decreasing.
- More process steps, higher sampling and design rule shrink are **driving efficiency and metrology performance**.
- There is a growing need to measure in-die and on device, as **test structures are less representative** of the actual process.
- Abundance of new materials, and multitude of physical properties that must be controlled in-line such as **composition, chemical purity, stress and more**.
- Especially in high-aspect ratio structures, the in-line control of the chemical components in the bath is essential to ensure void-free and uniform plating.
- From a dimensional perspective, the challenges increase significantly with complex 3D devices.

- Additional challenges include controlling local variation in the device level and the need to control multiple device parameters and properties.

To conclude - process control solutions must be much faster, applied in more layers, more accurate, be applicable for complex 3D structures and new materials, be utilized in many points on the wafer and expand more physical parameters.

Slide [17] – Nova solutions

With this I will move to the last part of my presentation, reviewing Nova's solutions to these key challenges.

I will start by addressing some of Nova unique technological solutions in dimensional, material, and chemical metrology as well as in algorithms and software. I will conclude by reviewing our portfolio of solutions to some key industry components such as Nanosheets, 3DNAND and Advanced Packaging.

Slide [18] - Dimensional

Starting with our unique dimensional metrology solutions, measuring critical dimensions and complete 3D profiles.

In Integrated Metrology, where Nova is a clear market leader, we have both high-end Normal incidence solutions with best-in-class throughput, as well as the ability to combine oblique measurement channels, driving IM to the performance of Stand-alone metrology in next generation R&D nodes.

In the optical Stand-Alone, we continue to develop the NOVA PRISM, with its additional Spectral Interferometry technology, enabling complete Wavefront measurement, and adding a new dimension to the world of OCD.

Slide [19] - Materials

In the material metrology we have 3 Nova-Unique product families:

- The VeraFlex with its combined XPS and XRF capabilities continues to be the only HVM solution that enables in-die process control for composition and thickness of ultra-thin films. We see a growing adoption of this technology in high volume manufacturing.
- An optical addition to our material metrology portfolio is the Nova Elipson. The Elipson, based on in-line Raman Spectroscopy, is increasingly utilized to measure material properties such as stress and crystallinity in both logic and Memory.
- The METRION is the newest addition to Nova's Materials Metrology Portfolio, bringing the technology of Secondary Ion Mass Spectrometry for the first time into the fab. SIMS

technology is used to measure complex logic and memory stacks and obtain precise depth-profiles of material properties.

Slide [20] - Chemical

Chemical metrology is the new addition to the Nova technology portfolio, following the ancosys acquisition earlier this year.

The ancolyzer product family is a suite of flexible tools with a large variety of technologies, which are too many to review.

I will just mention two unique technologies:

- On the left is HPLC, a very advanced technique, where multiple components can be separated and measured to very high accuracy.
- Optical spectrophotometry enables direct measurement of the chemical concentration of components without using any chemical by-products.

Slide [21] – SW & Algo

Our SW and Algorithm solutions are integral to any technology development and enhance the entire metrology portfolio.

In the physical modeling, our Nova MARS is not only driving OCD performance, but is also expanding to other technologies, where physical modeling of energy-matter interaction can improve the solutions.

The adoption of our Nova FIT data-driven ML solutions continues to grow dramatically. However, it is now clear that Physical modeling and machine learning are not separate entities and best results are obtained by applying smart combinations.

As there are multiple Nova tools in each Fab, they are typically connected to enhance their performance together. We now utilize this cloud-based Fleet Management connectivity with big-data analytics to provide even better process insight to our customers.

Slide [22] – Solutions for Nanosheets

After reviewing Nova's rich portfolio of disruptive dimensional, material, and chemical metrology solutions, I will now give few concrete examples of our holistic multiple-technologies solution to some key industry elements.

Nova has proven solutions in multiple steps which are key for manufacturing nanosheets, including XPS, Elipson, SIMS and OCD SI.

I will not go to all the details but will note a few examples:

- We are measuring multiple nanosheets thickness with XPS as well as the thickness of Lanthanum oxide and High-K materials.
- With our Raman based Elipson we are measuring the stress of both the SiGe after the nanosheets etch as well as the stress in the nanosheet when replacing the metal gate. In the gate formation we measure the deposition uniformity.
- With our PRISM SI OCD we help control multiple CDs along HAR gate and fin as well as measure the indentation and thickness of each individual nanosheet.

I will zoom in on a use case for METRION in-line SIMS for SiGe deposition.

Slide [23] – METRION use case

This use case by in-line SIMS describes controlling the uniformity of the critical Silicon-Germanium deposition in the Nanosheets formation.

The concentration of the Germanium, and in particular its uniform deposition on each nanosheet, dramatically affects the selectivity of the following etch process and directly impacts the electrical performance of the transistor.

METRION In-Line SIMS is used to monitor within-layer and within-wafer uniformity:

- On the bottom graph you can see the Germanium concentration variation across each one of the 3 individual Nanosheets in one specific location.
- While on the top graph you can see the uniformity of the Germanium concentration across the entire wafer, based on 9 measurement points.

Slide [24] – Solutions for 3DAND

Moving on to 3DNAND, we also have solutions from our multiple technologies to multiple process steps.

I will note examples on two of the steps:

- After the high-aspect-ratio holes are etched, some critical deposition steps must occur. Within these steps we measure the thickness of the thin liner with XPS, detect contamination of Fluorine and Chlorine with SIMS, and measure the full channel hole profile with our PRISM SI OCD, and in some cases also with our NovaFIT machine learning solutions.
- Nova also has a unique solution for the etch of the channel holes, particularly for the challenging step of processing the top decks in a multi-deck structure. With XPS we measure the thickness and composition of the Oxide-nitride tiers, and with Raman we measure the crystallinity and grain size of the Poly-Silicon channel.

Slide [25] – Zoom on 3DNAND

Zooming in on the solutions for 3DNAND and showing them more graphically, you can see examples from utilizing our entire technology portfolio:

- VeraFlex XPS – is the only surface sensitive method that can directly control complex ultra-thin film stack in-die.
- Metrion SIMS detects contamination in the Tungsten word-line deposition.
- Elipson Raman – characterizes the Polysilicon on the sidewalls.
- Integrated Metrology is critical for top-oxide post CMP monitoring.
- And our Optical Stand-Alone PRISM is monitoring the channel profile and bottom parameters.

Slide [27] – solutions for Packaging

The last segment following logic and memory where I want to present our portfolio of solutions is on multiple architectures of advanced packaging:

- With our OCD dimensional technologies, we are helping control the re-distribution lines (or RDL), as well as the CD and depth of Through Silicon Vias. We also control multi-layer thickness and topography post CMP.
- With our X-ray-based material metrology, we are monitoring Aluminum bond pads, high K materials, cobalt caps, and liner.
- With our ancolyzer based chemical metrology we monitor the material bath for multiple elements to ensure a stable and robust plating process of multiple materials. In addition to monitoring, in some applications the ancolyzer controls the actual bath replenishment.

Slide [28] - ancolyzer

Zooming in on one use case of the ancolyzer, where chemical metrology is critical for plating high-aspect-ratio structures.

Pillars, Holes, Trenches and Vias metallization are the core technology in many of the advanced packaging architectures and Copper is the most widely used metal.

As vias become smaller and higher in aspect ratios, tighter control of the plating bath solution is critical to ensure high quality void-free and uniform plating.

The ancolyzer is a very flexible multi-technology tool used to monitor inline multiple components of the bath – both organics and inorganics as well as chemical contaminants.

As you can see on the chart from an actual in-line monitor, excellent control of the multiple chemistries affecting the bath is achieved throughout the bath lifetime.

The concentration and functionality of the organic additives are critical for determining and controlling the plating bath's performance. The ancolyzer has multiple capabilities:

- Detecting and minimizing organic breakdowns.
- Measuring resist and bath to bath contamination as multiple metals are plated in sequence.
- And having specific holistic real-time indicators for bath and additive health.

The ancolyzer flexibility supports controlling all exiting plating tools and chemistries, and provides intelligent replenishment based on lifetime conditions.

Slide [29] – Future directions

All that I reviewed so far are proven solutions, but before I summarize, one note on some of our future technological directions, which continue to evolve at a high pace to match the growing challenges:

We will continue adding innovative metrology technologies along various wavelength and energy ranges on the dimensional front.

On the material front, we see the potential of additional technologies that can transition from the Lab into the Fab.

For chemical metrology, as part of the ancosys technical integration into Nova we plan to enhance the capabilities with Nova's existing HW technologies and with modeling and machine learning capabilities.

On the software and Algorithms, we continue to enhance the synergy between physical modeling and advanced machine learning, and we are applying such solutions to multiple technologies, beyond OCD.

Slide [30] - Summary

To summarize my part of the day:

- I talked about some key technological trends, including the exponential growth of data. We saw that there are multiple technological ways forward and that "More than Moore" directions are essential to continue the industry trends.
- I reviewed multiple technology inflections in the industry and their associated process challenges:
    - In logic we see a clear path forward from Nanosheets to Foresheets and CFET.

    - In Memory, 3DNAND is growing taller with multiple decks and DRAM will go through a 3D transition similar to NAND.
    - In the advanced packaging steps, tighter process windows are required, driving more metrology and process control.
- In all these, metrology is becoming ever more critical in solving process challenges and enabling continuous improvement in device performance.
- For the Dimensional, Material and Chemical metrology implications, I reviewed Nova's unique technology solutions of multiple types of HW, enhanced by innovative algorithms and software.
- Nova's diverse and innovative technology portfolio for all device segments is one of the fundamental enablers of our strategic path towards 1 Billion - as it supports the industry's exponential growth going forward.

Slide [30]

Thank you.