semiconductor solutions

A leading supplier to the semiconductor industry

Anand Nambiar, Jeff White, John Langan

1st Virtual CMD of Merck KGaA, Darmstadt, Germany, September 16, 2020



Disclaimer

Publication of Merck KGaA, Darmstadt, Germany. In the United States and Canada the group of companies affiliated with Merck KGaA, Darmstadt, Germany operates under individual business names (EMD Serono, Millipore Sigma, EMD Performance Materials). To reflect such fact and to avoid any misconceptions of the reader of the publication certain logos, terms and business descriptions of the publication have been substituted or additional descriptions have been added. This version of the publication, therefore, slightly deviates from the otherwise identical version of the publication provided outside the United States and Canada.

Disclaimer

Cautionary Note Regarding Forward-Looking Statements and financial indicators

This communication may include "forward-looking statements." Statements that include words such as "anticipate," "expect," "should," "would," "intend," "plan," "project," "seek," "believe," "will," and other words of similar meaning in connection with future events or future operating or financial performance are often used to identify forward-looking statements. All statements in this communication, other than those relating to historical information or current conditions, are forward-looking statements. We intend these forward-looking statements to be covered by the safe harbor provisions for forward-looking statements in the Private Securities Litigation Reform Act of 1995. These forward-looking statements are subject to a number of risks and uncertainties, many of which are beyond control of Merck KGaA, Darmstadt, Germany, which could cause actual results to differ materially from such statements.

Risks and uncertainties include, but are not limited to: the risks of more restrictive regulatory requirements regarding drug pricing, reimbursement and approval; the risk of stricter regulations for the manufacture, testing and marketing of products; the risk of destabilization of political systems and the establishment of trade barriers; the risk of a changing marketing environment for multiple sclerosis products in the European Union; the risk of greater competitive pressure due to biosimilars; the risks of research and development; the risks of discontinuing development projects and regulatory approval of developed medicines; the risk of a temporary ban on products/production facilities or of non-registration of products due to non-compliance with quality standards; the risk of an import ban on products to the United States due to an FDA warning letter; the risks of dependency on suppliers; risks due to product-related crime and espionage; risks in relation to the use of financial instruments; liquidity risks; counterparty risks; market risks; risks of by the divested Generics Group; risks in human resources; risks from e-crime and cyber attacks; risks due to failure of business-critical information technology applications or to failure of data center capacity; environmental and safety risks; unanticipated contract or regulatory issues; a potential downgrade in the rating of the indebtedness of Merck KGaA, Darmstadt, Germany; downward pressure on the common stock price of Merck KGaA, Darmstadt, Germany and its impact on goodwill impairment evaluations as well as the impact of future regulatory regulatory regulatory issues;

The foregoing review of important factors should not be construed as exhaustive and should be read in conjunction with the other cautionary statements that are included elsewhere, including the Report on Risks and Opportunities Section of the most recent annual report and quarterly report of Merck KGaA, Darmstadt, Germany. Any forward-looking statements made in this communication are qualified in their entirety by these cautionary statements, and there can be no assurance that the actual results or developments anticipated by us will be realized or, even if substantially realized, that they will have the expected consequences to, or effects on, us or our business or operations. Except to the extent required by applicable law, we undertake no obligation to update publicly or revise any forward-looking statement, whether as a result of new information, future developments or otherwise.

This presentation contains certain financial indicators such as EBITDA pre adjustments, net financial debt and earnings per share pre adjustments, which are not defined by International Financial Reporting Standards (IFRS). These financial indicators should not be taken into account in order to assess the performance of Merck KGaA, Darmstadt, Germany, in isolation or used as an alternative to the financial indicators presented in the consolidated financial statements and determined in accordance with IFRS. The figures presented in this statement have been rounded. This may lead to individual values not adding up to the totals presented.

Today's Call Speakers in the Semiconductor Solutions deep dive

Anand Nambiar Head of Semiconductor Materials



Joined Merck KGaA, Darmstadt, Germany in 2014 with the AZ Electronics acquisition

Jeff White Head of Delivery Systems and Services



Joined Merck KGaA, Darmstadt, Germany in 2019 with the Versum acquisition **John Langan** Chief Technology Officer Performance Materials



Joined Merck KGaA, Darmstadt, Germany in 2019 with the Versum acquisition



Agenda

- **Semiconductor industry trends** more data, more chips, more materials
- **Semiconductor Solutions** enabling the chipmakers
- **Delivery Systems & Services** safely guarding the molecule
- **CTO¹ Perspective** materials are driving the roadmaps
- **05** Executive summary



semiconductor industry trends -More data, More chips, more Materials

Technology trends inevitably drive exponential data growth... ...more chips needed to generate, transfer, process & store data



Semiconductor Solutions supports growth trend as part of "**the company behind the companies**, advancing digital living"

1) alliedmarketresearch.com, Prismark 2020, CAGR 2021-2026; 2) fortunebusinessinsights.com, post-gazette.com, CAGR 2018-2026; 3) mordorintelligence.com, computerweekly.com, CAGR 2020-2025;

4) mordorintelligence.com, Prismark 2020; CAGR 2020-2025; 5G = 5th-generation cellular wireless; IoT = Internet of Things

5) mordorintelligence.com, autonomous car market value CAGR 2020-2025

M

Semiconductor Solutions COVID-19 has vaulted the "digital transformation" by ~5 years¹

Expected COVID-19 impact on global datasphere² [zetabytes]



¹Source: McKinsey May 2020 "The COVID-19 recovery will be digital: A plan for the first 90 days"; ²Source: Seagate, IDC April 2020, Merck KGaA, Darmstadt, Germany

covid-19 impact on data growth expected to be positive

- Work-from-home/stay-at-home economy
 Significant increase in video conferences, online shopping, online gaming, streaming
- Change in consumers' and enterprises' digital behavior expected to be long-lasting
- Need for more, faster & more reliable data processing, storage and bandwidth
 Acceleration of semiconductor demand

semiconductor solutions stands ready to support increased demand



02 semiconductor solutions -Enabling the chip Makers

Semiconductor Solutions – integrated materials player, well positioned to serve the need of customers in semiconductor fabrication



llustrative Industry P&Ls based on Sources: ¹Prismark 2020, ²WSTS/SIA & SEMI Q1 2020; ³Representative player in the industry, non-exclusive list, not based on any underlying criteria; ⁴e.g. Filters, Pads, etc.; CPU = Central Processing Unit; RAM = Random Access Memory; SSD = Solid State Disk; CMOS = Complementary metal-oxide semiconductor



Semiconductor Solutions Partner of choice for semiconductor manufacturers globally



One fab address = two customers: buying cycles, interfaces & nature of business fundamentally different, but ... **combined, highly synergistic**

¹Source LINX-Consulting, wafer processing materials - excludes silicon wafers and packaging materials; ²Source: Gartner; ³2004-2019 15-year CAGR



Fab = Semiconductor fabrication plant

Becoming an industry-leading materials and services provider: **best-in-class portfolio of capabilities through directed growth and acquisitions**



Customers value **sizeable and complementary portfolio** of semiconductor materials, equipment & services **in attractive categories**

¹includes one quarter of Versum; ²Illustrtive based on guidance for 2020

Unique comprehensive products and services portfolio offers end-to-end solutions, well-placed in high growth segments





Beyond a comprehensive portfolio Semiconductor Solutions also has an industry spanning customer base, supplying various end markets

2019 wafer capacity by region¹ Selected customers per region²



¹SEMI World Fab Forecast Q3 2020 - Dec 2019 capacity,

²Representative, non-exclusive list, not based on any underlying criteria

Semiconductor Solutions has **OVER 100 CUSCOMERS** supplying all top 10 chip makers and virtually all of the top 100³

Focus on logic chips Focus on memory chips Focus on other chips

³Based on H1 2020 Sales



Only three companies are currently running volume production <7nm These companies have the largest market shares across all nodes

Number of companies currently running volume production per logic chip node¹



iniary locus on operation entitlency

M

¹Source: Wikichip.org and own data; volume production as of Sep 2020; countries are listed in alphabetical order

Semiconductor Materials Set to outgrow highly attractive semiconductor materials market

Semiconductor Solutions sales guidance vs. market [Indexed 2020 = 100%]



¹Source: Jan 2020 IC Insights 2018-2024 CAGR for wafer starts in million units

Market

- Technological trends inevitably drive exponential data growth
- More data requires more chips and higher complexity of chips
- Rising materials value added per wafer

semiconductor solutions

- Comprehensive offering focusing on attractive materials categories
- Integration topline synergies
- Critical mass and deep customer centricity
- Better customer understanding: know-how exchange and collaboration across DS&S and Semiconductor Materials
- Cutting-edge innovation and R&D capabilities



 $\mathbf{O}\mathbf{Z}$ Delivery systems
& services safely guarding the molecule

DS&S - Delivery Systems & Services Safely Guarding the Molecule - of Semiconductor Materials

Complex system of chemicals and gases behind every produced semiconductor chip...

Delivery Systems & Services

- Provides high-quality delivery and storage of specialty chemicals and gases
- Enables maintaining a safe and reliable environment

With **industry standard** for cost-effective, fab-wide gas and chemical supply and services:

- GASGUARD[®] gas delivery systems
- CHEMGUARD[®] chemical delivery systems
- FLOWMASTER[®] CMP slurry delivery systems and wafer/parts cleaning systems
- VAPORGUARD[®] automated temperature control systems
- And MEGASYS[®] on-site customer operations team

GASGUARD AP 11 The standard in gas distribution



18 million operating hours with **99.9997% reliability**





DS&S - Delivery Systems & Services: a trusted global player in safe and reliable delivery of hazardous materials to semiconductor industry



- Designing bulk spec gas delivery systems
- Managing construction and installation
- High-volume customers who store large specialty gas ISO containers outside fab





- Design and manufacture delivery systems for: specialty gases, CVD/ALD deposition materials, CMP slurries & cleans
- Systems store gas/chemical containers while in-use and control material delivery parameters to fab processes
- Interface with customer's fab process control and monitoring systems.







Provide delivery systems

MEGASYS &

in-fab service

maintenance, materials inventory

management, quality assurance, &







DS&S - Delivery Systems & Services Winning in the fab equipment market

key strengths

- Operational and project execution excellence with
 99.9997% uptime of our equipment
- 30 years of experience with a flawless safety record and full interoperability
- Global footprint with flexible capacity where the customer needs us
- Additional credibility with materials consuming process owners from sub-fab engineers' experience



Ensure next-gen process requirements have **integrated materials + equipment solution**



Enabling our customers in semiconductor fabrication **to run with operational excellence**



ctoperspective -Materials are driving the roadmaps

Innovation: global digitization needs and innovation in semiconductors reinforce each other



Moore's law evolving and path forward is clear



Beyond 2030

Quantum AI

6G

New semiconductor designs will require many new materials... ...uniquely integrated innovation model reduces time to market

Semiconductor Solutions well positioned to introduce new Materials Faster

~number of elements used in semi manufacturing



Advanced scaling will require



New products under development Existing products



Source: Ivo Raaijmakers, International Interconnect Technology Conference, Brussels, June 2019

R&D approach of Semiconductor Solutions... ...accelerates new materials introduction



Historical Model:

- Required many hand offs and delays
- Material Supplier focus on unit processes
- No device testing

NEW Model:

- Post Versum / Intermolecular
- Product offerings and capabilities for entire manufacturing process sequences
- Full electrical device integration testing shortening development time



Innovation: Semiconductor Solutions enables chip fabs to expand scaling limits



Novel materials provide needed solution

- Latest sub 10nm nodes, at lowest scaling level interconnect line need widths below 20nm
- Copper (Cu) has insufficient performance below 20nm
- **Other metals needed**, but not all compatible with production
- Cobalt (Co), ruthenium (Ru) and molybdenium (Mo) promising candidates and Semiconductor Solutions has already successfully developed solutions for our customers



 E.g. Intel reports 2x reduction in via resistance and 5-10x improvement in electromigration by moving from copper to cobalt

¹Source: C. Adelmann, IMEC, 2014 ² Bulk resistivity x electron mean free path $[10^{-16} \Omega m^2]$ as proxy ³ Higher melting temperature as proxy for lower electromigration



55 Executive Sumary

Executive SUMMary

More bata



More Chips

global technology trends inevitably drive exponential data growth... ...more chips needed to generate, transfer, process & store exponentially growing data high resilience

integrated materials player with a leading, comprehensive product portfolio and a wide customer base



above market growth from attractive portfolio, deep customer understanding and centricity and cutting-edge R&D capabilities



Anand Nambiar, Jeff White, John Langan

1st Virtual CMD of Merck KGaA, Darmstadt, Germany September 16, 2020



CONSTANTIN FEST



Head of Investor Relations +49 6151 72-5271 constantin.fest@emdgroup.com

SVENJA BUNDSCHUH



Assistant Investor Relations +49 6151 72-3744 svenja.bundschuh@emdgroup.com

ALESSANDRA HEINZ



Assistant Investor Relations +49 6151 72-3321 alessandra.heinz@emdgroup.com

ILJA DOERING



Institutional Investors / Analysts +49 6151 72-24164 ilja.doering@emdgroup.com

GUNNAR ROMER



Institutional Investors / Analysts +49 6151 72-2584 gunnar.romer@emdgroup.com

AMELIE SCHRADER



Institutional Investors / Analysts +49 6151 72-22076 amelie.schrader@emdgroup.com

EVA STERZEL



ESG / Institutional & Retail Investors / AGM +49 6151 72-5355 eva.sterzel@emdgroup.com





