

WAFER STARTS FOR MORE THAN MOORE APPLICATIONS

Market & Technology report - March 2018

Driven by megatrend markets, More than Moore devices' overall wafer demand is expected to grow at an almost 10% CAGR from 2017 to 2023.

WHAT ABOUT THE REPORT?

An update of this report will be released in June 2018 with additional More than Moore applications and components analysis such as:

- photonics
 - VCSEL
 - Sensors like fingerprint sensors, ambient light sensors...
 - 2.5D interposer platform applications
- Customers of this report will automatically receive the June update.

KEY FEATURES OF THE REPORT

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- This report is the first to present the entire wafer starts market for More than Moore devices
- 2017 - 2023 overall wafer forecasts (in units) for More than Moore markets, including MEMS & sensors, CMOS image sensors, RF devices, and power devices (discretes and modules)
- 2017 - 2023 wafer market metrics in wspy: breakdown by More than Moore application segment
- Detailed analysis and wafer forecast for each More than Moore application segment, plus wafer market metrics by component type
- 2017 - 2023 wafer market metrics in wspy: split by wafer size and, by semiconductor substrate material - silicon vs. non silicon-based
- Wafer starts analysis by More than Moore application segment and split by wafer size
- Overview and positioning of key players, by More than Moore device and by substrate type

MEGATREND MARKETS ARE AT THE HEART OF MORE THAN MOORE'S WAFER VOLUME EVOLUTION

Wafer demand (including MEMS & sensors, CIS, and power, along with RF devices) for More than Moore (MtM) reached almost 45 million 8-inch eq wafers in 2017. Wafer demand is expected to reach more than 66 million 8-inch eq wafers by 2023, with an almost 10% CAGR₂₀₁₇₋₂₀₂₃.

Numerous megatrend market drivers will contribute to MtM devices' growth : 5G (wireless infrastructure & mobile), mobile (including additional functionalities), voice processing, smart automotive, and Augmented Reality/Virtual Reality (AR/VR), artificial intelligence.

Driven by the increasing deployment of renewable energy sources (principally solar energy inverters) and industrial motor drives, as well as the growing electric and hybrid vehicles (EV/HEVs) automotive industry, power devices' wafer market size will grow at an almost 13% CAGR₂₀₁₇₋₂₀₂₃. In 2017, it accounted for more than 60% of overall MtM wafer starts and it will continue dominating the MtM industry.

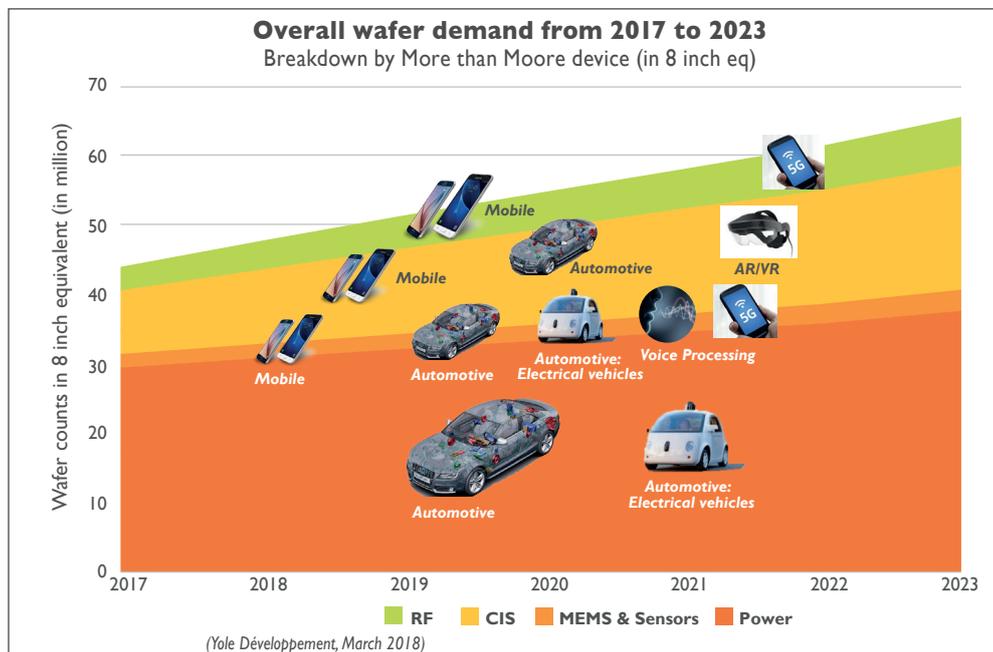
5G, a hot topic today, will likely be a huge part of the MtM evolution, bringing any service to any user anywhere, but also requiring new antennas, along with filtering functionality. These stringent requirements will lead to increasing demand for RF components like RF filters, power amplifiers

(PAs), and low-noise amplifiers (LNAs) to ensure access to tomorrow's radio network.

Meanwhile, the demand for advanced mobile applications that integrate more functionalities will require aggregating more and more devices such as fingerprint sensors, ambient light sensors, 3D sensing, microphones, and inertial MEMS devices. This will, in the near future, contribute to strong wafer growth in the MEMS & sensors wafer market.

Additionally, smart automobiles have reached a new level of complexity requiring the development and integration of new sensors. As such, we expect smart automobiles to drive consistent growth of CIS and sensor wafer production over the next five years, fueled by the expanding integration of high-value sensing modules like radar, imaging, and lidar. Although automotive will be mainly supported by these growth areas, classical MEMS & sensors such as MEMS pressure sensors and inertial MEMS will still continue growing at a reasonable rate, supporting the standard automotive world.

This report provides a detailed analysis of the wafer market forecast by MtM segment application, along with a comprehensive overview of the market segments driving MtM devices.



6-INCH AND 8-INCH ARE FORECAST TO REPRESENT MORE THAN 60% OF MORE THAN MOORE WAFERS' TOTAL WAFER CONSUMPTION

In terms of wafer size, the MtM wafer market - including MEMS & sensors, CIS, and power (MOSFETs, IGBTs, thyristors, and diodes (excluding Power ICs)), along with RF devices - is dominated by the 6-inch wafer format, followed by the 8-inch size, which is mostly supported by power device applications.

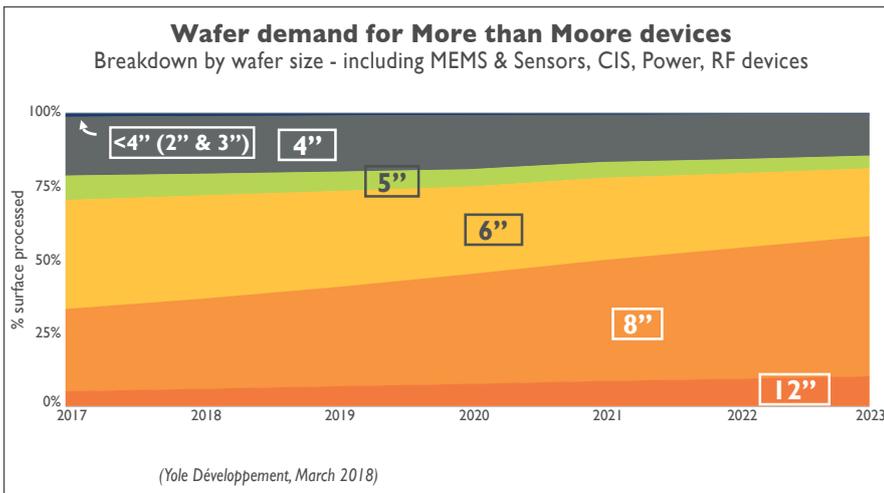
However, though 6-inch will continue increasing in the next few years, its share will decrease compared to 8-inch. Indeed, we expect 8-inch wafer diameter to progress significantly and surpass the 6-inch wafer size by 2023. This transition will be driven first by power

and MEMS & sensor applications, where the vast majority will convert their components from 6-inch to 8-inch over the next five years due to increasing volume production.

Nevertheless, 12-inch will represent the fastest growth from 2017 - 2023, with a 15% CAGR. We expect 12-inch wafer demand to grow from 3.3 million units in 2017 to 7.5 million in 2023, mainly fueled by Backside Illumination CMOS Image Sensors (BSI CIS) (3D stacked BSI, 3D hybrid BSI). On the other side, 4-inch wafer diameter is in large demand today for MtM applications driven by RF SAW (Surface Acoustic Wave) filter products. However, 4-inch's adoption will decrease due to the transition from 4-inch to 6-inch for these applications.

We still see some MtM products manufactured in wafer sizes below 4-inch, i.e. 3-inch and 2-inch wafer formats. However, these represent a very small volume, and we expect such sizes to die out (aside from small volumes still used for producing MEMS, power, and RF SAW devices).

This report offers a comprehensive overview of wafer starts market data, split by wafer size for MtM devices and including the following fields: MEMS & sensors, CIS, RF devices, and power devices. This report also furnishes a more in-depth analysis of the wafer starts split, with a separate forecast by type of component for each MtM device covered.



DESPITE SILICON'S DOMINANCE IN THE SEMICONDUCTOR AREA, ALTERNATIVE SUBSTRATES ARE DISRUPTING THE MORE THAN MOORE MARKET

Regarding semiconductor material, although silicon is by far the most dominant (with more than 80% market share), alternative non-silicon-based substrates like SiGe, GaAs, GaN, and SiC are increasing their importance within the MtM industry. Choosing the right substrate technology will strongly depend on the technical performance associated with the megatrends's requirements, as well as the cost.

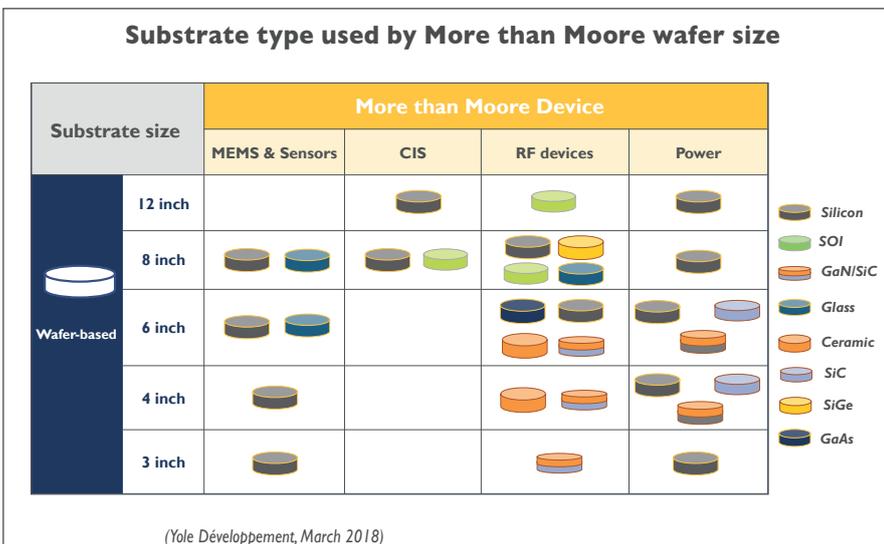
In the case of high-temperature applications, SiC will stay the preferred choice while GaN is better adapted for low-power DC/DC and AC/DC

converters. Moreover, SiC transistors are particularly advantageous for high-voltage and high-rating applications, and thus are considered as a technology choice for some MOSFET and diode products.

GaN could possibly reach high-voltage values, but would require bulk GaN as the substrate, which is currently impossible. However, due to their power efficiency and broadband capability, both GaN-on-SiC and GaN-on-Si are very good candidates for RF power devices, especially for macro base stations. Meanwhile, silicon cannot compete in high-frequency-range RF applications due to its limitations in terms of insertion loss and dielectric constant.

Looking ahead, glass is an appealing choice for low-power consumers like RF IPD, and high-frequency applications requiring low dielectric loss and low insertion loss. However, glass exhibits bad heat conductivity and thus is not compatible with solid-state RF components like PAs/LNAs and RF switches.

GaAs is not optimized for high-power applications like macro base stations. However, thanks to its maturity, its satisfying out-power, and its good linearity, GaAs is being used for PA devices. Furthermore, GaAs is especially advantageous for small-cell implementation for both sub-6GHz and the first mmWave small cells (28GHz - 39GHz range). Meanwhile, SiGe, ceramic, and SOI are the dominant technologies for LNAs, RF BAW (Bulk Acoustic Wave) filters, and RF switches, respectively.



Similarly, although InP substrate is considered as a promising solution from a performance point of view to enter the small cell market towards higher mm wave frequencies in a range of 60GHz - 70GHz, the technology's accessibility in terms of volume and players might still be limited. However, GaAs and InP are attractive solutions for photonics applications, while GaN could be an enabler for 5G infrastructure with increasing frequencies and high data rates, where power efficiency remains crucial. In this respect,

numerous non-silicon-based semiconductor substrates could in the long-term make serious inroads in the MtM market.

This report offers a comprehensive overview of the semiconductor substrates used in MtM applications, as well as technology trends and a wafer market forecast by application and component type. Moreover, a detailed analysis of the wafer forecast (split by wafer size and substrate type) has been calculated for the 2017 - 2023 timeframe.

OBJECTIVES OF THE REPORT

- Assess the wafer market for MEMS & sensors, CMOS image sensors, RF devices, and power devices applications
- Offer market metrics at wafer market level for the entire More than Moore (MtM) industry (2017 - 2023)
- Evaluate market developments in terms of market size (volume, value), substrate sizes/formats, and by MtM device
- Discuss the competitive landscape and identify key players in technology development and manufacturing
- Furnish an overview of who is doing what, and the specificities of each market
- Technology process, specification, and value chain
- Identify the key drivers that will shape the future MtM market
- Provide a clear overview in terms of wafer shipments, and identify business opportunities in the MtM industry

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Branch code: 00170
Account n°: 0170 200 1565 87
BIC or SWIFT code: CCFRFRPP
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