Trends in MEMS Manufacturing & Packaging

A REPORT ENTIRELY DEDICATED TO NEW MEMS PROCESSES AND MATERIALS

New MEMS manufacturing approaches pave the way to smaller, more performing and cost-effective devices!

Although MEMS technologies have not been driven by the same size demands as ICs, it doesn’t mean that MEMS manufacturing is just standing still. The fast growing MEMS markets, now driven by consumer applications, are:

- Size-driven: for demanding consumer applications like smart phones and laptops
- Performance-driven: for high end applications like aerospace
- Cost-driven: for high volume applications like cell phones, automotive and games consoles

New MEMS manufacturing, packaging technologies and specific materials are necessary for solving these issues. This Yole Développement report highlights the future challenges for MEMS production and packaging. From bulk micromachining to surface micromachining to SOI, and MEMS technology has been following a well-defined evolutionary technical roadmap with 3D integration being the next possible step. In the report, you will find manufacturing trends for the different MEMS devices in terms of processes, new packaging approaches, 3D integration, CMOS MEMS integration, new materials such as structured wafers...

The report analyzes the following MEMS processes at different levels:

- At the **substrate** level: engineered SOI, glass, thin wafers, silicon, a-Si,...
- At the **front end** level: piezo materials, getters, bonding, resists, CMOS MEMS, release stiction, DRIE, singulation, lithography, etching, sacrificial release, CAD tools...
- At the **packaging** level: thin film packaging, active capping, pixel-level packaging, Through Glass Vias, Through Si Vias...
- **Technology** platforms: TSV, hermetic WLP, interposer, standard packaging, MUMPS process, testing...
The objective of this report is to provide an understanding of current challenges of MEMS manufacturing, packaging & materials. For each MEMS manufacturing step, bottlenecks and challenges will be highlighted. It is a 350+ slide report.

In 2011, simplification of manufacturing remains an objective: The Yole Développement MEMS law “One product, one process, one package” still rules. Will it still rule in 2020? The current work on technology and product platforms attempts to overcome the Yole Développement MEMS law. But this approach will be custom-made standard processes. By 2020, it is likely that MEMS fabs will have developed internal standard process blocks but it will be fab-specific standard tools.

**DRIE** and **wafer bonding** are the technologies subject to major evolution: main reason is that both technologies are increasingly used for 3D TSV in the mainstream semiconductor business. Wafer bonding is the direct competitor for CMOS MEMS approach. For example, microbolometer players are more and more considering wafer bonding approach to stack the MEMS to the ROIC wafer. MEMS have been scarcely pushed by technological innovation. Most of the time, a MEMS is developed either by the use of micromachining to reduce existing sensors or the push is coming from system makers. As an example, lateral MEMS (accelerometers) have been developed by Leti because of military request from Thales. DRIE has been developed by Bosch because of automotive applications. The only exception is ADI that wanted to use its existing CMOS lines. Using CMOS is sometimes an historical choice (with the disadvantage that now the CMOS technology is evolving quicker than the MEMS technology). Indeed, **CMOS MEMS is likely to be restricted to very specific applications** where MEMS arrays will need very close electronic processing. For all other case, it will depend on MEMS product cycle time, flexibility, cost, integration, market demand and power consumption.

**Wafer forecasts 2009-2015 by type of step** (DRIE, wafer bonding, sacrificial etch, through Si vias, thin films packaging, CMOS MEMS, thin wafers) are estimated for all the analyzed MEMS technologies.

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TABLE OF CONTENTS

• Executive summary
  - Main MEMS manufacturing evolution
  - MEMS wafer forecasts by type of manufacturing

• 2000 - 2020 MEMS devices evolution
  - Inertial (accelerometers, gyroscopes)
  - Magnetometers
  - Pressure
  - Microphones
  - Micro mirrors
  - Micro bolometers
  - Oscillators

• MEMS historical & expected evolution
  - VOA
  - Accelerometer for seismic
  - Gyros for consumer

• Cost analysis

• Technical trends
  - MEMS Manufacturing Trends
  - MEMS & ASIC Interconnects
  - 3D MEMS

• Impact on MEMS equipment & materials
  - DRIE
  - Sacrificial release
  - Release stiction
  - Deposition
  - Cleaning
  - Lithography
  - Bonding
  - Singulation
  - Test
  - CAD tools
  - Glass wafers
  - SOI wafers
  - PZT
  - Resist

• MEMS companies:
  - To identify what will be the next MEMS production and packaging challenges
  - Be update of new technical evolution

• MEMS foundries:
  - Identify new processes to broaden your foundry service offer
  - Position your foundry offer in the competition

• R&D players:
  - Understand new technical challenges in MEMS
  - Develop new innovative solutions for MEMS manufacturing.

• Equipment & Material suppliers:
  - Understand the technical evolution of MEMS devices to develop solutions
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• Financial & Strategic investors:
  - Understand the potential of new MEMS processes
  - Identify promising startups

• Conclusions

• Appendices

WHO SHOULD BUY THIS REPORT?

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COMPANIES CITED IN THE REPORT


BIO

Dr. Eric Mounier has a PhD in microelectronics from the INPG in Grenoble. Since 1998 he is a co-founder of Yole Développement, a market research company based in France.

At Yole Développement, Dr. Eric Mounier is in charge of market analysis for MEMS, equipment & material. He is Chief Editor of Micronews, and MEMS’Trends magazines (Magazine on MEMS Technologies & Markets)
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ABOUT YOLE DÉVELOPPEMENT

Beginning in 1998 with Yole Développement, we have grown to become a group of companies providing market research, technology analysis, strategy consulting, media in addition to finance services. With a solid focus on emerging applications using silicon and/or micro manufacturing Yole Développement group has expanded to include more than 40 associates worldwide covering MEMS and microfluidics, Advanced Packaging, Compound Semiconductors, Power Electronics, LED, and Photovoltaic. The group supports companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to develop their business.

Services
- Market data, market research and marketing analysis
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Publications
- Collection of market & technology reports
- Players & market databases
- Manufacturing cost simulation tools
- Component reverse engineering & costing analysis

MEDIA
- Critical news, Bi-weekly: Micronews, the magazine
- In-depth analysis & Quarterly Technology Magazines:
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Definitions: “Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in their entirety. It is done by signing the purchase order which mentions “I hereby accept Yole Développement’s Terms and Conditions of Sale”.

“Buyer”: Any business user (i.e. any person acting in the course of its business activities, for its business needs) entering into the following general conditions to the exclusion of consumers acting in their personal capacity.

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“Intellectual Property Rights” (“IPR”): means any rights held by the Seller in its Products, including any patents, trademarks, registered models, designs, copyrights, inventions, commercial secrets and know-how, any company or trade mark and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not and including any pending registration of one of the above mentioned rights.

“Location” means the IP and databases, 3 different licenses are proposed. The buyer has to choose one license:

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“Seller”: Based in Lyon (France headquarters), Yole Développement is a market research and business development consultancy company, facilitating market access for advanced technology industrial projects. With more than 20 market analysts, Yole works worldwide with the key industrial companies, R&D institutes and investors to help them understand the markets and technology trends.

1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. ANY ADDITIONAL, DIFFERENT, OR CONFLICTING TERMS AND CONDITIONS IN ANY OFFER OR INVOICE OF THE BUYER AT ANY TIME ARE HEREBY OBEYED TO BY THE SELLER, SHALL BE WHOLLY IMPELLABLE TO ANY SALE MADE HEREBOTH AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.

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1.3 The Buyer is deemed to be accepted only upon written acceptance and confirmation by the Seller, within [7] days from the date of order, to be sent either by email or to the Buyer’s address. In the absence of any confirmation in writing, orders shall be deemed having been accepted.

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4. Liabilities

4.1 The Buyer or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products and for the use and interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and acts it deduces thereof. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information.

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4.3 The information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information.

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- the infringement of any patents, trademarks, registered models, designs, copyrights, inventions, commercial secrets and
- any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not and including any pending registration of one of the above mentioned rights.

4.7 The deadlines that the Seller is asked to mail the Products for information are given and on information provided for the information. If the Seller failed to meet its obligations within the agreed period, the Buyer is entitled to be entitled to claim the reimbursement of its first delivery to the exclusion of any further damages.

4.8.2. The Seller may, at its sole discretion, immediately terminate the contract for non-compliance, including, without limitation, those of saleability and fitness for a particular purpose, with respect to the Products. Although the Seller shall take reasonable steps to screen Products for infection or viruses, worms, Trojan horses or other codes containing corrupting or destructive properties before making the Products available, the Seller shall not be liable for any damages that may result from infection.

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6. Protection of the Seller’s IPR

6.1 The Seller shall be protected and indemnified and are the remain the property of the Seller and are protected under French and international copyright law and conventions.

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it to any other party other than employees of its company. The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use the Product for purposes such as:
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- in use when time-sharing, service bureau, bulletin board or similar arrangement or public display;
- in posting any Product to any other online service (including bulletin boards or the Internet);
- in licensing, leasing, selling, offering for sale or assigning the Product.

6.3.2 The Seller is not responsible towards the Buyer of all infringements of this obligation, whether this infringement comes from its employees or any person to whom the Buyer has sent the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

6.4 The Buyer shall define within its company point of contact of the needs of the contract. This person will be the recipient of each new report in PDF format. This person shall also be responsible for receiving all eventual electronic communications from the Seller, and the Seller will not be responsible for any failure to address any communications, which the Seller may send by e-mail or post, to an address other than that of the Buyer’s point of contact provided by the Buyer.

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8.1 All the provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to enforce and these provisions against the Buyer.

8.2 Any notices under these Terms and Conditions shall be given in writing. They shall be effective upon receipt by the other Party.

8.3.1.2 Any change to these Terms and Conditions and the Buyer, has accepted to have accepted the latest version of these terms and conditions, provided they have been communicated to him in due time.

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