Polymeric Materials for Advanced Packaging at the Wafer-Level - Sample 2018
ABOUT THE AUTHORS

Biographies & contacts

Amandine PIZZAGALLI, Market & Technology Analyst, Equipment and Materials Manufacturing

Amandine Pizzagalli is a Technology & Market Analyst, Equipment & Materials - Semiconductor Manufacturing, at Yole Développement (Yole). Amandine is part of the development of the Semiconductor & Software division of Yole with the production of reports and custom consulting projects. She is in charge of comprehensive analyses focused on semiconductor equipment, materials and manufacturing processes.

Previously, Amandine worked as Process engineer on CVD and ALD processes for semiconductor applications at Air Liquide. Amandine was based in Japan during one year to manage these projects.

Amandine graduated from CPE Lyon (France), with a technical expertise in Semiconductor & Nano-Electronics and holds an electronics engineering degree followed by a master's in semiconductor manufacturing technology from KTH Royal institute of technology (Sweden).

She has spoken in numerous international conferences and has authored or co-authored more than 10 papers.

Contact: pizzagalli@yole.fr

Lauranne Chemisky, Market & Technology Analyst, Semiconductor & Software Division

Lauranne Chemisky is a technology and market analyst in the Semiconductor & Software Team at Yole Développement (Yole). Lauranne is currently engaged in the development of market research reports as well as customized services for clients. She is able to leverage her technology training and experience in the fields of materials and semiconductor manufacturing processes for advanced packaging applications. Previously, Lauranne worked at Apple in the Softgoods Product Design Team as a material development engineer (CA, USA).

Lauranne holds a master’s degree in Materials Science & Polymers from ITECH (Lyon, FR) and an M.Sc. in Technology and Innovation Management from EM Business School (Lyon, FR).
COMPANIES CITED IN THE REPORT

(non-exhaustive list)

REPORT OBJECTIVES

• This report is a research update for the Polymeric materials market in the field of Advanced Packaging applications to provide an understanding of the applications, he technology trends, and market forecasts by function and End applications.

• The objectives of the report are to

  • Provide detailed information regarding the applicability of the polymeric material for Advanced Packaging applications
  • Detailed analysis of the major Advanced Packaging platforms using polymeric materials that could require the use of polymeric materials
  • Polymeric materials roadmap for the Advanced packaging platforms
  • Give the current status of the polymeric material adoption and the various type of polymeric material available on the market
  • Provide an overview of the technological trends for polymeric material
  • Understand the key benefits and added value of the polymeric material in the field of Advanced Packaging
    • How does polymeric material differ from the other alternative material solutions
  • Understand what are the remaining challenges of the implementation of the polymeric material in the field of Advanced Packaging
  • Offer market metrics at polymeric material market level for Advanced Packaging applications (2017-2023)
  • Evaluate market developments in terms of market size (volume, value, quantity), by material function and by Advanced Packaging platform
  • Provide a competitive landscape, identify key players in technology development and manufacturing
  • Give an overview of who is doing what, and specificities of each market

• The report does not cover the following applications

  • MEMS packaging
  • Panel substrate
  • Die-to-die assembly process
REPORT METHODOLOGY

Market forecast methodology

APPLICATION

- Forecast of system market volume (unit)
- Definition of functions using devices, technical requirements at device level and device penetration rate and competitiveness with alternative technologies

- Forecast of device market volume (unit)
- Definition of ASP per application
- Forecast of device market size ($)

- Definition of manufacturing flows for front-end and packaging at module and device level
- Forecast of device manufacturing equipment and material markets (unit and $)
- Forecast of device substrate markets (unit, wafers and $)

System Plus Consulting expertise in reverse costing / reverse engineering

Understanding and definition of market share

IP and patent position
REPORT METHODOLOGY

Technology analysis methodology

- Define the key parameters
- Understand the requested specifications per parameter and application
- Define the competing technologies and the potential evolutions of the technologies
- Define the roadblocks and challenges to be overcome
- Establish the technology roadmaps and maps
- Experts discussions

Information collection

Material makers
- Trade shows attendance and participation

Equipment makers
- Analysts’ processing to answer your needs and questionings on market size, positioning, technical challenges...

Device makers
- Analysis of the literature, web, academic publications, white papers...

System designers

OSAT

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METHODOLOGY - YOLE’S ANALYSIS FRAMEWORK

Yole’s market forecast methodology is based on a top-down + bottom-up approach, including dozens of interviews with companies throughout the value chain.
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Polymeric materials for Advanced Packaging at the wafer-level | Sample | www.yole.fr | ©2018
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<td>• Current used polymeric materials</td>
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KEY PACKAGING FAMILIES

Focus on this report
## KEY PACKAGING FAMILIES

Platforms focus on the report

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<tr>
<th>Packaging platforms</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No substrate</strong></td>
<td><strong>Wafer-Level Chip Scale Package (WLCSP)</strong>&lt;br&gt;The bumped integrated circuits can be directly mounted onto the printed circuit board of the end equipment by the original equipment maker</td>
</tr>
<tr>
<td><strong>Fan-Out Wafer-Level Packaging</strong></td>
<td>Fan-Out is that it is a package from which connections and bumping are out of the chip scale and where interconnections are RDL-based</td>
</tr>
<tr>
<td><strong>Organic substrates</strong></td>
<td><strong>FC BGA/CSP</strong>&lt;br&gt;&lt;br&gt;Flip chip packages utilize an intermediate “high density interconnect” (HDI) printed circuit board&lt;br&gt;&lt;br&gt;<strong>2.5D interposer</strong>&lt;br&gt;Any kind of substrate has the function of “interposing” between the die and PCB, however for practical purposes, the term interposer is used for additional interconnect components on top of a substrate, namely Si and Glass interposers</td>
</tr>
</tbody>
</table>

**3D TSV is a way to stack dies based on TSV interconnections used to stack silicon interconnect technology**
Global Wafer forecast demand for Advanced Packaging
*(in 300mm wafer eq. wafer starts)*

Yole Developpement © November 2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume (in 12 inch eq wafer starts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td></td>
</tr>
</tbody>
</table>

- FC-3D TSV memories
- FC-2.5D TSV
- FC-CSP
- FC-BGA
- Fan-In WLP
- Fan-Out WLP
Megatrend applications like 5G wireless technologies, electric vehicles, and advanced mobile devices demand miniaturization and extra functionality.

**Megatrend applications**
- 5G
- Smart automotive/ADAS
- AR/VR
- Voice processing
- Artificial intelligence
- Data center

**Advanced Packaging’s new requirements**
- Higher functionalities
- Lower power consumption
- Higher bandwidth
- More memory & sensors
- Lower latency
- Higher speed
- Tigher features size for further minizaturization

**Material processing: new needs**
- Stacked wafers: increased density
- Larger wafer size
- New material deposition methods to implement
- Advanced lithography patterning
- New materials to be deposited depending on the feature size
BENEFITS OF POLYMERIC MATERIALS FOR PACKAGING

Added-value of polymeric materials

Polymeric materials could offer better performance than any other type of materials

Why polymeric material in the Advanced Packaging area?

**Electrical**
- Insulating
- Breakdown Voltage
- Loss
- Energy dissipation

**Mechanical**
- Modulus
- Elongation
- Tensile Strength
- Viscosity

**Physical**
- Optical
- Thermal stability
- Thermal conductivity
- Tg
- CTE

**Chemical**
- Water absorption
- Adhesion
- Surface finish
- Chemical resistance

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Polymeric materials could be used in two different ways to fabricate a product:

- **Direct material**
  - Polymeric material is applied as a permanent material and **remains in the final product**

- **Indirect material**
  - Polymeric material is applied for temporary use in the process flow and then **removed after the IC device is processed**
  - This polymeric material applied temporarily is used for the fabrication of device but does not remain in the final product
Polymeric Materials for Advanced Packaging at the wafer-level

Polymeric Materials

- Direct material
  - Dielectric material
  - Bonding stacked material
  - Molding compound
  - Underfill
- Indirect material
  - Temporary bonding
  - Photo-resist
## Polymeric Materials Applicative Segmentation Matrix

### Polymeric Material functionalities

<table>
<thead>
<tr>
<th>Direct material</th>
<th>Indirect material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric material</td>
<td>Bonding stacked bonding</td>
</tr>
<tr>
<td>Molding Compound</td>
<td>Underfill</td>
</tr>
<tr>
<td>Temporary bonding</td>
<td>Photo-resist</td>
</tr>
</tbody>
</table>

### Advanced Packaging segments

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<th>WLCSP</th>
<th>Flip-Chip 2.5D interposer</th>
<th>FC BGA</th>
<th>TSV way to connect 3D stacked memories</th>
<th>3D BSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>FO WLP</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>WLCSP</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Flip-Chip</td>
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<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>FC-BGA</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>TSV way to connect</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>3D stacked memories</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>✔</td>
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**Polymeric materials for Advanced Packaging at the wafer-level | Sample | www.yole.fr | ©2018**
### WHERE POLYMERIC MATERIALS ARE APPLIED?

In the field of Advanced Packaging

<table>
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<tr>
<th>MATERIAL FUNCTION</th>
<th>PROCESS STEP LEVEL</th>
<th>ROLE</th>
<th>ADVANCED PACKAGING PLATFORM</th>
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<td>Patterning</td>
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<td></td>
<td>Bump/UBM</td>
<td></td>
<td>FC BGA</td>
</tr>
<tr>
<td></td>
<td>TSV</td>
<td></td>
<td>2.5D interposer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Bonding</td>
<td>D2W assembly level</td>
<td>Mechanical support</td>
<td>3D TSV (development)</td>
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<tr>
<td>stacked material</td>
<td>W2W assembly</td>
<td>Miniaturization</td>
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<td></td>
<td></td>
<td>Handling wafer</td>
<td>3D TSV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.5D interposer</td>
</tr>
<tr>
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<td>Bonding/debonding carrier from the semiconductor device</td>
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<td></td>
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<td>Underfill</td>
<td>Bump/UBM</td>
<td>Mechanical support</td>
<td>FO WLP</td>
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<td></td>
<td>D2W</td>
<td>Repassivation</td>
<td>FO WLP</td>
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<td>Dielectric material</td>
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<td>Passivation</td>
<td>WLCSP</td>
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<td>Bump/UBM</td>
<td></td>
<td>FC BGA</td>
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<td>TSV</td>
<td>Isolation</td>
<td>3D TSV</td>
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<td>Molding compound</td>
<td>Encapsulation</td>
<td>Reconstituted wafer</td>
<td>FO WLP</td>
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Breakdown by polymeric material function

CAGR 12%

Revenue (in $M)
- $0 M
- $200 M
- $400 M
- $600 M
- $800 M
- $1,000 M
- $1,200 M
- $1,400 M

2018 2019 2020 2021 2022 2023

POLYMERIC MATERIALS DEMAND FOR ADVANCED PACKAGING

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Total Polymeric material for Advanced Packaging at the wafer-level

- Dielectric material
- Photoresist material
- Molding compound material
- Temporary bonding material
- Underfill

POLYMERIC MATERIALS DEMAND FOR ADVANCED PACKAGING* FROM 2017 TO 2023

2017

- < $700M
  - < $200M
  - > $70M
  - ~ $30M
  - ~ $370M

2023

- ~ $1.3B
  - ~ $61M
    - CAGR: +12%
  - ~ $340M
    - CAGR: 10%
  - ~ $180M
    - CAGR: +13%
  - ~ $90M
    - CAGR: 30%

*New Brand Equipment

**CAGR: Compound Annual Growth Rate
Polymeric materials for Advanced Packaging at the wafer-level

Polymeric materials for semiconductor

Epoxies (EPO)
Polyimides (PI or PSPI)
Polybenzoxazole (PBO)
Benzocyclobutene (BCB)
WPR
Silicones
Al-X
Others

Fluoropolymers (PFCB)
Polyparaxylene (PPX)
Polynorbornene (PNB)
POLYMERIC MATERIALS PROPERTY SUMMARY

Main properties of polymers

<table>
<thead>
<tr>
<th>Property</th>
<th>PI</th>
<th>BCB</th>
<th>Epoxy</th>
<th>PBO</th>
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<tbody>
<tr>
<td>Dielectric constant</td>
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<td>2.0</td>
<td>3.0</td>
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<td>CTE (ppm/°C)</td>
<td>100</td>
<td>100</td>
<td>36</td>
<td>20</td>
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<tr>
<td>Modulus (GPa)</td>
<td>1</td>
<td>2</td>
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<td>4</td>
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<tr>
<td>Tensile Strength (MPa)</td>
<td>20</td>
<td>54</td>
<td>400</td>
<td>400</td>
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<tr>
<td>Elongation (%)</td>
<td>33</td>
<td>66</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Tg (°C)</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Cure temperature (°C)</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>&gt;60</td>
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<td>Stress (MPa)</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>3</td>
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<tr>
<td>Water absorption (%)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Each material have advantages and drawbacks.
**APPLICABILITY OF POLYMERIC MATERIALS IN THE PACKAGING AREA**

<table>
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<th>Advanced Packaging platforms</th>
<th>Polymeric Material functionalities</th>
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</thead>
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<tr>
<td>FO WLP</td>
<td>Direct material: PI, PBO, WPR</td>
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<tr>
<td></td>
<td>Indirect material: Epoxy, Polysiloxane, Epoxy, Polyimide Acrylic</td>
</tr>
<tr>
<td>WLCSP</td>
<td>Direct material: PI, PBO</td>
</tr>
<tr>
<td></td>
<td>Indirect material: Epoxy, Silicone</td>
</tr>
<tr>
<td>Flip-Chip</td>
<td>2.5D interposer: PI, PBO</td>
</tr>
<tr>
<td>FC-BGA/CSP</td>
<td>3D stacked memories: PBO, WPR</td>
</tr>
<tr>
<td>FC BGA</td>
<td>3D BSI</td>
</tr>
<tr>
<td>TSV way to connect</td>
<td>3D BSI</td>
</tr>
</tbody>
</table>

Polymer materials: PI, PBO, WPR, Epoxy, Polysiloxane, Polyimide, Acrylic.
KEY POLYMERIC MATERIALS SUPPLIERS FOR PACKAGING

By functionality (non-exhaustive list) – An exhaustive list of companies will be provided in the full report.

Direct materials

- Dielectric material
- Permanent bonding
- Molding Compound
- Underfill

Indirect materials

- Temporary bonding materials
- Photo-resist

KEY POLYMERIC MATERIALS SUPPLIERS FOR PACKAGING

By functionality (non-exhaustive list) – An exhaustive list of companies will be provided in the full report.
2017 POLYMERIC MATERIALS MARKET SHARE

In the field of Advanced Packaging

<table>
<thead>
<tr>
<th>Dielectric material</th>
<th>Mold compound</th>
<th>Underfill</th>
<th>Photoresist</th>
<th>Temporary Bonding</th>
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<tr>
<td>FUJIFILM</td>
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<td>NAGASE</td>
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<td>Hitachi Chemical</td>
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<td>DOW</td>
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<td>HD Microsystems</td>
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*Non-exhaustive list of companies - Full analysis in the report - Each color is associated to a material supplier’s market share
Polymeric materials for Advanced Packaging at the wafer-level | Sample | www.yole.fr | ©2018
POLYMERIC MATERIALS FOR ADVANCED PACKAGING AT THE WAFER-LEVEL
Market & Technology report - November 2018
Polymers materials market revenue will double over the next five years.

KEY FEATURES
- Detailed analysis of polymeric materials used in the following advanced packaging platforms: WLCSP (fan-in WLP), FOWLP, flip-chip (FC BGA/CSP), 2.5D interposer, 3D stacked TSV
- Thorough analysis of the polymeric materials used in different material-based functionalities, including dielectric material, bonding stacked material, molding compound, underfill, photoresists, and temporary bonding material
- 2017 - 2023 polymeric materials market metrics (value and quantity): breakdown by advanced packaging platform and material functionality
- 2017 global polymeric materials market share in the advanced packaging sector
- 2017 polymeric materials suppliers, by material function
- Overview of the players using polymeric materials, by advanced packaging application and by function
- Roadmap for polymeric materials adoption
- Updated polymeric materials technology trends analysis across advanced packaging platforms

POLYMERIC MATERIALS: MASSIVE MARKET ADOPTION IN THE ADVANCED PACKAGING SECTOR

Driven by movements towards further miniaturization and higher functionalities, megatrend applications like artificial intelligence (AI), 5G, and augmented reality (AR)/virtual reality (VR) are creating huge business opportunities and contributing to the growth of advanced packaging applications. Indeed, these megatrend applications are fueling the next generation of advanced packaging platforms (high-density FOWLP, 3D stacked TSV memory, WLCSP, and flip-chip), which have reached a new level of complexity and now demand higher integration-level requirements. These lofty standards will strongly influence the increasing demand for advanced materials with new technical specifications, in order to achieve better performance.

With respect to materials, polymeric materials (due to their excellent electrical, chemical, and mechanical properties) are already being applied in large-volume manufacturing in some advanced packaging process steps, and will increasingly be implemented when adopting additional functionalities in the same field.

The polymeric materials market generated revenue in excess of $700M in 2018, driven by dielectric material, and is expected to peak at ~$1.3B by 2023 with a 12% compound annual growth rate (CAGR) depending on the material type over this period. Polymeric materials growth will find support mostly from the expansion of dielectric material for more complex devices, followed by the broad introduction of polymeric temporary bonding material. The latter will be accelerated by the ramp-up of 3D stacked TSV in DRAM memory applications.

In this context, Yole Développement's report explains the dynamics of the polymeric materials market, as well as the advanced packaging platforms currently integrating polymeric materials. This report also offers: a detailed analysis of the polymeric materials market (by volume and value for advanced packaging); a market growth estimate for the 2017 - 2023 timeframe; and breakdowns by advanced packaging platforms and material function type.

DISPERSSION OF POLYMERIC MATERIALS INTO DIFFERENT FUNCTIONALITIES THROUGHOUT THE PACKAGING SECTOR

Polymeric materials are primarily used to protect printed wiring boards (PWB) from moisture, handling, and environmental influences. However, over the last few years, polymeric materials have attracted significant interest in the microelectronics field, while also making serious inroads in the advanced packaging area, adopting numerous functionalities within various packaging platforms. There are a wide variety of polymeric materials available to packaging manufacturers: PI, PBO, BCB, epoxies, silicones, and acrylic, all of which are defined by their constant dielectric, cure temperature, stress, etc. Today, polymeric materials in the advanced packaging industry have already found integration in major process steps: RDL, bump/UBM, through-silicon vias (TSV), and assembly levels, as well as at the bonding interface.
For polymeric dielectric materials-driven RDL passivation and UBM re-passivation, polyimide (PI)-based material is often favored. However, it appears that PBO, with its high drop-reliability properties, is an appealing choice for thick RDL layers in a thickness range above >10um. Moreover, it has been demonstrated that warpage and stress are greatly reduced with PBO, especially for bigger wafer sizes (300 mm).

Looking ahead, the molding compound only used for FOWLP at the wafer packaging level is based primarily on an epoxy which requires a low-as-possible CTE in order to avoid the wafer warpage issues induced via CTE mismatch between mold and silicon. Also, the high adhesion between the polymeric molding material and RDL must undergo a reliability test.

From a technical point of view, liquid molding compound is today the dominant material applied at wafer level for FOWLP. Nevertheless, granular material could move ahead in the polymeric materials market for FOWLP at both wafer and panel level.

Meanwhile, temporary bonding materials differ not only in terms of material function, but also from one advanced packaging platform to another, since the challenges are different depending on the platform. For instance, selecting the right temporary bonding material for FOWLP depends on the molding compound itself with respect to mechanical stress, CTE, thermal conductivity, die shift, and wafer warpage, while topography and post-bonding processing are the main concerns for 3D stacked TSV. These are typically based on thermoplastic or thermosets. Alternative solutions like PI and PBO are being evaluated, but there are still some cleaning-compatibility and removal issues to overcome.

Finally, regarding underfill material, the choice of a specific material and technique depends on a variety of parameters: end-application, thermal & reliability requirements, bump & pad metallurgy, die size, and silicon process node. For standard FC BGA/CSP at the assembly level, capillary underfill (CUF) is mostly used. However, due to further miniaturization and the gap between the substrate and the chip, pre-applied wafer-level underfill is also an option. Meanwhile, pre-applied underfills have gained a lot of traction for high-density applications (i.e. FOWLP and GPU) and for applications requiring large die-size in the range of 30X30 mm², while CUF is much more advantageous for small die-size (10X10 mm²) due to better flow.

Therefore, choosing the right polymeric material strongly depends on technical performance associated with functionality requirements and cost.

This report provides a comprehensive analysis of the different existing polymeric materials used for each advanced packaging process step, along with their status. Also presented is the maturity level of each polymeric material, by advanced packaging function. A technology roadmap showing the future steps for these polymeric materials solutions is included too.

The polymeric materials market is diversified and fragmented into varied suppliers like HD Microsystems, JSR Corporation, Merck, DOW, Nagase, Asahi Kasei, Henkel, Hitachi Chemical, Sumitomo Bakelite, TOK, Brewer Science etc. including several polymeric materials suppliers focused on one specific material. Each company has developed expertise in a specific material or two, but not all of them. Thus there is no clear leader amongst materials suppliers across the different functions and sectors – rather, one supplier is dominant in each material category.

Looking ahead, most materials suppliers involved with advanced packaging originate in myriad fields, from agricultural to pharmaceuticals, and span the entire materials range for microelectronics. Lucrative microelectronics business opportunities drive M&As between materials suppliers entering from different industries in a quest to acquire share in advanced packaging.

Some materials vendors utilize different strategies to skip a step in the advanced packaging polymeric materials processes:

- In an effort to evolve towards greater diversification, some materials suppliers have reshuffled the landscape through M&A - i.e. Nissan Chemical’s acquisition of Thin Materials, which allowed Nissan Chemical to enter the temporary bonding materials field.
• In the hopes of acquiring market share in other regions, recent acquisitions have transpired amongst materials suppliers aiming to expand their market reach: for example, Mactac America, which acquired Lintec Corp.
• Others are already seasoned specialists in materials for microelectronics, and maintain their leadership role by consistently enhancing their product portfolio.

On the other hand, Chinese polymeric materials suppliers (i.e. Kempur) coming from the integrated circuit business are trying to penetrate the advanced packaging market by leveraging their materials line to meet current packaging requirements. Many of these new Chinese players, which still lack significant market share, benefit from strong subsidies offered by local governments. This could help them compete with the top players in the mid-term.

Yole Développement’s report provides a map of the key polymeric materials involved in each polymeric material function and advanced packaging process step, as well as the material types offered. This report also provides quantified, detailed market share for major materials suppliers, segmented by process step and material functionality.

OBJECTIVES OF THE REPORT
• Detailed analysis of the major advanced packaging platforms using polymeric materials that could require the use of polymeric materials
• Polymeric materials roadmap for the advanced packaging platforms
• Give the current status of the polymeric material adoption and the various type of polymeric material available on the market
• Provide an overview of the technological trends for polymeric material
• Understand the key benefits and added value of the polymeric material in the field of advanced packaging
• How does polymeric material differ from the other alternative materials solutions
• Understand what are the remaining challenges of the implementation of the polymeric material in the field of advanced packaging
• Offer market metrics at polymeric material market level for advanced packaging applications (2017-2023)
• Evaluate market developments in terms of market size (volume, value, quantity), by material function and by advanced packaging platform
• Provide a competitive landscape, identify key players in technology development and manufacturing
• Give an overview of who is doing what, and specificities of each market

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WHAT’S NEW
• Polymeric materials market - status and evolution since 2012
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• Global polymeric materials market overview, segmented by advanced packaging application and material function: dielectric material, bonding stacked material, molding compound, underfill, photoreists, and temporary bonding material
• 2017 - 2023 global polymeric materials market forecast, in market value and units: split by advanced packaging platform and material function
• Update regarding key 2017 polymeric materials suppliers
• New analysis based on the competitive landscape and market share of polymeric materials suppliers, by material function

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We work across multiple industries to understand the impact of More-than-Moore technologies from device to system.

From A to Z…

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Industries included:
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- Medical systems
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- Energy management
- Mobile phone and consumer electronics
- Automotive
Yole Développement, System Plus Consulting, KnowMade and PISEO, all part of Yole Group of Companies, keep on increasing their collaboration to offer, in 2018, a collection of 150+ reports. Combining respective expertise and methodologies from the 4 companies, the reports aim to provide market & technology analysis, patent investigation and patent infringement risk analysis, teardowns & reverse costing analysis. They cover:

- MEMS & Sensors
- RF devices & technologies
- Imaging
- Medical technologies (MedTech)
- Photonics
- Advanced packaging
- Manufacturing
- Advanced substrates

- Power electronics
- Batteries and energy management
- Compound semiconductors
- Solid state lighting
- Displays
- Software
- Memory

You are looking for:

- An analysis of your product market
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The combined team of 60+ experts (PhDs, MBAs, industry veterans…) from Yole Développement, System Plus Consulting, KnowMade and PISEO, collect information, identify the trends, the challenges, the emerging markets, the competitive environments and turn it into results to give you a complete picture of your industry landscape.

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MEMS & SENSORS

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  - Silicon Photonics 2018 – Update
  - Consumer Biometrics: Hardware & Software 2018 – Update
  - Inkjet Functional and Additive Manufacturing for Electronics 2018
  - Fingerprint Sensor Applications and Technologies – Consumer Market Focus 2017
  - Sensors and Sensing Modules for Smart Homes and Buildings 2017
  - Acoustic MEMS and Audio Solutions 2017
  - MEMS & Sensors for Automotive Market & Technology Trends 2017
  - High End Inertial Sensors 2017
  - Magnetic Sensor 2017

- REVERSE COSTING® – STRUCTURE, PROCESS & COST REPORT – by System Plus Consulting
  - Piezo MEMS 2018 *

- PATENT ANALYSES – by KnowMade
  - MEMS Microphone – Patent Landscape Analysis
  - Knowles MEMS Microphones in Apple iPhone 7 Plus – Patent-to-Product Mapping 2017

- LINKED REPORTS – by Yole Développement, System Plus Consulting and KnowMade
  - MEMS Pressure Sensor 2018 – Market & Technology Report
  - Gas & Particles 2018 – Market & Technology Report
  - LiDARs for Automotive and Industrial Applications 2018 – Market & Technology Report
  - LiDAR for Automotive 2018 – Patent Landscape Analysis
  - MEMS Packaging 2017 – Market & Technology Report

RF DEVICES AND TECHNOLOGIES

- MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - Wireless technologies (Radar, V2X) for Automotive 2018
  - RF Standards and Technologies for Connected Objects 2018
  - RF & Photonic Components & Technologies for 5G Infrastructure 2018

- REVERSE COSTING® – STRUCTURE, PROCESS & COST REPORT – by System Plus Consulting
  - Automotive Radar Comparison 2018

- PATENT ANALYSES – by KnowMade
  - RF Acoustic Wave Filters 2017 – Patent Landscape Analysis

- LINKED REPORTS – by Yole Développement, System Plus Consulting and KnowMade
  - 5G impact on RF Front End Modules and Connectivity for Cellphones 2018 – Market & Technology Report – Update
  - RF Front End Modules for Cellphones 2018 – Patent Landscape Analysis
  - Advanced RF System-in-Package for Cellphones 2018 – Market & Technology Report – Update*
  - RF GaN 2018 – Patent Landscape Analysis

SOFTWARE

- MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - Consumer Biometrics: Sensors & Software 2018 – Update
  - Processing Hardware and Software for AI 2018 - Vol. 1 & 2
  - From Image Processing to Deep Learning, Introduction to Hardware and Software
OUR 2018 REPORTS COLLECTION (2/4)

IMAGING & OPTOELECTRONICS

○ MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - Status of the Compact Camera Module and Wafer Level Optics
  - Industry 2018 – Update
  - 3D Imaging and Sensing 2018 – Update
  - Sensors for Robotic Vehicles 2018
  - Machine Vision for Industry and Automation 2018
  - Imagers and Detectors for Security and Smart Buildings 2018
  - Uncooled Infrared Imagers 2017

○ PATENT ANALYSES – by KnowMade
  - iPhone X Dot Projector – Patent-to-Product Mapping

○ LINKED REPORTS – by Yole Développement, System Plus Consulting and KnowMade
  - Status of the CMOS Image Sensor Industry 2018 – Market & Technology Report - Update
  - CMOS Image Sensors Monitor 2018* – Quarterly Update**
  - Camera Module 2017 – Market & Technology Report
  - LiDARs for Automotive and Industrial Applications 2018 – Market & Technology Report
  - LiDAR for Automotive 2018 – Patent Landscape Analysis

ADVANCED PACKAGING

○ MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - Status of Advanced Packaging Industry 2018 – Update
  - Status of Advanced Substrates 2018: Embedded Die and Interconnects, Substrate Like PCB Trends
  - 3D TSV and Monolithic Business Update 2018 – Update
  - Power Modules Packaging 2018 – Update
  - Discrete Power Packaging 2018 – Update*

○ PATENT ANALYSES – by KnowMade
  - Hybrid Bonding for 3D Stack – Patent Landscape Analysis

○ LINKED REPORTS – by Yole Développement and System Plus Consulting
  - Advanced RF System-in-Package for Cellphones 2018 – Market & Technology Report - Update*
  - Fan-Out Packaging 2018 – Market & Technology Report – Update*

MANUFACTURING

○ MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - Wafer Starts for More Than Moore Applications 2018
  - Equipment for More than Moore: Technology & Market Trends for Lithography & Bonding/Debonding 2018
  - Polymeric Materials for wafer-level Advanced Packaging 2018
  - Laser Technologies for Semiconductor Manufacturing 2017
  - Glass Substrate Manufacturing in the Semiconductor Field 2017
  - Equipment and Materials for Fan-Out Packaging 2017
  - Equipment and Materials for 3D TSV Applications 2017

○ LINKED REPORTS – by Yole Développement and System Plus Consulting

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MEMORY
- **MARKET AND TECHNOLOGY REPORT** – by Yole Développement
  - Emerging Non Volatile Memory 2018 – Update
  - Memory Packaging Market and Technology Report 2018 – Update*
- **QUARTERLY UPDATE** – by Yole Développement**
  - Memory Market Monitor 2018 (NAND & DRAM)
- **MONTHLY UPDATE** – by Yole Développement**
  - Memory Pricing Monitor 2018 (NAND & DRAM)
- **REVERSE ENGINEERING & COSTING REVIEW** – by System Plus Consulting
  - DRAM Technology & Cost Review 2018
  - NAND Memory Technology & Cost Review 2018
- **PATENT ANALYSES** – by KnowMade
  - 3D Non-Volatile Memories – Patent Landscape

COMPOUND SEMICONDUCTORS
- **MARKET AND TECHNOLOGY REPORT** – by Yole Développement
  - Status of Compound Semiconductor Industry 2018*
  - GaAs Materials, Devices and Applications 2018
  - InP Materials, Devices and Applications 2018
  - Bulk GaN Substrate Market 2017
- **LINKED REPORTS** – by Yole Développement, System Plus Consulting and KnowMade
  - SiC Transistor Comparison 2018 – Structure, Process & Cost Report
  - Power SiC 2018 – Patent Landscape Analysis
  - GaN-on-Silicon Transistor Comparison 2018 – Structure, Process & Cost Report

POWER ELECTRONICS
- **MARKET AND TECHNOLOGY REPORT** – by Yole Développement
  - Status of Power Electronics Industry 2018 – Update
  - Discrete Power Packaging 2018 – Update*
  - Power Electronics for Electric Vehicles 2018 – Update
  - Integrated Passive Devices (IPD) 2018
  - Wireless Charging Market Expectations and Technology Trends 2018
  - Thermal Management Technology and Market Perspectives in Power
  - Electronics and LEDs 2017
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  - Market Opportunities for Thermal Management Components in Smartphones 2017
- **LINKED REPORTS** – by Yole Développement, System Plus Consulting and KnowMade
  - Power Modules Packaging 2018 – Market & Technology Report – Update
  - Power ICs Market Monitor 2018 – Quarterly Update**

BATTERY AND ENERGY MANAGEMENT
- **MARKET AND TECHNOLOGY REPORT** – by Yole Développement
  - Li-ion Battery Packs for Automotive and Stationary Storage Applications 2018 – Update
- **PATENT ANALYSES** – by KnowMade
- **LINKED REPORTS** – by Yole Développement and KnowMade
  - Solid State Electrolyte Battery 2018 – Market & Technology Report
  - Solid-State Batteries 2018 – Patent Landscape Analysis

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SOLID STATE LIGHTING

- MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - LiFi: Technology, Industry and Market Trends
  - LED Lighting Module Technology, Industry and Market Trends 2017
  - CSP LED Lighting Modules
  - Phosphors & Quantum Dots 2017 - LED Downconverters for Lighting & Displays
  - Horticultural Lighting 2017

- LINKED REPORTS – by Yole Développement and System Plus Consulting

DISPLAYS

- MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - Quantum Dots and Wide Color Gamut Display Technologies 2018 – Update
  - Displays and Optical Vision Systems for VR/AR/MR 2018

- PATENT ANALYSES – by KnowMade
  - MicroLED Display – Patent Landscape Analysis

MEDTECH

- MARKET AND TECHNOLOGY REPORT – by Yole Développement
  - BioMEMS & Non Invasive Emerging Biosensors: Microsystems for Medical
  - Applications 2018 – Update

- Point-of-Need Testing Application of Microfluidic Technologies 2018 – Update
- Neurotechnologies and Brain Computer Interface 2018
- CRISPR-Cas9 Technology: From Lab to Industries 2018
- Ultrasound Technologies for Medical, Industrial and Consumer Applications 2018
- Inkjet Functional and Additive Manufacturing for Electronics 2018
- Liquid Biopsy: from Isolation to Downstream Applications 2018
- Chinese Microfluidics Industry 2018
- Scientific Cameras for the Life Sciences & Analytical Instrumentation Laboratory Markets 2018*
- Artificial Organ Technology and Market 2017
- Connected Medical Devices Market and Business Models 2017
- Status of the Microfluidics Industry 2017
- Organs-On-Chips 2017
- Solid-State Medical Imaging 2017
- Medical Robotics Market & Technology Analysis 2017

- PATENT ANALYSES – by KnowMade
  - Microfluidic IC Cooling – Patent Landscape
  - Circulating Tumor Cell Isolation – Patent Landscape
  - OCT Medical Imaging – Patent Landscape
  - Pumps for Microfluidic Devices – Patent Landscape 2017
  - Microfluidic Technologies for Diagnostic Applications – Patent Landscape 2017
  - FLUIDIGM – Patent Portfolio Analysis 2017

- LINKED REPORTS – by Yole Développement, System Plus Consulting and KnowMade
  - Organs-On-Chips 2017 – Market & Technology Report
  - Organ-on-a-Chip – Patent Landscape Analysis
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PATENT ANALYSES – by KnowMade
- Wireless Charging Patent Landscape Analysis
- RF Acoustic Wave Filters Patent Landscape Analysis
- NMC Lithium-Ion Batteries Patent Landscape Analysis
- Pumps for Microfluidic Devices Patent Landscape
- III-N Patent Watch
- FLUIDIGM Patent Portfolio Analysis
- Knowles MEMS Microphones in Apple iPhone 7 Plus Patent-to-Product Mapping 2017
- Consumer Physics SCiO Molecular Sensor Patent-to-Product Mapping
- Patent Licensing Companies in the Semiconductor Market - Patent Litigation Risk and Potential Targets
- Microfluidic Technologies for Diagnostic Applications Patent Landscape

TEARDOWN & REVERSE COSTING – by System Plus Consulting
More than 60 teardowns and reverse costing analysis and cost simulation tools published in 2017

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**Unique, cost-effective ways to reach global audiences.**
Online display advertising campaigns are great strategies for improving your product/brand visibility. They are also an efficient way to adapt with the demands of the times and to evolve an effective marketing plan and strategy.

<table>
<thead>
<tr>
<th>Benefit from the i-Micronews.com traffic generated by the 11,200+ monthly unique visitors, the 10,500+ weekly readers of @Micronews e-newsletter</th>
<th>Several key events planned for 2018 on different topics to attract 120 attendees on average</th>
<th>Gain new leads for your business from an average of 340 registrants per webcast</th>
</tr>
</thead>
</table>

**Brand visibility, networking opportunities**
Today’s technology makes it easy for us to communicate regularly, quickly, and inexpensively – but when understanding each other is critical, there is no substitute for meeting in-person. Events are the best way to exchange ideas with your customers, partners, prospects while increasing your brand/product visibility.

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Webcasts are a smart, innovative way of communicating to a wider targeted audience. Webcasts create very useful, dynamic reference material for attendees and also for absentees, thanks to the recording technology.

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