



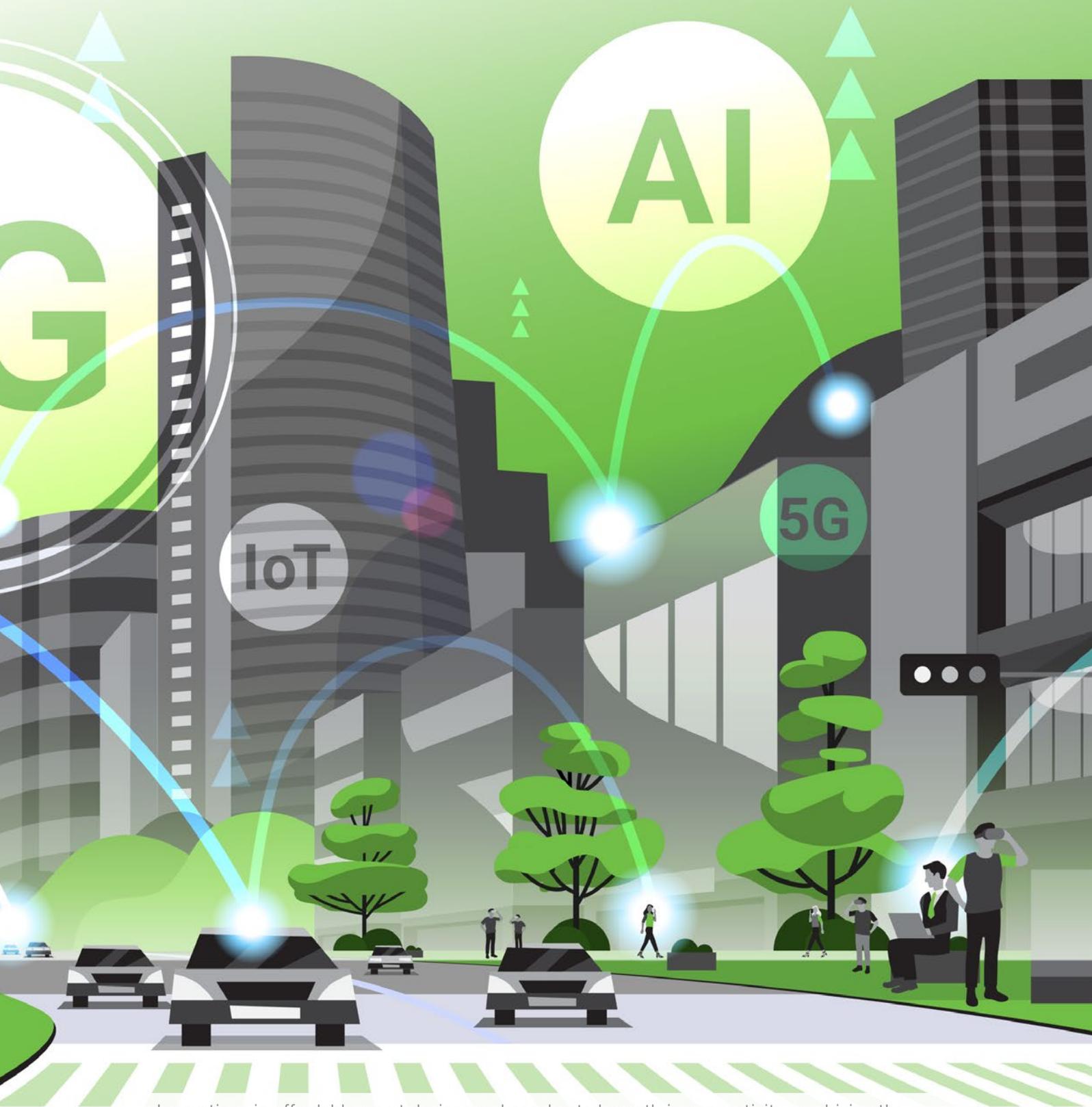
Continuing A Strong Bond
Advancing the Next Challenge in
Semiconductor Packaging





Driving the Digital Age - Advanced Packaging Rides on the Waves of 5G, AI, IoT Technologies

New end-market applications such as 5G, Internet of Things (IoT) and Artificial Intelligence (AI) are revolutionizing the semiconductor industry.



Innovations in affordable smart devices and accelerated growth in connectivity are driving the demand for advanced packaging technologies. Beyond the mobile market; the advanced packaging industry also serves other market segments in Automotive Infotainment, Artificial Intelligence and Server/Cloud industries. Big data requires greater processing power and higher speeds. As the world migrates to 5G networks and IoT; miniaturization results in increasingly complex semiconductor packaging requirements.

To meet these demands, the semiconductor packaging industry is re-inventing rapidly to develop new solutions. Heraeus Electronics seeks to do the same by innovating new advanced packaging solutions that address new packaging architectures such as System-in-Packaging, package stacking and heterogenous integration. It is our conviction to assist customers to stay as leaders of the technology landscape.



Phone



Wearables



Infotainment Dashboard



Server Room

We at Heraeus Electronics are ready for innovative 5G Device Solutions

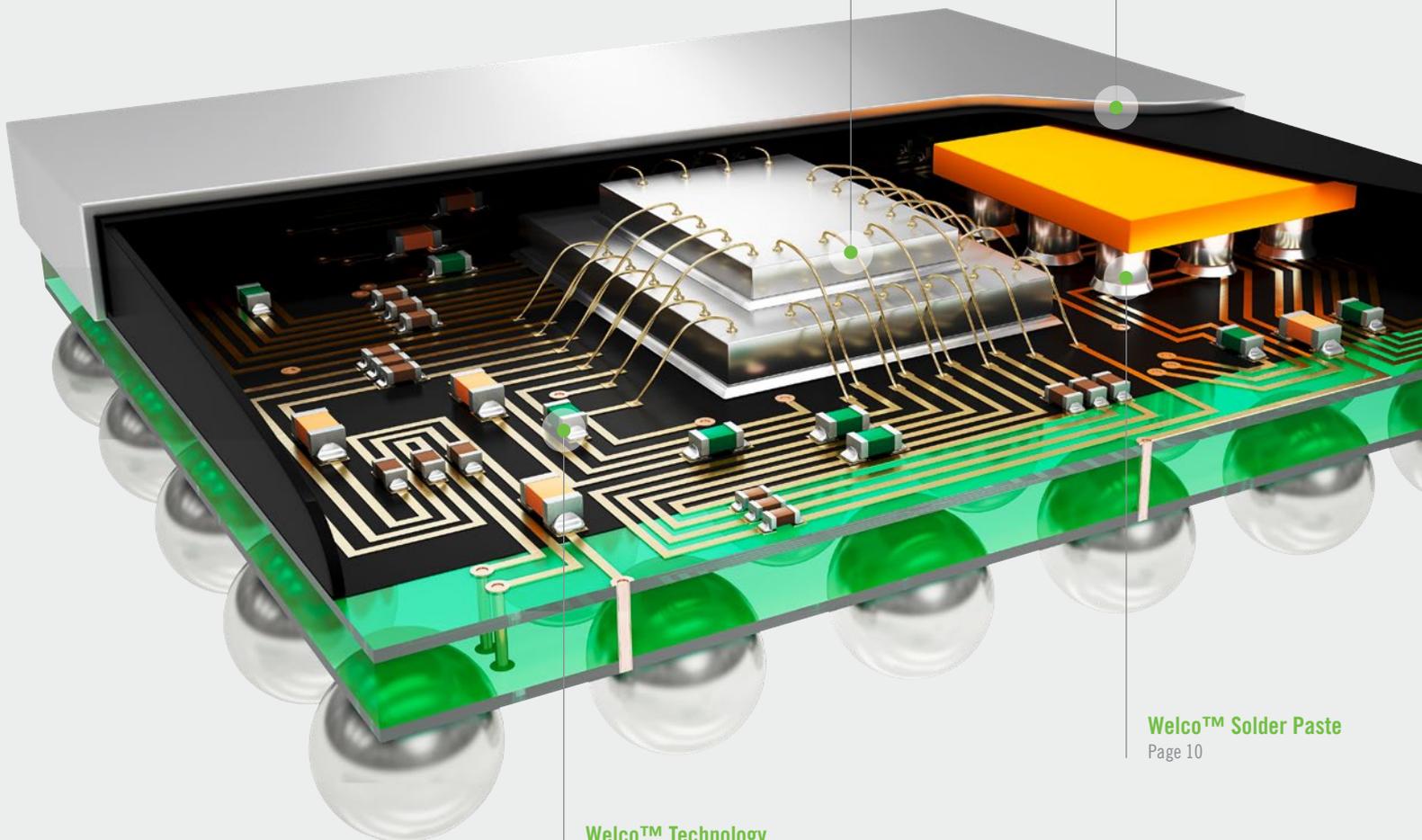
Continuing a Strong Bond with Heraeus Advanced Packaging Solutions

Heraeus has been a leading materials supplier to the semiconductor industry for decades. Widely known as a technology leader for bonding wires, we have been tackling the next technological challenge in semiconductor packaging and developed best-in-class advanced packaging solutions.

Advanced Packaging & SiP

Bonding Wire
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Shielding Solution**
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Heraeus Electronics - Taking on the Next Technological Challenge Together

Challenges Faced in the Digital Age



Heterogenous Integration of Devices

With wireless and mixed-signal devices, bio-chips, power devices and others in a single package, new requirements are constantly placed on the electronics industry.



Cost Pressure

The rising costs of raw materials, coupled with a competitive market, create cost-sensitive pressure on manufacturers.



Miniaturization

The continuous trend towards miniaturization of electronic components is demanding new technical requirements for the production processes.



High Performance Computing

With miniaturization, devices are operating in higher current density. Materials must meet such requirements.



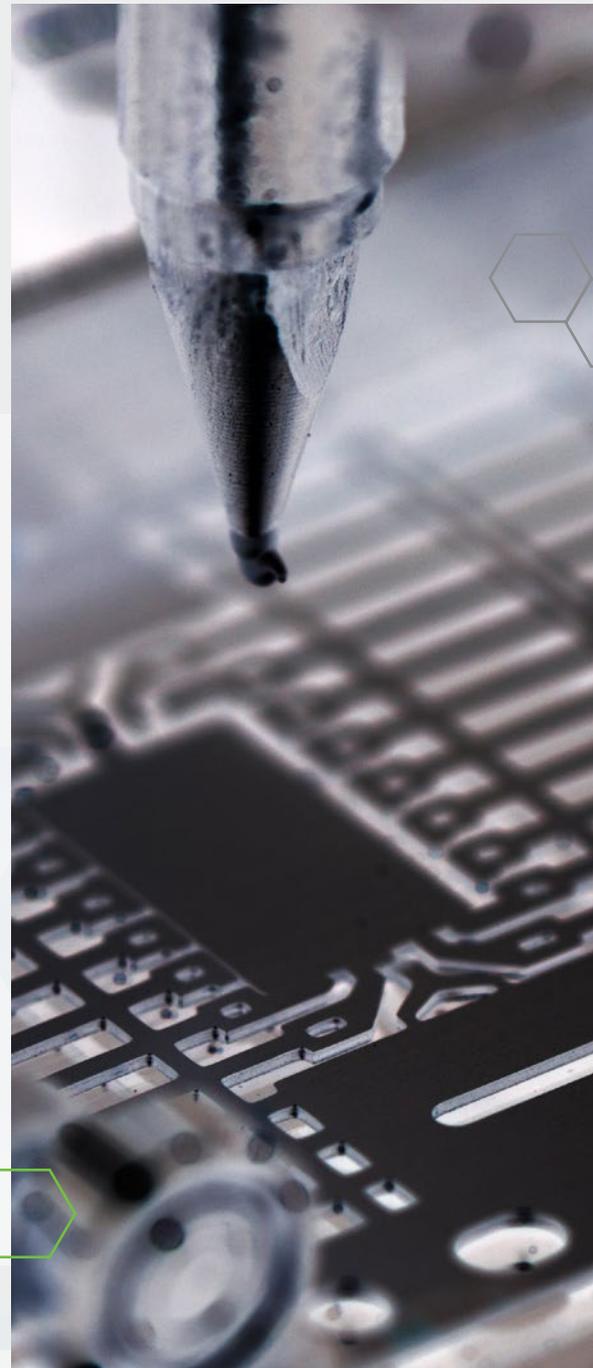
Customization and Flexibility

The trend toward customized products is also creating challenges in deadline and meeting quality standards as compared to standard manufacturing operations.

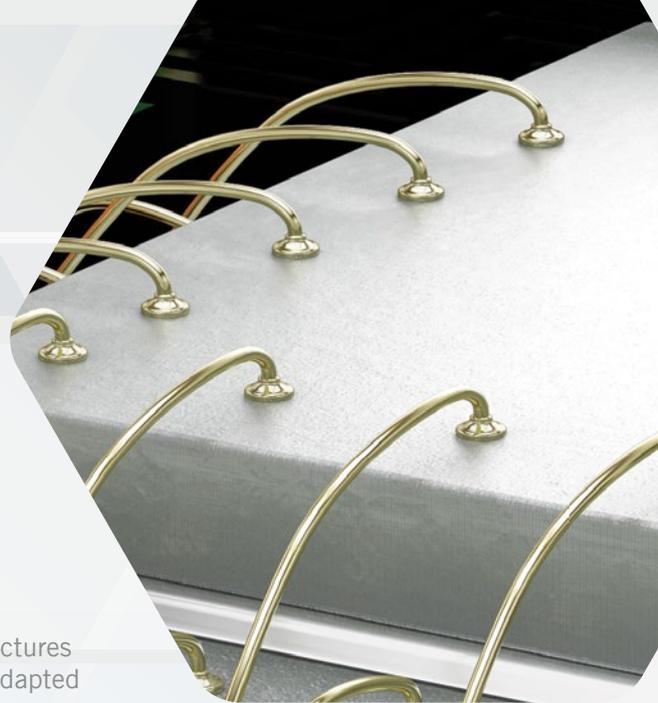


Higher Integration Support

Advanced materials must demonstrate the capability to manage chip-package interactions and integration with other materials during processing and assembly.



From Melting Precious Metals to **Micro-Joining Technology**



As requirements for applications become more demanding, Heraeus has developed a series of bonding wires of finer structures that can withstand harsher conditions. All our wires can be adapted to suit your specific needs.

Gold Bonding Wire

Available in a full range of diameters to suit your applications, our gold bonding wires span from high-power and discrete components to high pin-count, ultra-fine pitch devices. It can be used for different bonding processes such as ball bonding, stud bumping and wedge bonding.

We have a broad selection for the best workability and highest reliability gold bonding wires, namely AW14, AW66, AW99, HD5, HA6, Radix, Formax, RelMax, FP2, HA3 and LiteGold.

(NEW!) Gold-Coated Silver Bonding Wire

The newest addition to our bonding wire family, AgCoat® Prime offers a real alternative to gold wire for the memory device packaging. [\(Read more about this world's first gold-coated bonding wire on page 8-9\)](#)

Silver Bonding Wire

Our silver bonding wires have been developed to offer the perfect combination of significant cost reduction compared to gold wires and having the required bonding features for sensitive devices. They achieve excellent reliability and bondability.

Our wide choice of Ag-based alloyed wires includes AgLite®, AgUltra®, AgUltra-HR® and AgUltra-LR®. It is made of quality materials and can be used as a cost-effective alternative to Au wires.

Copper Bonding Wire

Due to its relatively low-cost materials and excellent thermal and electrical properties, these copper bonding wires are developed as an alternative interconnect material to gold-based solutions.

Our copper bonding wire is the market leader with the best established Maxsoft® series.

Palladium Coated Copper Bonding Wire

These wires are designed with a layer of palladium and gold ash on the surface of copper to prevent oxidation and improve its second bond workability.

We have PdSoft®, PdPro® and PdFlash® in the Palladium Coated Copper series.

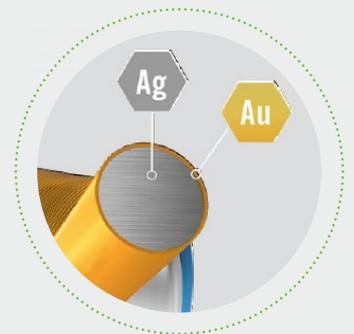


Low-Cost Alternative To Gold Wire Without Inert Gas

As new technologies emerge at an accelerating pace, the semiconductor market is increasingly reliant on gold bonding wire for devices such as memory devices and high-end smartcards to perform at optimal levels. However, using gold bonding wire raises production cost, and in a highly competitive market, the need for cost-efficiency has led manufacturers to scour for alternatives. On the other hand, all other alternative wires as a substitute are not the most ideal as they have shorter floor life and require inert gas.

Heraeus is proud to introduce its newest bonding wire – AgCoat® Prime, the world's first gold-coated silver alloy bonding wire that offers the bondability and reliability of gold wire, less the exorbitant price. With just minor parameter adjustment to suit your needs, there is no major disruption on wire migration or changes to production equipment and facilities.

AgCoat® Prime Gold-Coated Silver Bonding Wire is uniquely engineered to combine the best of gold and silver, offering an inert gas-free alternative to gold bonding wire for the semiconductor packaging industry. With a layer of gold on the exterior, its characteristics are closely aligned to gold bonding wire. This means that it is able to form a free air ball with no inert gas required. It also boasts a longer floor life of 60 days, thus enabling longer spool length for production efficiency.

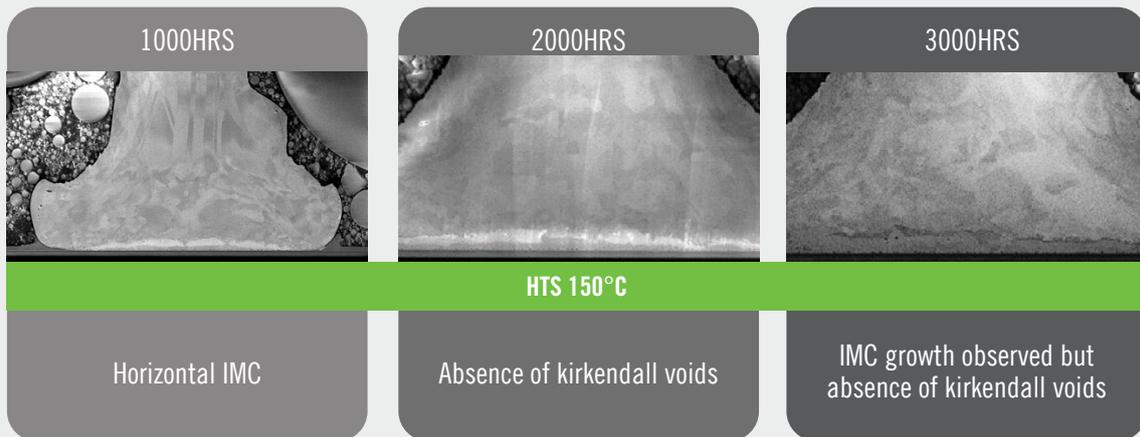


Uniquely designed and engineered with a silver alloy core base material, coated with a gold layer on the exterior



Better IMC Performance

Reliability Performance: HTS



Benefits

Cost Efficiency

- ~50% more cost efficient
- No inert gas required

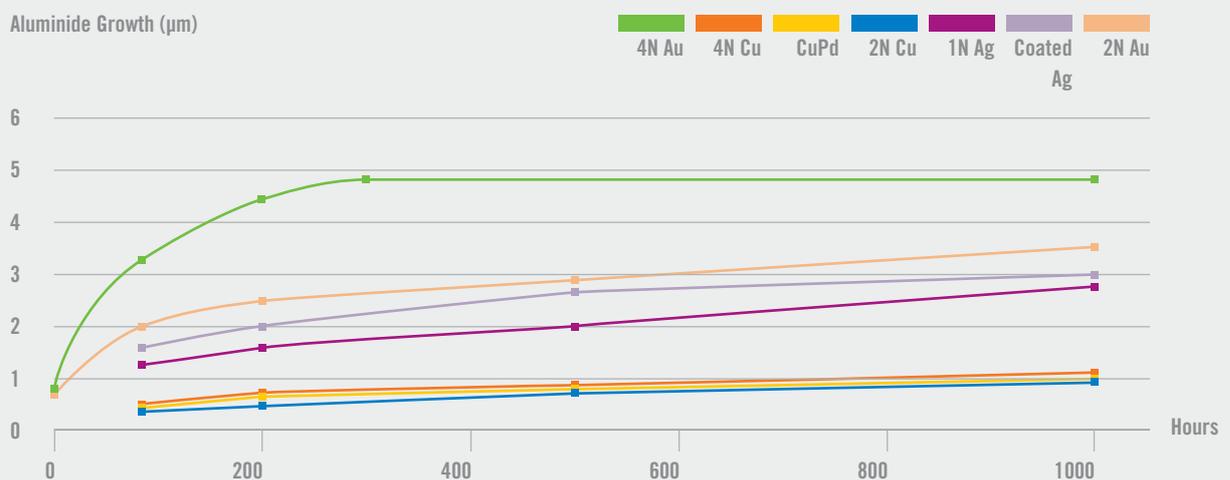
Better IMC Performance

- More reliable due to lower IMC growth rate
- IMC coverage of >70% and use green molding compound with high PH
- No Kirkendall voids observed after HTS 2000 hours
- No Ag migration

Comparable Bonding Performance to Au Wire

- Comparable MTBA to Au wire – minimum 4 hours
- No issue on high and low looping profile
- Good stud bump formation for SSB Bonding

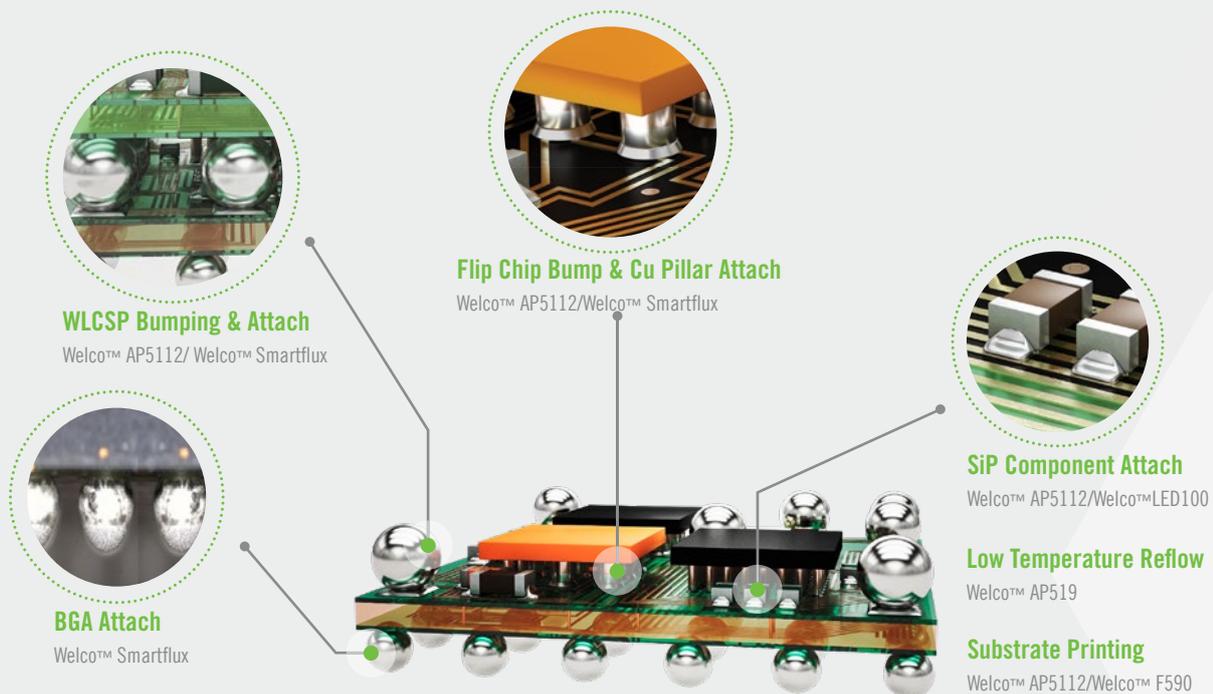
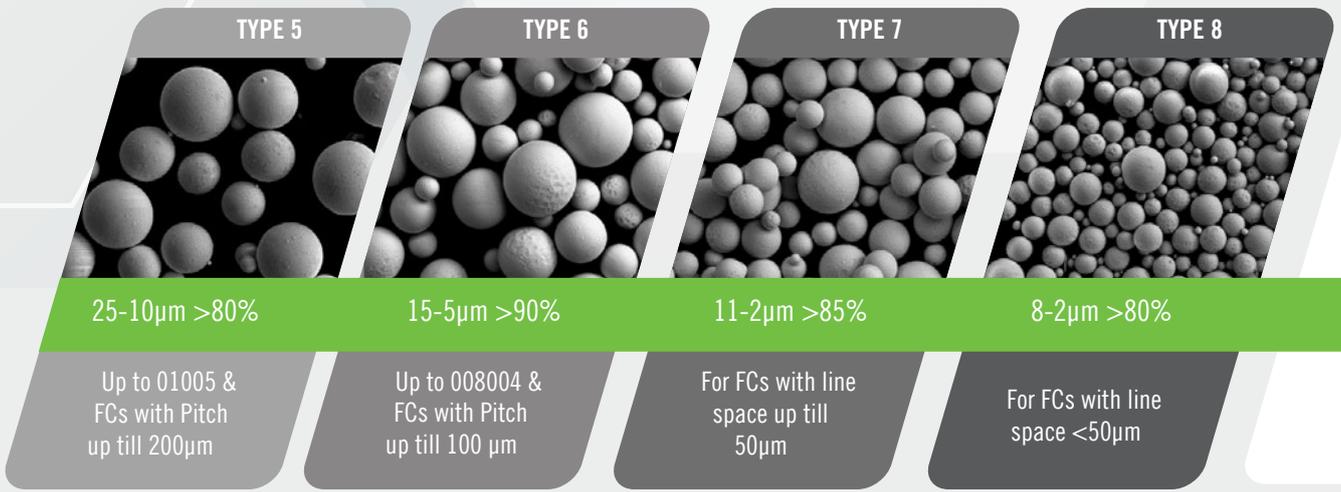
Thermal Ageing (HTS) of Coated-Ag of Unmolded Device



Heraeus Electronics Proprietary - Welco™ Technology

Our proprietary Welco™ Technology produces best-in-class fine powders for Advanced Packaging Applications. With our uniquely formulated Welco™ Fine Pitch solder paste, our technology improves yield by eliminating voids and with excellent consistency in solder volume.

Welco powder has very tight particle size distribution that exceeds IPC specifications, thus allowing smaller pitch to be attained and having the ability to pack more devices into the packaging.



Welco™ AP5112

Welco™ AP5112 is a halogen-free water-soluble solder paste specifically formulated for Advanced Packaging and System-in-Package. It has excellent printability, offering superior fine pitch printing performance while producing minimal, easily cleanable residues that maximizes yield.

This high-performing paste is RoHS compliant and enables manufacturers to have low voids performance even in multiple reflow processes.

It is designed for use in fine pitch applications such as mobile communications, consumer electronics and computing and automotive infotainment.

Welco™ AP5112 is available in Type 4 standard as well as in Type 6 and 7 Welco™ powder.



MAGNIFICATION
x2000

IPC Spec PSD >80%

RECOMMENDATION

Benefits

- Halogen-free
- Good printability on fine-pitch pad size
- Good wetting performance
- Good cleaning properties
- Long stencil life (≥ 8 hr) & long staging life (≥ 8 hr)
- No splashing
- Minimal residue
- Available in Type 4 to 7 powders
- Available in low alpha count SAC305 alloy

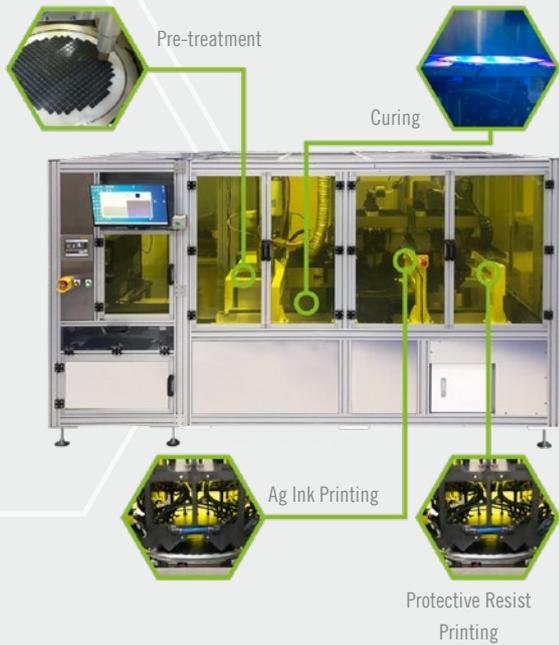


Welco™ AP519

Welco™ AP519 T6 solder paste is a low-temperature, state-of-the-art no-clean, lead-free solder paste formulated with Heraeus proprietary Welco powders. It is specifically designed for processes that require a low peak reflow temperature of $\leq 170^\circ\text{C}$. Applications include BGA, SMD component or flip-chip attach in fine-pitch semiconductor packages such as System-in-Packages (SiP), Package-on-Packages (PoP), etc. It can also be used for mini and microLED attach requiring low reflow temperatures.

Benefits

- Uses high-quality Welco™ Type 6 powders
- Narrow size distribution
- Uniform spherical shapes
- Batch-to-batch consistency
- Low peak reflow temperature at 170°C
- Best-in-class low-void performance
- Excellent fine pitch paste release
- Long stencil life (≥ 8 hr) & long staging life (≥ 8 hr)
- Colorless flux residue after reflow



Heraeus Full System Solution for EMI Shielding of Semiconductor Packaging

With the trend toward heterogeneous integration, miniaturization and 5G, higher operating frequencies and higher semiconductor packaging density has led to the need for enhanced EMI shielding, both within the device and also against the electromagnetic noise from outside the device.

Therefore, compartment shielding at packaging level is required and classical shielding via metal housings is no longer possible at such a small scale.

Heraeus has developed a full system solution that optimizes EMI shielding while ensuring proper functioning of high-frequency onboard chips and their ultra-fast data transmission. This system consists of Heraeus special particle-free silver ink and a manufacturing process that uses inkjet printing to apply the shielding coating.

Key Advantages

Superior Shielding Performance

- -60 dB shielding with thin Ag coating, tested up to 50GHz

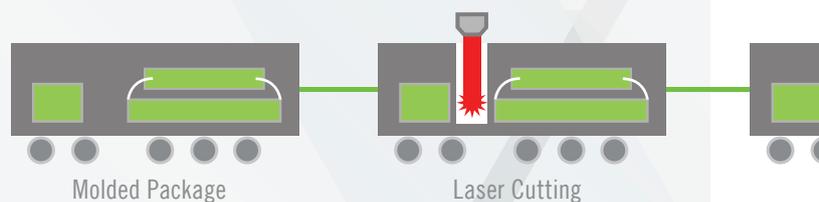
Selective Coating Capability

- Customised print layout with targeted ink deposition to create selective printing; no masking or etching required
- Reduces process complexity, time and cost
- Offers package designers opportunity for various pattern layout without long cycle time and high costs

Improved Efficiency (compared to PVD Sputtering)

- 3 times lower capex and smaller footprint
- 3 times higher process speed
- 25% lower TCO

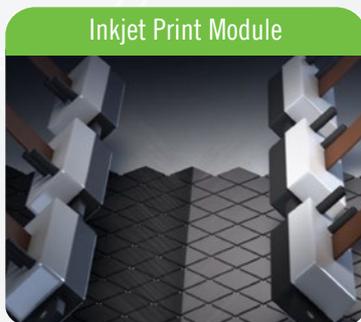
Heraeus selective printing enables trench coating and compartmental shielding in one equipment



Heraeus Prexonics® Inkjet Printing System Solution



- Metal decomposition (“MOD”) ink formulated for inkjet printing
- Inks are particle-free
- No risk of clogging issue
- No EHS concerns vs nano particle inks



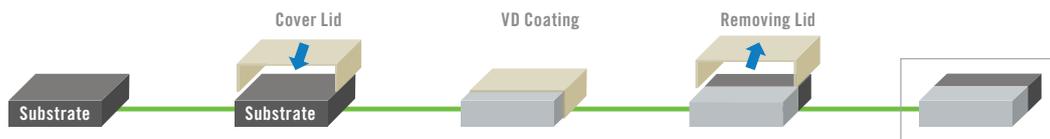
- Printing parameters optimized to the viscosity of ink and substrate
- Ease and speed of print conversion for design changes
- High speed printing of top surface and sidewall, up to 10 - 12 WPH (based on 10x10mm SiP)



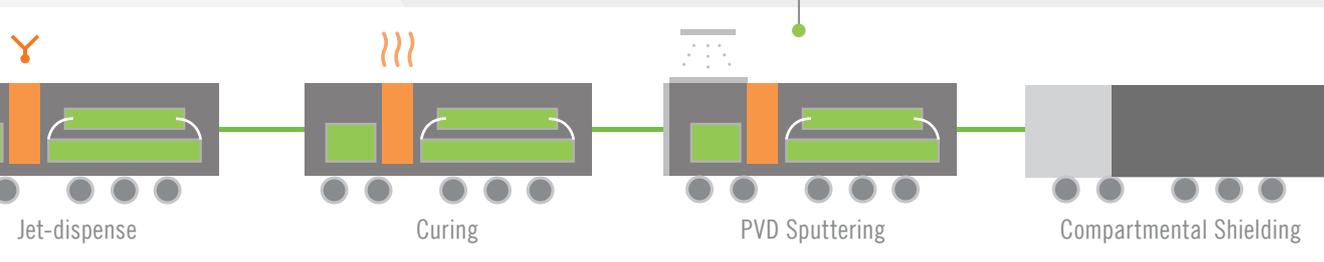
- Curing parameters fine-tuned to the ink and substrate
- UV system for high speed curing
- Delivers optimal Ag crystal structure and conductivity in the printed layer

Heraeus Prexonics® enables selective coating without the high cost and complexity

Existing process is complex, time-consuming, and costly



Heraeus Inkjet Printing with selective print layout **shortens the process**



*Trench coating and compartmental shielding in one equipment.

We are Heraeus Electronics

We are one of the leading manufacturers of materials for the assembly and packaging of devices in the electronics industry. We develop sophisticated material solutions for the automotive, power electronics, and semiconductor industry. Our core competencies include bonding wires, solder and sinter materials, thick film pastes, and substrates.

Headquartered in Hanau, Germany, Heraeus Electronics has a global footprint with eight production sites across six countries, ensuring a high supply chain reliability.

Additional four service centers located across Asia, USA and Europe enable us to support the needs of local markets, ensuring proximity and quick response time for our regional customers. Our customers benefit from shortened development cycles with higher first-time success rates, leading to faster time to market.



Headquartered in
Hanau, Germany



Product distribution to
over 50 countries



More than **50 years**
of experience in providing
materials for the electronics
industry



8 production sites
across **6 countries**



Over **1200**
employees worldwide

Production Sites and Application Centers

Strategic Locations to Support Our Customers Worldwide



PRODUCTION SITES

- Hanau
- Timisoara
- West Conshohocken
- Johor Bahru
- Changshu
- Zhaoyuan
- Singapore (2x)

APPLICATION CENTERS

- Hanau
- West Conshohocken
- Shanghai
- Hsinchu
- Singapore

Providing Material Solutions That Matter

Your Reliable Partner Who is Always There for All Your Needs

With an optimal infrastructure and comprehensive equipment, we shorten product development cycles through our application knowhow and expertise in matching materials, thereby lowering costs and bringing next-generation products faster to market.

Our expertise in material integration, optimization and understanding of material combinations, and the ability to test them under simulated conditions in our lab allow manufacturers to better understand material behaviors and the reliability of their products under simulated conditions. This accelerates the development process with higher first-time success rates.



HERAEUS GROUP THE GLOBAL TECHNOLOGY COMPANY

The Heraeus Group is a broadly diversified and globally leading family-owned technology company, headquartered in Hanau, Germany. The company's roots go back to a family pharmacy started in 1660. Today, Heraeus bundles diverse activities in the Business Platforms Metals and Recycling, Healthcare, Semiconductor and Electronics as well as Industrials. Customers benefit from innovative technologies and solutions based on broad materials expertise and technological leadership.

In the 2022 financial year, the group generated revenues of €29.1 billion (US\$30.6 billion*) with approximately 17,200 employees in 40 countries. Heraeus is one of the top 10 family-

owned companies in Germany and holds a leading position in its global markets.

(* calculated with 2022 average exchange rate, 1€ = 1.0530 US\$)

About Heraeus Electronics

Heraeus Electronics is a leading manufacturer of materials for the assembly and packaging of devices in the electronics industry. The company develops material solutions for the automotive, power electronics and advanced semiconductor packaging market and offers its customers a broad product portfolio - from materials and material systems to services.

The data given here is valid. We reserve the right to make technical alterations.

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The descriptions and engineering data shown here have been compiled by Heraeus using commonly-accepted procedures, in conjunction with modern testing equipment, and have been compiled as according to the latest factual knowledge in our possession. The information was up-to date on the date this document was printed (latest versions can always be supplied upon request). Although the data is considered accurate, we cannot guarantee accuracy, the results obtained from its use, or any patent infringement resulting from its use (unless this is contractually and explicitly agreed in writing, in advance). The data is supplied on the condition that the user shall conduct tests to determine materials suitability for particular application. The Heraeus logo, Heraeus, Condura®, DTS®, Die Top System® and the Condura, DTS, Die Top System figurative mark are trademarks or registered trademarks of Heraeus Holding GmbH or its affiliates. All rights reserved.

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