

## Whitepaper

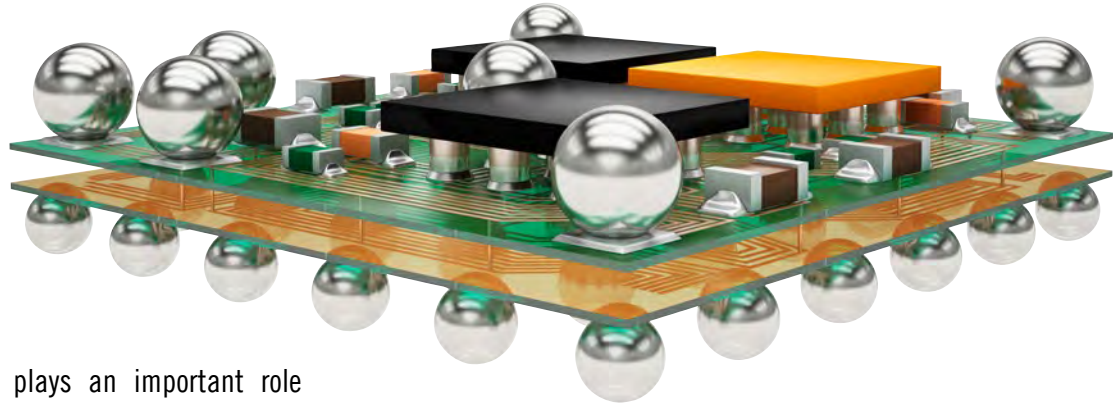
# SOLDER PASTE FOR SIP PRINTING OF THE FUTURE



**ELECTRONIC DEVICES** such as smartphones, tablets or high-end laptops must perform greater tasks and should be as portable and compact as possible.

To enable more functions in a smaller space, System in Package (SiP) technology combines multiple semiconductor chips and many passive components together into a tiny module. This is a challenge for production, as complex and numerous steps are necessary to complete the assembly of such SiPs.

**The result:** Longer production times, lower capacities and higher costs. With Welco AP5112 Type 7, Heraeus Electronics offers a unique solder paste where passive components and flip-chips with copper-pillars can be assembled simultaneously – while lowering solder defects; and increasing efficiency and quality in production.



“Flip-chip technology plays an important role in the production of modern microelectronics. “More than Moore” concept leverages on flip-chips technology; to combine a large number of functions in a very small space,” says Li-san Chan, Head of Advanced Packaging Market Segment at Heraeus Electronics. “However, the assembly process for SiPs, multiple flip-chips packages require higher complexity process steps to ensure good yield. One example: flux for assembling the flip chip copper column pads and the solder paste for mounting the passive components previously had to be applied in several steps.

This is time-consuming and requires additional investments in production capacities and printing stencils. In-addition, there could be flip-chips with varying die and Cu pillar sizes in the same package; that give co-planarity and open joints challenges. With Welco AP5112 T7, we now offer

the industry a convenient and efficient solution”. (Fig. 1) The innovative solder paste from Heraeus Electronics

- Simplifies SiP production considerably
- Significantly reduces flip-chips open-joints defects
- Helps to eliminate tombstones defects
- Creates more flexibility for users

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*says Li-san Chan, Head of Advanced Packaging Market Segment at Heraeus Electronics*

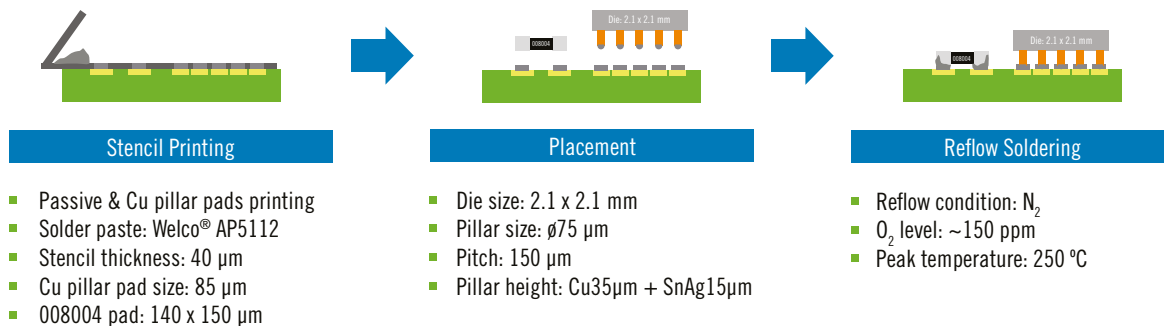


Fig 1: Printing in one step: The solder paste Welco AP5112 T7 from Heraeus Electronics is a combination of the flux platform Welco AP5112 and the ultra-fine alloy powder SAC305 type 7. The material can be used to solder both passive components and flip chip Cu pillars assembly. Microelectronics manufacturers can thus save one process step in SiP production - for higher throughput times and greater efficiency.

# AII-IN-ONE PRINTING FOR CU PILLAR CONTACTS AND PASSIVE COMPONENTS

For Welco AP5112 T7, Heraeus Electronics is using its water-soluble halogen-free AP5112 flux platform and combining it with Welco SAC305 Type 7 alloy powder. With its unique rheology, AP5112 offers excellent printing properties and enables the printing of extremely fine solder dots. Welco Type 7 powder SAC305 is characterized by its perfectly spherical powder particles and highly uniform particle size. More than 80 percent of the particles are in the range between 2~11 micrometers – it is highly suited for applications that require ultra-fine pitch. During the reflow process, low oxides surface of Welco powder ensure optimum metal coalesce and reliable bonding of the metals.

In combination with both flux and powder, the new Welco AP5112 T7 solder paste achieves printing of flip chip and passive components' pads in one single step. We can call this technique “All-In-One Printing”. It enables packaging houses and/or OSATs to save a complete process step while achieve extremely fine printing with stencil openings at 70 micrometers and spacing at 50 micrometers – ideal for vast majority of SiP Cu Pillars flip-chips (Fig. 2). “A further advantage: Welco AP5112 T7 has no splattering. An innovatively selected organic component was added to create AP5112 flux platform.” explains Li-san Chan. “With its unique, proprietary flux chemistry Welco AP5112 T7 does not splatter

during fast reflow temperature ramps, thus helping to avoid solder beads”.

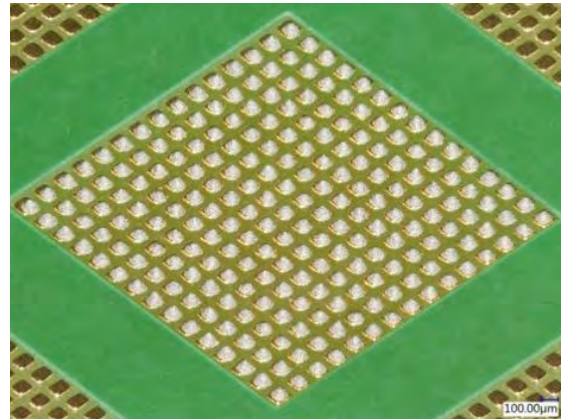
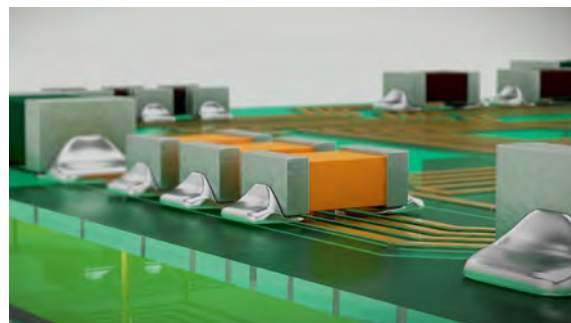


Fig 2: Fine solder dots for advanced technology: With its unique properties, Welco AP5112 T7 enables high-quality print results with very small stencil apertures from 70 micrometers and distances from 50 micrometers – ideal for SiP modules with high packing density.



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*says Li-san Chan, Head of Advanced  
Packaging Market Segment at Heraeus  
Electronics*

# PERFECT DISTANCING (NOT SOCIAL DISTANCING!), NO VOIDS - FOR PERFECT SOLDER CONTACTS

Just how powerful the new solder paste is demonstrated by Heraeus Electronics materials experts via a series of comprehensive tests.

“In one of our tests, we assembled a flip-chip and passive component 008004 onto a substrate, and after the reflow process we examined the solder points in detail,” says Li-san Chan.

The X-ray images show (Fig. 3): The solder joints of the Cu pillar and the passive component are very dense and have only minimal voids of less than one percent. This makes Welco AP5112 T7 the best in class material for void performance. The innovative solder paste also offers outstanding

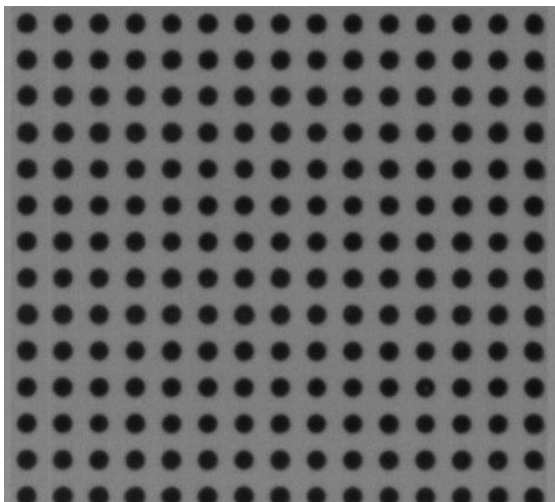


Fig 3: Reliable contacts, no voids: The x-ray image of the copper pillar pads from Heraeus Electronics' test series shows the excellent performance of Welco AP5112 T7 with reliable solder joints and no bridging.

performance in terms of line spacing and bridging. No solder bridging is found even at very fine pitch.

In the test series, very uniform solder bumps are achieved for Cu Pillars as well as for the passive component 008004 (Fig. 4). The experts from Heraeus Electronics repeated the tests with different stencil openings of 80 to 100 percent against the pad size. The solder height can be controlled very precisely. This allows users to effectively eliminate tombstones – and achieve greater reliability of the soldering joint.

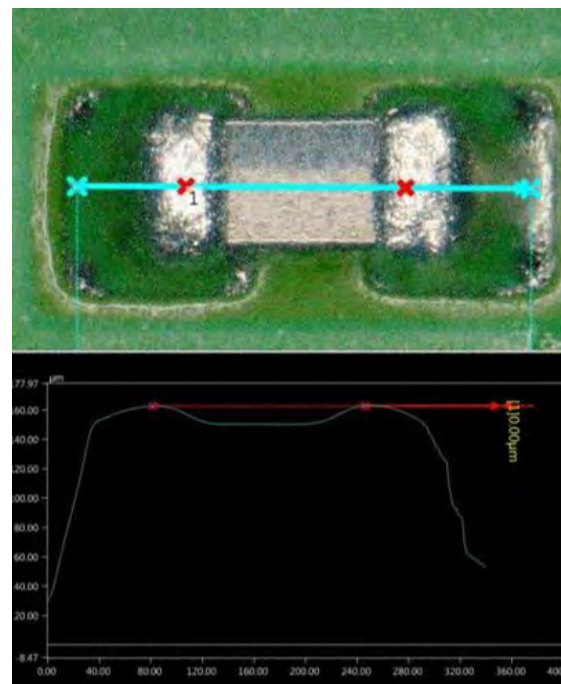


Fig 4: Optimum height control: The solder bumps with Welco AP5112 T7 of the passive component show very uniform solder heights in the test series at Heraeus Electronics - even with different stencil openings from 80 to 100 percent. Electronics manufacturers can thus effectively avoid production defects such as tombstones.

# STABLE VISCOSITY OVER 72 HOURS – FOR FLEXIBLE PROCESSING

The benefits do not stop here, Welco AP5112 T7 offers processing advantages. “Long pot life and stencil life are basic requirement for the industry. The longer printing paste can be processed, the more flexible the processes can be planned,” says Li-san Chan. “To simulate a processing operation, we exposed Welco AP5112 T7 paste in a laboratory environment and measured its viscosity over 72 hours. The results show that the solder material is extremely stable over this long period (Fig. 5). In another test, we examined the viscosity during the printing process”.

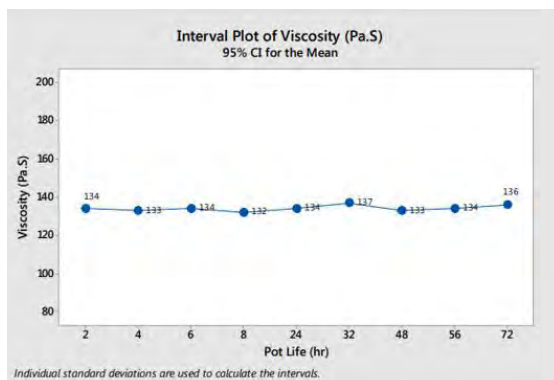


Fig 5: Excellent pot life over three days: Flexibility in queue time is an important factor in the industry. With a stable viscosity, Welco AP5112 T7 can be optimally processed within 72 hours - for maximum flexibility in production planning and minimum material waste.

For this test, solder dots were printed onto a gold-plated substrate with a DEK stencil printer over several hours and the diameters of the dots were examined. Even after eight hours (typically equivalent to one operator shift in an OSAT), the dots with Welco AP5112 T7 showed very uniform diameter (Fig. 6). Welco AP5112 T7 retains its rheological behavior over this period. The solder bumps obtain a uniform height after reflow. In addition, the optimized flowability allows flip chips to be fixed more precisely and prevents the components from misalignment and open-joints – for fewer defects and rejects.

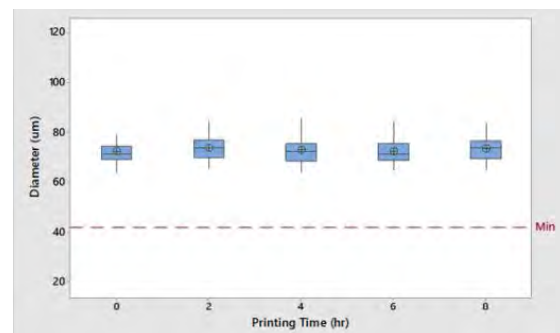


Fig 6: Highly stable viscosity during printing: During the test, Heraeus Electronics printed dots with Welco AP5112 T7 for over eight hours and measured the diameters. The dots showed very uniform diameters over the entire test period - for a precise print image over 8 hours.

***“This makes Welco AP5112 T7  
the best in class material for void  
performance”***

***says Li-san Chan, Head of Advanced Packaging  
Market Segment at Heraeus Electronics***



# Quality and efficiency for the microelectronics of the future

With its unique features, Welco AP5112 T7 offers semiconductor packaging houses an easy way to significantly simplify production processes in the manufacture of SiP modules and increase efficiency.

“The demand for miniaturization of semiconductors and higher packing density of SiP modules will continue to increase in the future,” says Li-san Chan. “Miniaturization remains a distinctive competitive factor. With Welco AP5112 T7, Heraeus Electronics offers a unique material to allow production of complex electronic components more efficient, to achieve higher quality – and to meet the production requirements of tomorrow.”



[INFOBOX]

### **Welco AP5112 T7 – The solder paste high-end technology**

In the new solder paste Welco AP5112 T7, Heraeus Electronics combines the properties of its Welco AP5112 flux platform and its SAC305 Type 7 ultra-fine alloy powder, which means that this unique material offers many advantages in the manufacture of SiP modules:

#### **Simplify processes, increase efficiency**

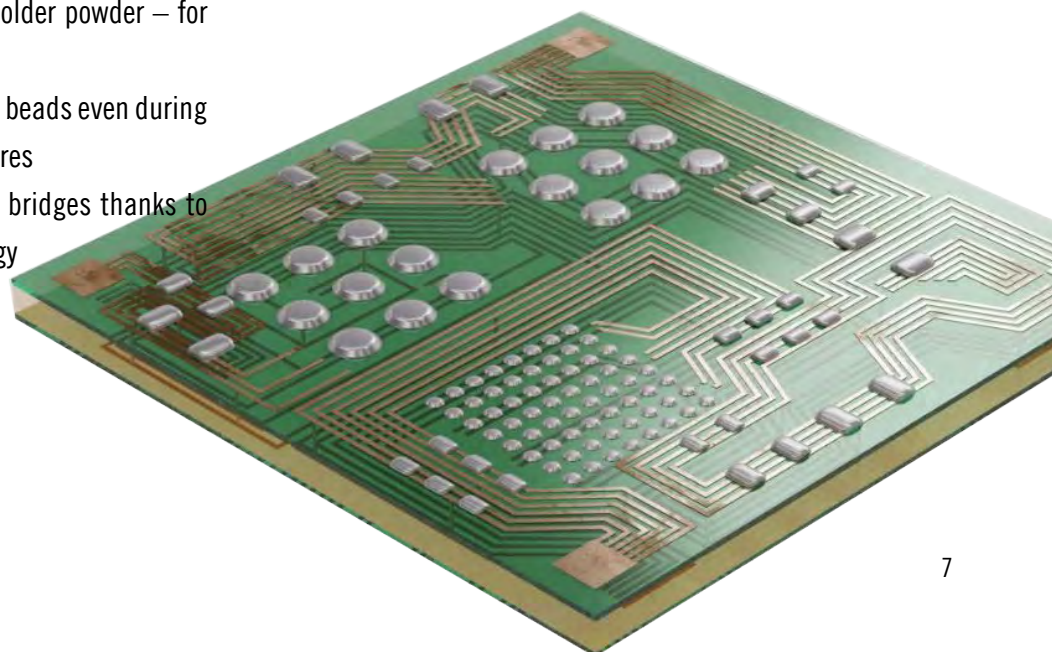
- All-in-one printing for flip chip and SMD pads – for shorter production times and higher yield
- Saving on additional tools such as printing plates and production capacity

#### **Higher quality, more demanding applications**

- Realization of finest printing structures with stencil openings from 70 micrometers and distances from 50 micrometers
- Leading in void performance thanks to superior quality of Welco solder powder – for reliable solder joints
- No splashing and no solder beads even during reflow at higher temperatures
- No tombstones and solder bridges thanks to permanently stable rheology

#### **More flexibility in production**

- Stable viscosity with a pot life of over 72 hours
- Uniform solder volume over 8 hours of continuous printing



# HERAEUS GROUP THE GLOBAL TECHNOLOGY COMPANY

A globally leading technology group, Heraeus is headquartered in Hanau, Germany. Founded in 1851, it is a family-owned portfolio company which traces its roots back to a pharmacy opened by the family in 1660. Today, Heraeus combines businesses in the environmental, energy, electronics, health, mobility and industrial applications sectors.

In the 2018 financial year, Heraeus generated revenues of €20.3 billion with approximately 15.000 employees (including staff leasing) in 40 countries. Heraeus is one of

the top 10 family-owned companies in Germany and holds a leading position in its global markets.

With technical expertise, a commitment to excellence, a focus on innovation and entrepreneurial leadership, we are constantly striving to improve our performance. We create high-quality solutions for our clients and strengthen their long-term competitiveness by combining unique material expertise with leadership in technology.

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