

December 10, 2013
Tanaka Precious Metals
Tanaka Holdings Co., Ltd.
Newlong Seimitsu Kogyo Co., Ltd.
Taiyo Chemical Industry Co., Ltd.

Tanaka Precious Metals, Newlong Seimitsu Kogyo and Taiyo Chemical Industry Commence to Provide Submicron Gold Particle Micro-composite Pattern Printing Technology on December 4

The technology enables batch printing of bonding material micro-composite patterns bondable at 200°C and heat resistant to 300°C - In combination with screen printing, it resolves numerous issues for devices such as MEMS and LEDs with low heat resistance

Tanaka Kikinzoku Kogyo K.K.^(*) (a company of Tanaka Precious Metals, Head office: Chiyoda-ku, Tokyo; President & CEO: Hideya Okamoto), Newlong Seimitsu Kogyo Co., Ltd. (Head office: Shinagawa-ku, Tokyo; President & CEO: Masayuki Itagaki) and Taiyo Chemical Industry Co., Ltd. (Head office: Takasaki-shi, Gunma; President & CEO: Hitoshi Ogawa) commence to provide technology enabling the batch formation of micro-composite patterns on substrates using screen printing with **AuRoFUSE™** low-temperature bonding material utilizing submicron-sized (1/10,000 mm) gold particles on Wednesday, December 4, 2013. The companies provide **AuRoFUSE™**, printing machines and screen mask technology to customers, including consulting on the introduction of the technology and sample prototype support.

Manufacturers of LED (light emitting diode) chips and MEMS (microelectromechanical systems) devices will be able to achieve the following by implementing the technology.

- Print formation of micro-composite patterns for high heat-resistant and low-resistivity electrode bonding and sealing frames with excellent step absorption on gold (Au) wiring of silicon wafers and substrates is possible.
- Printed sealing frames can create airtight seals by having a finer structure by thermocompression bonding at 200°C.
- Patterns can be formed using high-definition screen printing, and processing can be reduced because the combination of multiple processes such as plating, deposition and sputtering are not required
- 8-inch wafer size patterns formation is possible.
- **AuRoFUSE™** enables work to be performed with minimal material loss because it can withstand repeated printing. It is believed that this can practically reduce the cost of key processes



AuRoFUSE™ sealing frames (200 micrometers wide) printed on an 8-inch wafer

■ Printing technology has been developed to form "thinner, smaller and narrower" AuRoFUSE™ micro-composite patterns

AuRoFUSE™ is a paste-type bonding material containing a mixture of gold particles with the particle diameter controlled to be submicron sized and an organic solvent. Generally, microscopic particles have the characteristic called "sintering" where particles bond to each other when heated to a temperature under the melting point. If AuRoFUSE™ is heated to 200°C, the solvent evaporates, and the gold particles undergo sinter bonding without the application of pressure. Sufficient bonding strength of approximately 30 megapascals (MPa) can be maintained at temperatures under 300°C. Bonding strength at high temperatures can be achieved without pressing the load onto components during bonding.

Tanaka Kikinzoku Kogyo has been examining process technology using AuRoFUSE™ to enable users to easily form micro-composite patterns on substrates. It was thought that "thin, small and narrow" formation was essential to use gold material efficiently in the process, and the Company has focused on the combination with high-definition screen printing suit for mass production, and the joint development with Newlong Seimitsu Kogyo and Taiyo Chemical Industry. Tanaka Kikinzoku Kogyo handled printing stability of AuRoFUSE™, Newlong Seimitsu Kogyo performed the technical evaluation required for using AuRoFUSE™ in screen printing machines, and Taiyo Chemical Industry calibrated the printing mask specifications.

■ Effective for airtight sealing of MEMS

As devices become more highly functional, MEMS device manufacturers are facing with the issue of rising packaging costs in wafer-level packaging (WLP). For example, reduced plating costs and improvements in yield are essential in conventional sealing methods using fusion bonding at 200°C by applying multi-layer gold-indium plating on the sealing frame.

Sealing frames formed by screen printing AuRoFUSE™ provide densification and high vacuum sealing^{(*)2} as a result of forming gold particle sintered compacts using thermocompression bonding (200°C, 100MPa). Gold sintered compacts have compression deformability able to absorb unevenness on substrate surfaces, and not only can reduce the surface treatment (CMP) that was required by conventional bonding, but also improve product yield. Miniaturization of packages becomes possible by reducing the printing width, and the technology is considered to have extremely versatility for the future.

■ Resolution of the issue of "heat" in bonding materials used in power devices such as high-output LEDs

Currently, tin-based and gold-based solder widely used as die bond materials^{(*)3} have heat resistance up to melting point, but there are various issues as a die bond material in next-generation power devices expected to have even higher performance. For example, in the field of high-output LEDs, bonding wire is used to electrically connect the chip surface and the substrate, but it has been indicated that the wire blocking the light emitting surface reduced brightness. Because of this, flip chip bonding is gaining attention for being able to provide better light emission efficiency by using protrusions (bumps) instead of wires as terminals to connect to electrodes. When doing so, the contact area becomes smaller, and the thermal resistance of the solder alloy itself is higher, which reduces the heat dissipation from the element, and results in higher temperature of the element and consequentially lower light emission performance. AuRoFUSE™, which is a gold-gold bond, is able to eliminate element damage from the perspective of high heat dissipation.

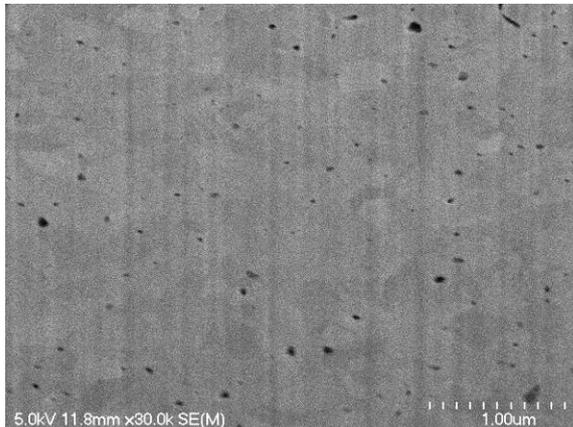
Furthermore, next-generation power semiconductors using silicon carbide (SiC) and gallium nitride (GaN) have operating temperatures that can exceed 300°C. Because of this, although materials melt in bonds using gold-tin solder, bonding with **AuRoFUSE™** provides sufficient heat dissipation and bonding strength even at 300°C.

Tanaka Kikinzoku Kogyo has been providing samples of **AuRoFUSE™** since December 2009, but the commencement of the provision of this technology marks the establishment of a mass production capable to manufacture 200 kg of **AuRoFUSE™** per year. The company is aiming for annual **AuRoFUSE™** sales of 2 billion yen by 2020 by providing the material as a standalone product and also providing **AuRoFUSE™** combined with other technologies as in this case.

Tanaka Kikinzoku Kogyo will exhibit at the 15th IC Packaging Technology Expo located at Tokyo Big Sight (Koto-ku, Tokyo) from January 15 (Wed) until January 17 (Fri), 2014. The booth (East Hall 43-001) will contain exhibits of samples of wafers with patterns formed using the technology, and technical staff will be on-site to respond to interviews.



AuRoFUSE™ paste



Sectional structure of a sealing frame after
compression deformation
(150°C, 100MPa, 30 minutes)

- (*1) Tanaka Kikinzoku Kogyo K.K.: The core company conducting manufacturing operations in the Tanaka Precious Metals Group, which has Tanaka Holdings Co., Ltd. as its holding company.
- (*2) A helium leakage of 1.0^{-13} Pa.m³/s is achieved. That means the leakage was such that the pressure of 1 m³ rose by 0.000000000001 Pascal per second.
- (*3) Die bond material: The material used to bond chips to lead frames, ceramics and substrates.

■ **Tanaka Holdings Co., Ltd. (Holding company of Tanaka Precious Metals)**

Headquarters: 22F, Tokyo Building, 2-7-3 Marunouchi, Chiyoda-ku, Tokyo

Representative: Hideya Okamoto, President & CEO

Founded: 1885

Incorporated: 1918

Capital: 500 million yen

Employees in consolidated group: 3,895 (FY2012)

Net sales of consolidated group: 839.2 billion yen (FY2012)

Main businesses of the group:

Manufacture, sales, import and export of precious metals (platinum, gold, silver, and others) and various types of industrial precious metals products. Recycling and refining of precious metals.

Website: <http://www.tanaka.co.jp/english> (Tanaka Precious Metals),

<http://pro.tanaka.co.jp/en> (Industrial products)

■ **Tanaka Kikinzoku Kogyo K.K.**

Headquarters: 22F, Tokyo Building, 2-7-3 Marunouchi, Chiyoda-ku, Tokyo

Representative: Hideya Okamoto, President & CEO

Founded: 1885

Incorporated: 1918

Capital: 500 million yen

Employees: 1,455 (FY2012)

Sales: 808.6 billion yen (FY2012)

Main businesses:

Manufacture, sales, import and export of precious metals (platinum, gold, silver, and others) and various types of industrial precious metals products. Recycling and refining of precious metals.

Website: <http://pro.tanaka.co.jp/en>

< **About the Tanaka Precious Metals** >

Established in 1885, the Tanaka Precious Metals has built a diversified range of business activities focused on the use of precious metals. On April 1, 2010, the group was reorganized with Tanaka Holdings Co., Ltd. as the holding company (parent company) of the Tanaka Precious Metals. In addition to strengthening corporate governance, the company aims to improve overall service to customers by ensuring efficient management and dynamic execution of operations. Tanaka Precious Metals is committed, as a specialist corporate entity, to providing a diverse range of products through cooperation among group companies.

Tanaka Precious Metals is in the top class in Japan in terms of the volume of precious metal handled, and for many years the group has developed and stably supplied industrial precious metals, in addition to providing accessories and savings commodities utilizing precious metals. As precious metal professionals, the Group will continue to contribute to enriching people's lives in the future.

The eight core companies in the Tanaka Precious Metals are as follows.

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| - Tanaka Holdings Co., Ltd. (pure holding company) | - Tanaka Kikinzoku Kogyo K.K. |
| - Tanaka Kikinzoku Hanbai K.K. | - Tanaka Kikinzoku International K.K. |
| - Tanaka Denshi Kogyo K.K. | - Electroplating Engineers of Japan, Limited |
| - Tanaka Kikinzoku Jewelry K.K. | - Tanaka Kikinzoku Business Service K.K. |

■ **Newlong Seimitsu Kogyo Co., Ltd.**

Headquarters: 3-21-5 Higashi-gotanda, Shinagawa-ku, Tokyo

Representative: Masayuki Itagaki, President & CEO

Established: 1948

Capital: 40 million yen

Employees: 130 (as of April 2012)

Sales: 2.6 billion yen (FY2012)

Businesses: Manufacture and sale of screen printing machines

Website: <http://www.newlong.co.jp/en/>

■ **Taiyo Chemical Industry Co., Ltd.**

Headquarters: 2947-1 Kuragano-cho, Takasaki-shi, Gunma

Representative: Hitoshi Ogawa, President & CEO

Established: 1970

Capital: 160 million yen (wholly-owned by Taiyo Yuden Co., Ltd.)

Employees: 223 (as of April 2013)

Sales: 4.48 billion yen (FY2012)

Businesses: Surface treatment of electronic components such as multi-layer capacitors, manufacture and sale of packaging tools (metal masks, pallets), processed metal components (laser processing and etching) and screen masks for high-definition printing

Website: <http://www.taiyo-kagaku.co.jp>