

Tanaka Denshi Kogyo Taps Cu, Ag Alloy as Next-Generation Bonding Wires

For 126 years since its founding, Tanaka Kikinzoku (Precious Metals) Group has contributed to the advancement of various industries with its products made of precious metals. Precious metals are used over a broad spectrum of applications and offer infinite possibilities.

Tanaka Denshi Kogyo Group, a core business of Tanaka Precious Metals Group, has been operating four manufacturing bases, including overseas plants in China, Singapore, Malaysia, and Japan. In these bases, bonding wires for semiconductors are manufactured for the past 50 years since the company was formed in 1961. Tanaka Denshi Kogyo K.K. has the world's largest share of gold (Au) wires, among its products.

Market Trend of Au Wires

Au wires have a wide variety of features that can be used based on the package to be adopted. At present, there are more than 20 variations.

Recently, the diameter of bonding wires has been getting thinner progressively over the years in order to implement finer design rules for chip wiring and to reduce material costs. Wires with a diameter of about 15 μ m are now being used. For this reason, most Au wires are of high strength type compared with previous wires.

Moreover, ball bondability with improved roundness than before is needed for bonding Au wires to an extremely small bonding pad. Au wires, such as

those with improved 2nd bondability for low-cost lead-free type packages, have been developed to meet various demands in the market.

Transition from Au Wires to Cu Wires

The highest percentage of cost related to Au wires is the material cost. A limit has been set in terms of reducing the cost of Au wires to meet the severe cost reduction requirements in recent years. Copper (Cu) is one of the materials that can be used as a substitute for Au. Various semiconductor manufacturers are working on shifting from Au wires to Cu wires.

Table 1: Advantages of features of CLR-1A

| Item | Wire cost | Squashed ball roundness | 2nd bondability | Capillary life |
|----------------|-----------|-------------------------|-----------------|----------------|
| CLR-1A | ☆☆☆ | ☆☆☆☆ | ☆☆☆☆ | ☆☆ |
| CLR-1 | ☆☆☆☆ | ☆☆☆☆ | ☆☆☆☆ | ☆☆ |
| Bare Cu | ☆☆☆☆ | ☆☆☆☆ | ☆☆ | ☆☆☆☆ |
| Au | ☆☆ | ☆☆☆☆ | ☆☆☆☆ | ☆☆☆☆ |

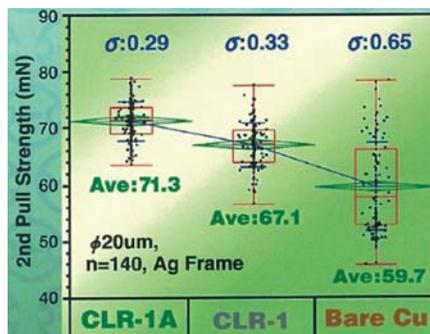


Fig. 2: Comparison of 2nd pull strength

To meet the wide ranging market needs for Cu wires, Tanaka Denshi Kogyo has added to its product lineup called the CLR-1A type, which is a palladium (Pd)-coated Cu wire, in addition to bare Cu wires. The CLR-1A type has superior 2nd bondability and longer capillary life compared with conventional Pd-coated Cu wires. This new product has been drawing attention recently in the market, which has seen mass production shifting to the full-scale use of Cu wires.

Table 2: Advantages of SEA type wire

| Item | Wire type | Gold wire | SEA | Copper wire |
|-----------------------------------|-----------|-----------|---------------------|--------------------------------|
| Material cost | | ☆☆ | ☆☆☆ | ☆☆☆☆ |
| Chip Damage & Al-splash | | ☆☆☆ | ☆☆ | ☆☆ |
| Forming Gas | | — | Only N ₂ | N ₂ +H ₂ |
| Process window (1st and 2nd bond) | | ☆☆☆ | ☆☆ | ☆☆ |

Shift from Au Wires to Ag Alloy Wires

While the use of Cu wires can significantly reduce cost, there are considerable technological



Fig. 3: Appearance of SEA type wires

obstacles to their application. Among others, reducing the damage to the bonding pad has been addressed as a major issue.

Tanaka Denshi Kogyo has developed the SEA type silver (Ag) alloy wire. This SEA type Ag alloy wire does not reduce cost as much as Cu wires, but can reduce the rate of damage that occurs to the pad to extremely low levels, offering excellent productivity and reliability.

In addition, only nitrogen gas (N₂) needs to be used as forming gas for the SEA type, whereas a mixture of N₂ and hydrogen gas (H₂) must be used as forming gas for Cu wires. Therefore, the SEA type can keep the running cost low and offer high safety.

Recently, there are many cases where cost reduction has been achieved quite easily within a short period of time by using the SEA type wire when it is not convenient to apply Cu wires because of pad damage or other issues.

In addition to Au wires, the company has been making efforts to carry out research and development of Cu wires and Ag alloy wires, which are the next-generation bonding wires. Along this line, Tanaka Denshi Kogyo will continue with its commitment to support the advancement of the next-generation semiconductor industry. □

| | |
|--------------|---|
| Au [Gold] | Stable Stitch Bond Bonding Wire GSA, GSB |
| | Fine Pitch Applications GFC, GFD, MGQ20 |
| | High Strength & Fine Pitch Applications GMG, GMH-2, MGFL1 |
| | Super Low Loop Applications GLF |
| | High Reliability Applications GPG, GPG-2, GPG-3, MGA22 |
| | Cost Effective Au Alloy Wire LC |
| | Au Alloy & Au Bumping Wire GBC, GBE |

Fig. 1: Typical example of Au wires of Tanaka Denshi Kogyo

<http://www.tanaka-bondingwire.com>

EEJA's Wafer Plating Technique Suits Advanced Chip Fabrication

Plating applications in semiconductor fabrication processes have diversified in recent years. Characteristics, like uniformity of shape, alloy ratio, inner stress, and hardness in addition to uniformity of film thickness and appearance demanded of plating films, advance every day.

This article introduces the Stir CUP-PLATER wafer plating equipment by the Electroplating Engineers of Japan Ltd. (EEJA). The Stir CUP-PLATER was designed for use in experiments, prototype manufacturing, and small-scale mass-production applications (Photo 1). The Stir CUP-PLATER is equipped with a newly developed plating mechanism that provides excellent basic performance and responds flexibly to a wide variety of requirements.

Wafer Plating Equipment Features

Compared with conventional products, the Stir CUP-PLATER has superior features in achieving uniform plating film thickness and in removing bubbles from the resist pattern, enabling high-speed plating under high current density conditions.

Random agitation

In electrolytic plating, although the deposition rate is proportionate to the electric current per unit area, the current cannot be increased indefinitely. This is because the supply of metal ion to the wafer surface from the plating liquid in close proximity will gradually run out as the current is increased, causing a decline in film thickness uniformity or defects, including the so-called burnt deposit. These problems can be averted by constantly replacing the plating liquid close to the electrodes. For this purpose, methods generally used include rotating a wafer or jetting out a

large volume of plating liquid. There are, however, other problems in using these methods. In the case of the first method, for example, it is difficult to attain the agitation effect at the rotation center portion or to protect the cathode contact portion. EEJA's Stir CUP-PLATER has mechanically driven cyclone paddles set in front of the wafer to randomly agitate the plating solution, thereby enabling plating with high film thickness uniformity even at high current densities.

Reduced-pressure pretreatment unit

In through hole via and trench filling applications, plating miss or pits caused by air bubbles adhering to the wafer surface could result in a major quality defect. There are various methods for removing bubbles, such as high-pressure washing, using chemical solutions or ultraviolet to improve wettability, or using alcohol as a substitute. For forming a plating film on delicate resist patterns, the method of allowing the plating liquid to penetrate under reduced pressure is recommended so that the resist is not deformed or destroyed. Equipment with a reduced-pressure pretreatment unit has already been supplied to many customers who have expressed satisfaction with its performance.

Total circumference sealed cathode contact

The Stir CUP-PLATER uses the entire outer circumference of a wafer (approximately 2mm) to pass electricity. This method makes it possible to achieve excellent film thickness uniformity for plating at high current compared with the method where electricity is passed in parts of a wafer. Furthermore, as the backside of a wafer does not come in contact with the plating liquid, it can be kept clean and there is no need to use resist to provide protection. This method has been developed based on the concept of minimizing the portions that come in contact with the plating liquid. Thus, it also contributes to minimizing the bringing in and taking out of the plating liquid to and from the plating cell to maintain the plating liquid in optimal condition.

Upward compatibility

EEJA offers automatic plating equip-



Photo 2: POSFER

ment for mass production called POSFER (Photo 2), which is equipped with the same plating cell as that of the Stir CUP-PLATER. With EEJA's equipment, users can seamlessly move from development to mass production.



Photo 3: Au bump

Wafer Process Samples by EEJA

Au bump process

[MICROFAB Au series (Photo 3)]

The deposition rate of the conventional type is 0.8ASD (amperes per square decimeter), whereas that of the Stir CUP is 1.6ASD, demonstrating a rate increase of 200 percent.

Cu process

[MICROFAB Cu series (Fig. 1)]

The method is classified into the bump process with a deposition rate of 5ASD for the conventional type compared with 20ASD for the Stir CUP, a rate increase of 400 percent, and the via filling process. This equipment can be used for filling a via of high aspect ratio (Fig. 2).

SnAg process

This equipment can perform high-precision control of the concentration of Ag in plating film without having to change the plating liquid composition.

Conclusion

EEJA has an extensive proven track record in delivering plating process as well as plating equipment. The company intends to advance its technology development in order to consistently provide the best solutions to customers. □

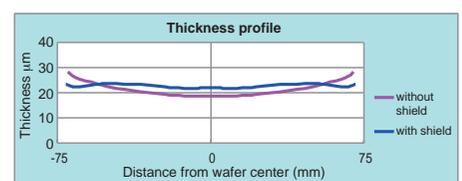
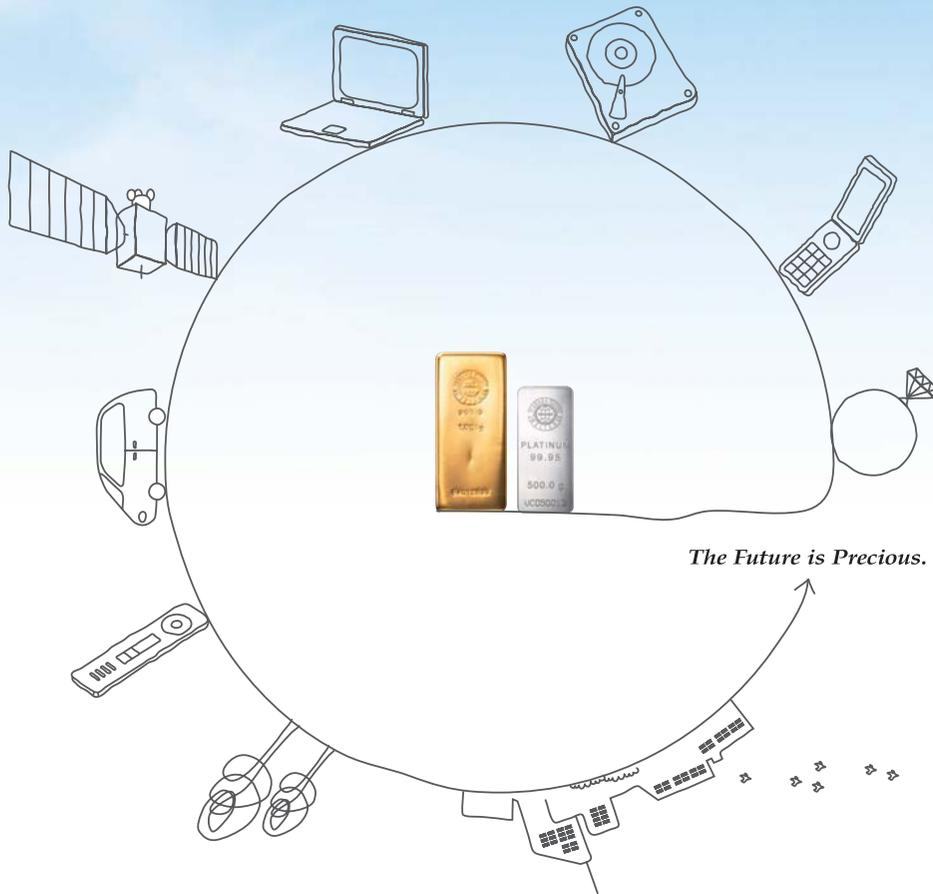


Fig. 1: Thickness profile by Cu processing

<http://www.eeja.com>



Photo 1: Stir CUP-PLATER



Precious Metals Can Be Utilized
In Many Different Ways
This is How We Can Do It!

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