Tanaka Beats Hurdle of Cu Wire Adoption in Cars ICs

Since around 2008, the shift from gold (Au) bonding wire to copper (Cu) bonding wire has been taking place on full scale with the aim of reducing costs. Compared with Au, Cu presents challenges in reliability and bonding characteristics in terms of chemical stability, and therefore, its adoption in automotive semiconductors has been limited. TANAKA DENSHI KOGYO K.K. has been offering in its lineup Cu bonding wires that meet diverse customer needs. This time, however, the company has developed the CA-1 type Cu bonding wire designed for adoption in automotive semiconductors.

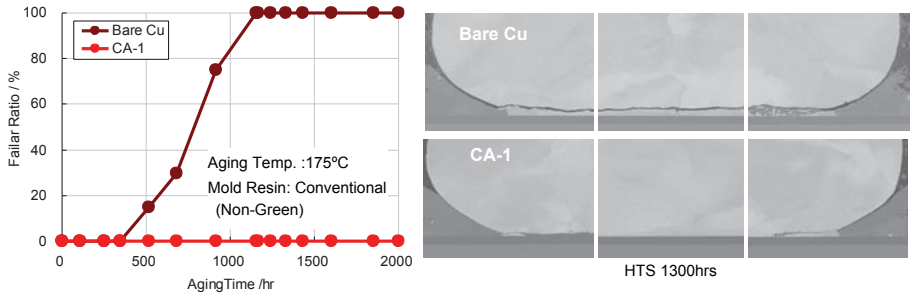
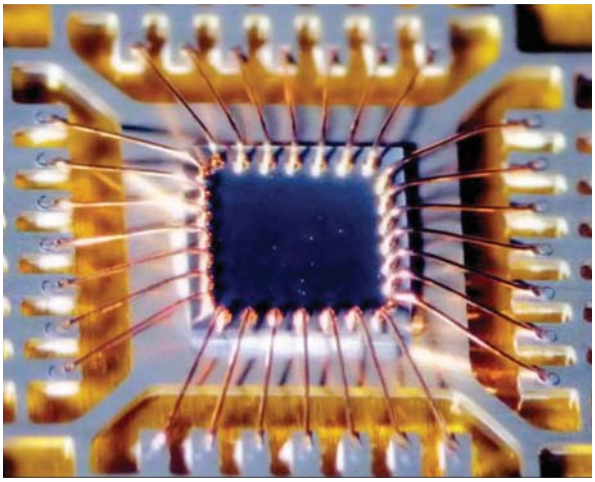


Fig. 1: Comparison in high-temperature storage reliability test

Higher Reliability, Productivity

Conventionally, the market of Cu bonding wires has been divided into two types: bare Cu wires, whose main component is high-purity Cu, and palladium (Pd)-coated Cu wires that are coated with thin Pd membrane. It has been general in the industry that both types use Cu wires with a purity of 99.9 percent or higher as a base material. These wires have yet to satisfy the required characteristics for wire products, for which high reliability is especially required, among automotive semiconductors. CA-1, an alloy with Cu as a base material, provides excellent reliability (Fig. 1).



CA-1 type Cu bonding wire

CA-1 type Cu bonding wire

Meanwhile, conventional bare Cu wires have a disadvantage in their connection to leads, and in general, productivity has been sacrificed for cost reduction. CA-1 provides improved connectivity in stitch bonding.

A comparison of the process windows of ultrasonic output and bonding load, which provide a measure for improved productivity, shows that CA-1 features a much wider margin than bare Cu (Fig. 2). ❑

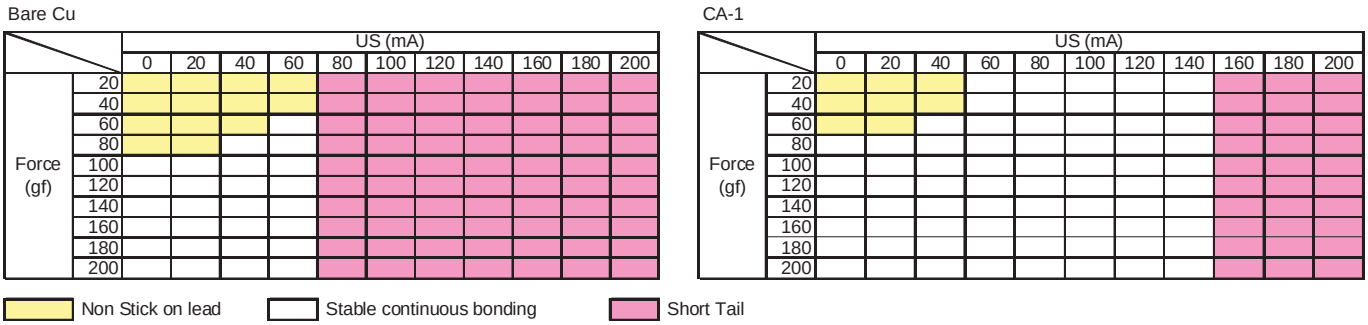


Fig. 2: Comparison of process windows for stitch bonding

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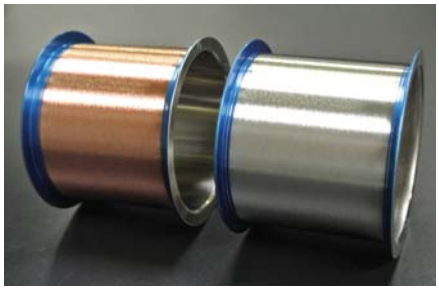
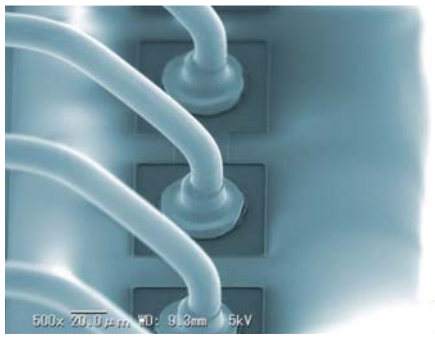
Ag-Alloy Properties Fit as Promising Bonding Wire Material

As gold (Au) is a chemically and physically stable material, it has been widely used as a material for electronic components for quite some time. However, due to the price reduction of semiconductor devices in recent years, coupled with the hikes of Au prices, moves to use alternative materials to replace Au as bonding material have been gaining momentum. A sample alternative material is copper (Cu) bonding wire. However, it has been difficult to replace all Au bonding wires using Cu bonding wires because Cu is (1) hard; (2) its bonding process is complex; and (3) its productivity and yield are poor. Hence, bonding wires that use silver (Ag), which is available at relatively low price among precious metals, and resolves the above drawbacks of Cu, have begun to attract attention as a main component.



Cu bonding wire & Ag alloy bonding wire



Ag alloy bonding wire

Ag-Alloy Bonding Wires

TANAKA DENSHI KOGYO K.K. embarked on the development of Ag bonding wires in 2009. The company has developed and commercialized Ag-alloy bonding wires, SEA and SEB.

Bonding wires that use Ag as a main component features (1) lower material cost than Au; (2) productivity and yield in bonding are almost comparable to those of Au bonding wires; (3) absence of complex bonding process; and (4) high reflectivity in optical semiconductors in the low-wavelength region. These features make them as promising material alternative for Au bonding wires (Table 1).

In general, when using Ag as a semiconductor bonding material, electromigration and sulfurization are causes of concern. TANAKA DENSHI KOGYO has successfully addressed these problems in its Ag-alloy bonding wires by adding various elements that suppress those problems to high-purity Ag and by optimizing their amounts. Furthermore, Ag exhibits very high reflectivity in the low-wavelength region. Thus, Ag-alloy bonding wires improve the performance not only of semiconductor ICs, but also of optical semiconductors represented by light-emitting diodes (LEDs). Ag-alloy bonding wires can be used as a bonding material for a wide range of ICs, from semiconductor ICs to optical semiconductors. Thus, Ag-alloy bonding wires fully play the role as an alternative material for Au bonding wires.

At present, many users already use Ag-alloy bonding wires for mass production, and inquiries from users around the world are abounding. Evaluations of Ag-alloy bonding wires to make them suitable for mass production have been steadily underway.

Ag-Alloy Bonding Wires in Future

TANAKA DENSHI KOGYO considers that demand for Ag-alloy wires will further increase in the future. The company intends to carry forward product design that pleases customers and to develop Ag-alloy bonding wires that meet customer needs. ❑

Table: Characteristics of various bonding wires

Bad ☆ ←→ ☆ ☆ ☆ ☆ Good

	Gold	SEA/SEB	Copper
Material Cost	☆	☆☆☆	☆☆☆☆
Shield Gas	—	N_2	N_2-H_2
Chip Damage	☆☆☆☆	☆☆☆	☆
Bondability	☆☆☆☆	☆☆☆	☆
Reflectivity	☆	☆☆☆☆	☆

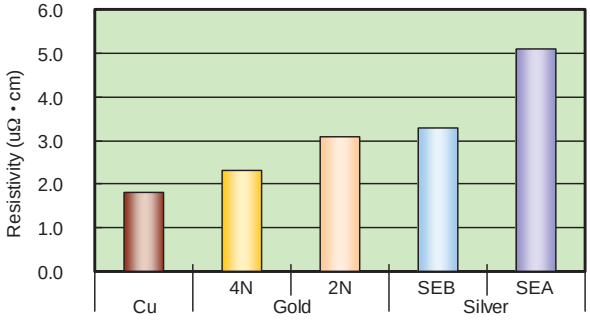


Fig: Resistivity

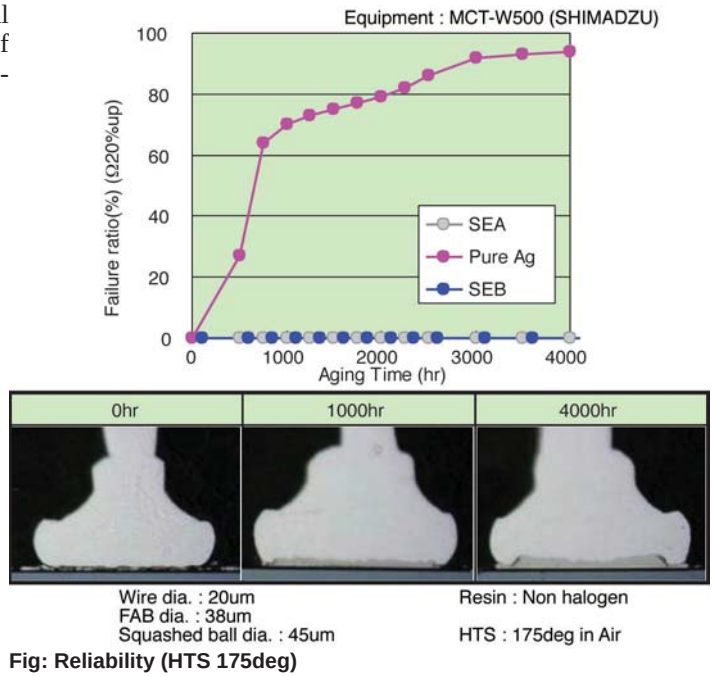


Fig: Reliability (HTS 175deg)

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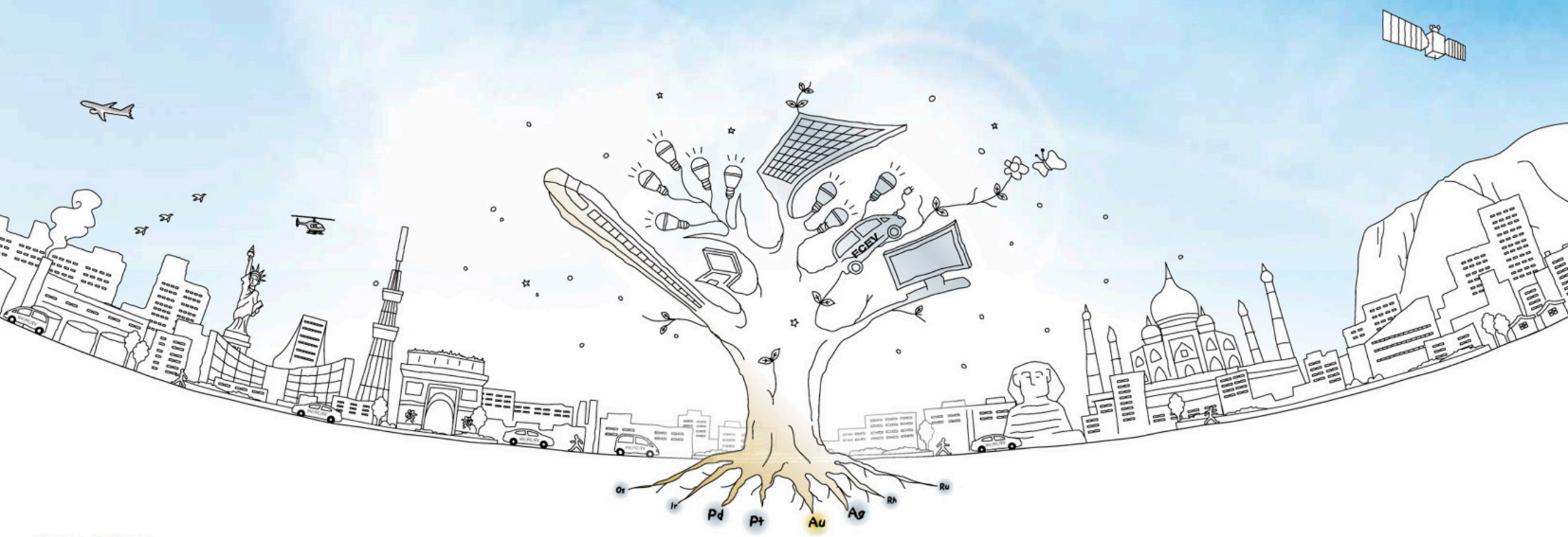
Contributing to industrial development through precious metals and creating a more beautiful future — TANAKA's Green Technology



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