

High Conductivity Copper Alloy for Lead-Frame “EFTEC-45”

In recent years of so-called IT revolution, cellular phones and network equipment are making dramatic progress. Copper alloys for lead-frames are used in the semiconductor packages for these electronic equipment, and it is required that, for low pin-count packages such as dual inline package (DIP), small outline package (SOP) and discrete devices, they have well-balanced characteristics in terms of strength and electrical conductivity.

Figure 1 shows the TS-EC diagram of copper alloys for lead-frames where the horizontal and vertical axes represent the tensile strength and electrical conductivity, respectively. EFTEC-45 is located in the middle of EFTEC-3 and -64T, both being Furukawa Electric's products, so that it is a well-balanced alloy with respect to strength and electrical conductivity. In terms of alloy components, it belongs to the Cu-Cr-Sn-Zn system, the same as for EFTEC-64T that has an excellent track record in high pin-count packages such as quad flat package (QFP). Therefore, leading-edge technologies acquired by EFTEC-64T have been applied to achieve not only basic characteristics required for lead-frame materials but also excellent surface performance and high reliability.

Table 1 shows the standard specifications. Two types of temper, 1/2H and H, have been specified to allow suitable selections depending on applications. Table 2 shows the bending workability evaluated under the conditions of sample width = 10 mm and the W-shaped bending with an bending angle of 90°. The minimum bending radius of EFTEC-45 represented by R/t (R for radius and t for thickness) is zero, demonstrating superior bending workability.

Figure 2 shows the isothermal softening curve of H-temper of EFTEC-45 representing the changes in the Vickers hardness when the material is heated up to five minutes at 450°C and 500°C. EFTEC-45 is seen to have sufficient heat resistance at these high-temperature environments. Thus, the material characteristics are not damaged by high-temperature heating even at the time of wire bonding, thereby maintaining excellent performance. It is also suitable for Pb-free soldering processes of recent years.

Table 1 Standard specifications.

| Properties | | Temper | |
|-------------------------|-------|---------|---------|
| | | 1/2H | H |
| Tensile strength | MPa | 360~440 | 400~480 |
| 0.2 % yield strength | MPa | 330~410 | 390~470 |
| Elongation | % | ≥ 10 | ≥ 5 |
| Hardness | Hv | 115~135 | 120~145 |
| Electrical conductivity | %IACS | ≥ 77 | ≥ 77 |

Table 2 Bending workability. (Width = 10 mm)

| Alloys | Temper | Allowable bending radius (R/t) | |
|----------|--------|--------------------------------|---------|
| | | Good Way | Bad Way |
| EFTEC-45 | 1/2H | 0 | 0 |
| | H | 0 | 0 |
| C194 | H | 0 | 0.6 |

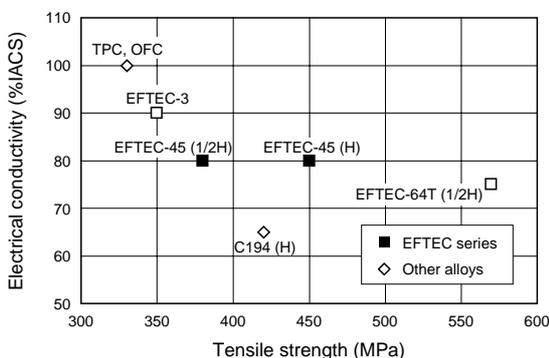


Figure 1 TS-EC diagram of copper alloys for lead-frames.

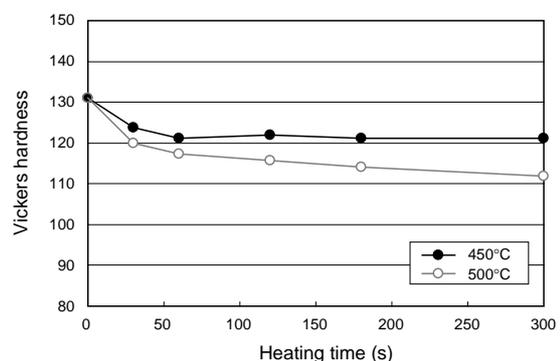


Figure 2 Isothermal softening curve.

Table 3 Ag platability.

| | Pre-treatment | Heating temperature (°C) | | |
|-----------|-----------------|--------------------------|------------|------------|
| | | 350 | 400 | 450 |
| EFTEC-45 | with etching | no blister | no blister | no blister |
| | without etching | no blister | no blister | no blister |
| EFTEC-64T | with etching | no blister | no blister | no blister |
| | without etching | no blister | no blister | no blister |

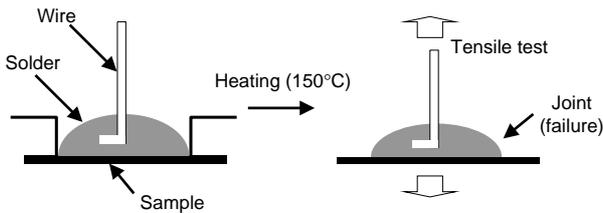


Figure 3 Testing method for solder joint strength.

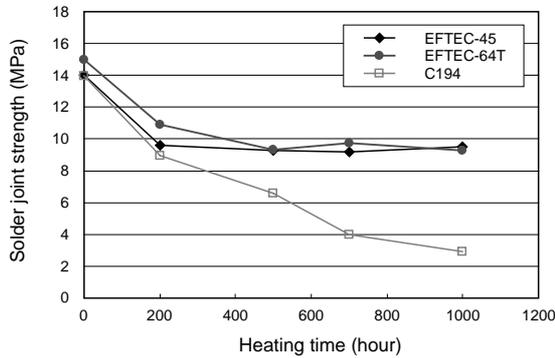


Figure 4 Solder joint strength.

EFTEC-45 is superior in surface performance, a crucial characteristic for lead-frame materials. Table 3 shows the results of Ag platability tests, in which the number of blisters after a 10-minute heating at temperatures of 350, 400, and 450°C is used for the evaluation. No blisters occurred due to Ag plating under all the conditions, demonstrating excellent Ag platability. Moreover, blisters do not occur when the surface is etched in pre-treatment for plating, negating the influences of plating method.

For semiconductor equipment, it is essential to assure the reliability of solder bonding with substrates. Figure 3 shows the testing method for solder joint strength, and Figure 4 the results, where the tests are carried out up to 1000 hours at 150°C using eutectic solder. EFTEC-45 is seen to have sufficient joint strength after a holding time of 1000 hours, confirming enhanced soldering reliability when used in semiconductor equipment.

EFTEC-45 has satisfactory characteristics in terms of the adhesiveness with oxides, solderability, resolderability (solder wettability of solder plating after aging), and stress corrosion cracking, demonstrating such well-balanced characteristics as for EFTEC-64T.

As described above, EFTEC-45 is especially suitable as a lead-frame material for low pin-count packages, being superior in cost effectiveness also. Moreover, it is applicable to other uses such as connectors and relays.

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