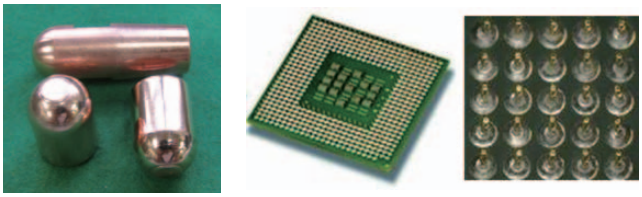
# High-Strength Copper Alloy Wires and a Rods - EFTEC-98W, 98BD and 98FC

## 1. INTRODUCTION

As electronic devices are becoming smaller, lighter in weight and higher in performance, our company has been developing leads and connectors for electronic parts, and conductive materials such as welding electrodes, to fulfill various needs. Materials of copper alloy wires and rods have been requiring higher mechanical strengths, higher electrical conductivities and cable sizes thinner than existing materials.

Our company has commercialized CZ rod and CC rod as spot welding electrode chips which have superior electrical conductivities, mechanical strengths and heat resistances. In addition, we have commercialized EFTEC-194W and EFTEC-64W, which have medium electrical conductivities and medium mechanical strengths, targeting the applications for CPU lead pins, etc.

Figure 1 shows the examples of the application.



Welding electrode chips
CZ rod, CC rod

CPU lead pin
EFTEC-194W

**Figure 1 Examples of the application.**

In recent years, requirements for electronic parts especially with high mechanical strengths have been increasing. A beryllium copper alloy (C1720) is well known as a good example of copper alloy with a high mechanical strength. However, it is high in price and contains environmentally-unfriendly substances.

Given these factors, we have developed environmentally-friendly and high mechanical strength copper alloys "EFTEC-98" series, which are consisting of Cu-Ni-Si alloys (Colson alloys) with slight additive elements.

## 2. HIGH MECHANICAL STRENGTH COPPER ALLOY WIRES AND RODS, "EFTEC-98" SERIES

The EFTEC-98 series are optimal for the parts which require high mechanical strengths. Figure 2 shows the relations between the tensile strengths and the electric conductivities of our existing copper alloys and of the developed alloy wires which are added with high mechanical strength copper alloys.

The EFTEC-98W (wire) shows a good electrical conductivity and a high mechanical strength. Therefore, it can be used for coil springs. Also, as Figure 2 shows, its characteristics are equivalent to the beryllium copper alloy. Therefore, it can be easily substituted for a beryllium copper alloy.

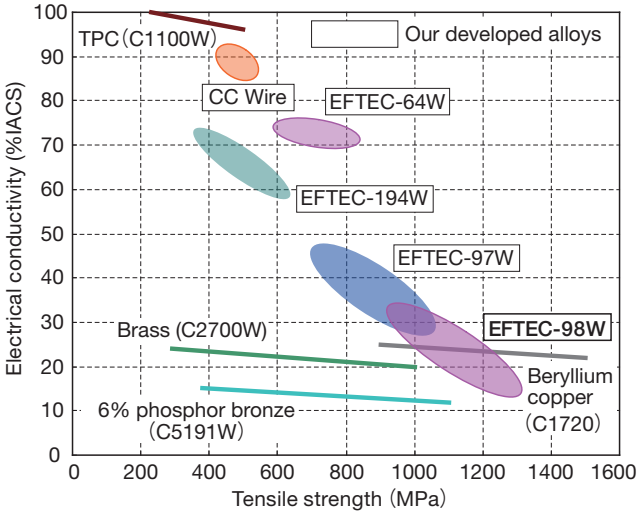



**Figure 2 Relations between tensile strengths and electrical conductivities in wires.**

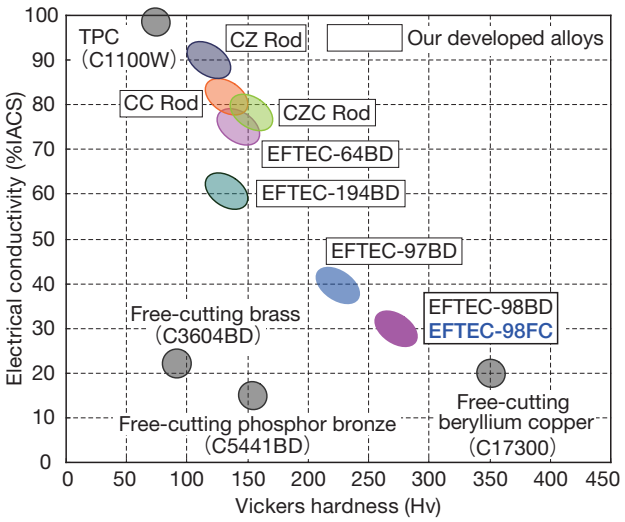



**Figure 3 Relations between Vickers hardness and electrical conductivities in rods.**

Figure 3 shows the relations between the Vickers hardness and the electrical conductivities of the rods.

The EFTEC-98BD (rod) is used for shank materials and arm materials of portable spot welding guns which are used for welding automobile bodies and steel furniture.

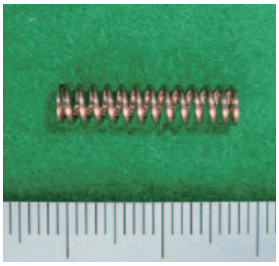
The EFTEC-98FC is optimal for the connectors which require high mechanical strengths and cutting performances.

Also, as Table 1 shows, the coefficients of thermal expansion and the longitudinal elastic moduli of the EFTEC-98 series and the beryllium copper are equivalent. Therefore, the EFTEC-98 series can be substituted easily for the beryllium copper alloys.

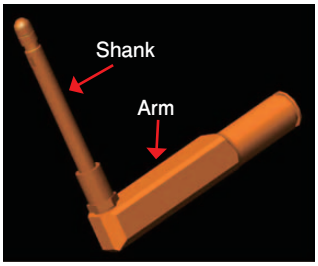
Figure 4 shows the application examples of high mechanical strength copper alloy materials.

**Table 1 Physical characteristics (typical values).**

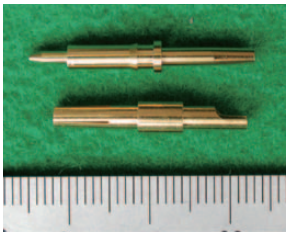
| | Coefficient of thermal expansion $\times 10^{-6}$/K | Thermal conductivity W/(m·K) | Electrical conductivity % IACS | Longitudinal elastic modulus GPa | Specific Gravity |
|---|---|---|---|---|---|
| EFTEC-98 series | 17.8 | 120 | 30 | 125 | 8.8 |
| Beryllium copper alloy (C1720) | 17.8 | 109～130 | 22 | 127 | 8.3 |



Coil spring
EFTEC-98W




Portable welding gun parts
EFTEC-98BD



Connector pins
EFTEC-98FC

**Figure 4 Examples of application of the developed materials.**

## 3. CHARACTERISTICS OF THE EFTEC-98FC WITH A HIGH CUTTING PERFORMANCE

Cutting work such as turning and boring are occasionally done as the processing methods of copper alloy parts. For the parts which have highly complicated forms or require high dimensional accuracies, free-cutting bronze (C3604BD), free-cutting phosphor bronze (C5441BD) and free-cutting beryllium copper (C17300) have been used. However, some of these copper alloys are not good for human bodies and the environment because lead is added.

Given this factor, we have succeeded in developing a copper alloy material EFTEC-98FC which does not contain environmentally-unfriendly substances but has a high mechanical strength and a superior cutting performance.

The EFTEC-98FC is a Cu-Ni-Si based alloy, which is similarly to the EFTEC-98W and the EFTEC-98BD, and additive elements are changed in order to meet both a high strength and a cutting performance.

The EFTEC-98FC is a copper alloy material in which sulfides are dispersed in the metal by adding sulfur. The cutting performance of this alloy is enhanced by controlling the disperse status of the sulfides. Table 2 shows the chemical compositions of the EFTEC-98 series.

**Table 2 Chemical composition (typical values).**

(mass%)

| | Ni | Si | Sn | Zn | Mg | Fe | S |
|---|---|---|---|---|---|---|---|
| EFTEC-98W, BD | 3.75 | 0.9 | 0.15 | 0.5 | 0.1 | - | - |
| EFTEC-98FC | 3.75 | 0.9 | 0.15 | - | - | 0.15 | 0.15 |

Actually-used free-cutting beryllium copper disperses fine lead grains in the metal as chip breakers at cutting work, and these lead grains finely divide cut material pieces. The mechanism is that metal pieces are divided by lead grains which melted and weakened by the heat generated in the cutting work.

On the other hand, the EFTEC-98FC disperses sulfides as chip breakers in the metal, thereby divide cut metal materials finely. The mechanism of the division: the sulfide grains in the cutting chips induce ductile breaking caused by the plastic deformation which is brought by the cutting work. Then the cutting chips generate cracks and the cracks diffuse. Finally, the cutting chips are divided.

Figure 5 shows the shapes of the cutting chips generated in the process of lathe work on the EFTEC-98FC and the free-cutting beryllium copper alloy. In the general copper alloy, the cutting chips are in irregular spirals. In the EFTEC-98FC and in the free-cutting beryllium copper alloy, cutting chips are finely divided.

EFTEC-98FC

Free-cutting beryllium copper alloy

**Figure 5 Shapes of cutting chips of the EFTEC-98FC and the free-cutting beryllium copper alloy.**

## 4. CONCLUSION

The EFTEC-98 series can be substituted for the copper alloy parts in which high price beryllium copper alloys have been used. They can be supplied at low prices, thereby contribute to the cost reduction. In addition, the EFTEC-98FC is an optimal copper alloy material for the connectors, etc. which require automatic operation by NC machining such as cutting and boring.

Our copper alloy materials have balanced mechanical strengths and electrical conductivities. We can provide the copper alloy materials which best meet your purposes.

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