The Copper Alloy Strip EFCUBE-820 for Connectors

1. INTRODUCTION

Connectors used between circuit boards and between modules have been becoming smaller and highly-functional because the technological development has been taking place in response to the high functionalization and the reduction in size and weight of electronic equipment. High-strength copper alloys used for small-sized electric contact materials in small-sized connectors require a better performance to bending to meet the space saving, the resource saving and the productivity improvement, as shown in Figure 1. Although there is a trade-off between a performance to bending and to strength, these characteristics have been considerably improved by controlling the microstructures of Cu-Ni-Si alloys (Colson alloys). We developed a new alloy EFCUBE-820 (UNS: C64775) with this technology.

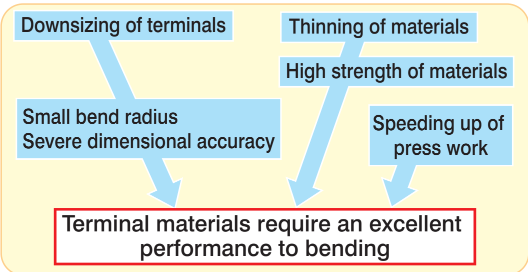

Figure 1 The background of the development.

2. CHARACTERISTICS

The newly developed alloy strip EFCUBE-820 (Temper-H) was evaluated for the characteristics shown in Table 1, and the results were compared with the phosphor bronze alloy (JIS-C5210) and a general Cu-Ni-Si alloy as shown in Figure 2. The representative values of the new alloy EFCUBE-820's (Temper-H) basic characteristics are shown in right-hand columns of Table 1.

Table 1 The basic characteristics of the EFCUBE-820 (Representative value, Temper-H) and evaluation methods.

Item	Evaluation method	Representative value
Tensile strength	Tensile test Conform to JIS Z2201, 2241	800 MPa
0.2% yield strength		770 MPa
Elongation		7%
Young's modulus		110 GPa
Vickers hardness (Hv)	Conform to JIS Z2244	245
Electric conductivity	Four-terminal method at 20°C	38%IACS
Performance to bending	90° W-type bend (Minimum bendable radius) Conform to JIS Z2248	Minimum bendable radius R=0
Stress relaxation rate	Conform to JCBA T309(2004) Keep at 150°C for 1000 hours	8%

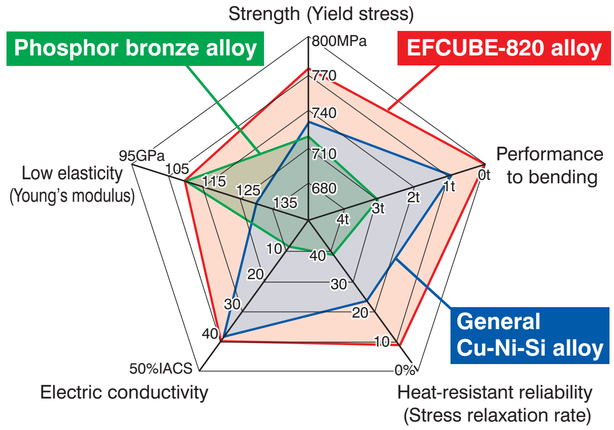

Figure 2 The characteristics of EFCUBE-820 alloy and other copper alloys.

The EFCUBE-820 alloy showed a good performance to bending. It had the high strength that was equivalent to that of the phosphor bronze alloy (Temper-SH-ESH). At the same time, no crack occurred without an inner bend radius.

Moreover, 180°U-type closely-attached bend test was performed with respect to its performance to bending. Figure 3 shows the results.

The phosphor bronze alloy and the general Cu-Ni-Si copper alloy generated large cracks that cause a lowering of the contact pressure and a poor conduction. In contrast, the EFCUBE-820 alloy had the high strength of greater or equal to 800 MPa in tensile strength, and also showed a good performance to bending that had no crack on the bent part.

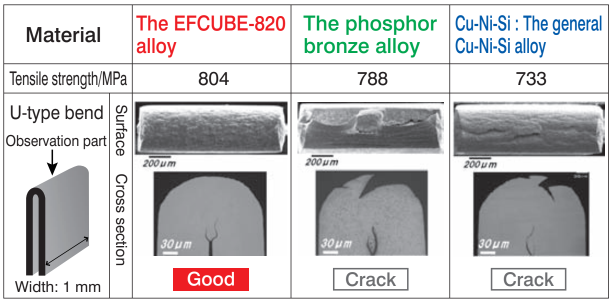

Figure 2 180° U-type bending test.

Shown in Table 2, the EFCUBE-820's composition is a Cu-Ni-Si precipitation-hardened copper alloy. It gives consideration to the cost reduction of the materials because the expensive Ni content is less than in general Cu-Ni-Si alloys. Also, it contains no environmental pollutants. (The slightly-added Cr is not hexavalent chromium.)

Table 2 The chemical composition of the EFCUBE-820 alloy (mass%)

Ni	Si	Zn	Sn	Cr	Mg
2.30	0.65	0.50	0.15	0.15	0.10

The EFCUBE-820 alloy has also an excellent (or good) performance to plating. When it was plated with Sn, no peeling was observed in the peeling test at 160°C after keeping it for 120 hours. When the environmental tests such as the salt spray test or the mixed gas corrosion test were performed on Ni-based (thickness: 1 μm) Au plating (thickness: 0.1 μm), it showed a good performance to plating without a pinhole, and corrosion did not attack the base material. This is the effect of the control of the surface state and the inclusion, and the sub-additive element.

3. APPLICATION

Table 3 shows the relation between the development trend of connectors and the required characteristics of the copper alloys that are used in electric contact materials.

Table 3 The development trend of connectors and the required characteristics of the copper alloy electric contact materials.

The trend of connectors		The required characteristics of the copper alloy electric contact material				
		High strength	High performance to bending	Low stress relaxation rate	High electric conductivity	Low Young's modulus
Downsizing	Space saving	●	●			●
	Lowering in height	●	●			●
High function	Multipolarization, narrowing in pitch	●			●	
	High currency			●	●	
	High reliability	●		●		●
Production cost reduction	Widening of dimension tolerance					●
	Speeding up of press work		●			

Materials require a high strength and a low Young's modulus to have deformations within the elastic limits of the copper alloys even when the lengths of contact springs (L-length) become short due to the downsizing of connectors. In addition, they require a low Young's modulus to absorb the slight size spread caused by the press works such as a punching and a bending when material terminals are manufactured. That is because the size spread is prone to affect the contact pressure fluctuation of the electric contact. Also, they require a high conductivity because the cross section of conductors per 1 pin decreases with the multipolarization and the narrowing in pitch.

Moreover, materials require a good anti-stress relaxation because the contact pressure is lowered by the creep phenomenon. The lowering occurs when they are used in box terminals for wire harnesses in automobiles, and in the high temperature environment where lamps are a typical source of heat. The high current connectors require a high conductivity and an anti stress relaxation to restrain Joule heat and to secure the reliability of the contact pressure.

The EFCUBE-820 alloy shows better characteristics than existing materials in all the items in Figure 2, so it meets the requirements above and contributes to the technical innovation of connectors. Figure 4 shows the examples of the optimum applications that take advantage of the EFCUBE-820's alloy characteristics. Also, its high strength and its good performance to bending contribute to the thinning of the copper alloy contact materials for connectors. The natural resource saving and the cost reduction are possible by adopting it instead of existing copper alloys.

[Optimum applications of the EFCUBE-820 alloy]
(CT: connector)

- Connectors for electric and electronic devices
  CTs for boards, battery CTs, CTs for flexible printed circuits, card and media CTs, sockets for camera modules and central processing units, jacks
- Connectors for automobiles
  Female terminals for wire harnesses, various switches
- High currency connectors
  Springs of multi-contact CTs

Figure 4 The optimum applications of the EFCUBE-820 alloy.

4. CONCLUSION

EFCUBE-820 has the tensile strength of 800 MPa and shows a good performance to bending. Also, its electric conductivity and its heat-resistant reliability are good. It is an optimum choice as an electric contact material for various connectors.

For detailed technical data of the EFCUBE-820 alloy, please consult the catalog on our website.

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