Article ID: 1003－7837(2005)02,03－0574－04

The study on the rough surface of KFC copper strip applied to lead frame*

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Abstract: In the paper, the rough surface of KFC copper strip applied to lead frame was studied and analyzed. The method of energy spectrum analysis, SEM and metallographic analysis are adopted to study and analyze. To compare the component of the rough surface of KFC copper strip with one of the normal copper strip, the component abnormity is not found. But to observe its microstructure of the rough surface, there are thinner and regular dimpling in the surface before the polishing, and bigger crystal grains are found after the polishing. The coarse structure vanished when the sample is heated higher than 700℃. It is shown that current annealing technique is not reasonable and should be improved and optimized.

Key words: copper alloys; lead frame; KFC alloys

CLC number: TG146.1+1 **Document code**: A

1 Introduction

Lead frame materials are one of the basic parts of the IC. The function of the lead frame is to fix the slug, to provide the mechanical carrier, to protect the inner component, to transfer electric signal and to emanate heat quantity. It is the framework of IC. Copper alloy has become important lead frame materials for the excellent over-all properties. Copper alloy lead frame have already occupied 80% of the total amount of lead frame materials. Now hundreds of lead frame materials have been developed in the world. According to the different performance, it can be divided into four types: high strength type, high conductivity type, high strength and high conductivity type, high strength and medium conductivity type. According to the different component, it can be mainly divided into Cu-Fe-P series, Cu-Cr-Zr series and Cu-Ni-Si series, Cu-Ag series, etc. Though there are different kinds of lead frame materials, the macro brands are KFC, C1220 and C194. KFC which is of Cu-Fe-P series is the most representative one. Its specific conductance is higher than 85%IACS and its ultimate strength is about 400 MPa[1－3].

There are a few corporations which produce copper strips applied to lead frame in China. Its production capacity is smaller, the brand is fewer, and the quality and the precision are not very much. To compare with other countries, China has a gap in quality of production of the lead frame. The rough surface deficiency of KFC copper strip is one of these problems. The deficiency is being the obstacle to enhance quality

Received date: 2005－07－01

* **Foundation item**: Project supported by Hi-tech research and development program (863 Program) of P. R. C (2004AA3Z1460, 2004AA33G060)

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of product.

In order to know the cause of the forming of the rough surface, the materials component, surface condition and its microstructure have been studied and analyzed by the method of energy spectrum analysis, SEM and metallographic analysis. It is usefully to improve the quality of the product and to enhance technological level of the production of lead frame. These can also reduce the gap with the advanced countries.

2 Study and analysis

2.1 Pattern of the surface

The production flow of the lead frame is as follows: continuous casting→hot rolling→cool rolling→the first annealing→cool rolling→the second annealing→cool rolling→end product. The defect of surface rough is found after the cool rolling process, and it is not disappeared or decreased with the change of the deformation rate.

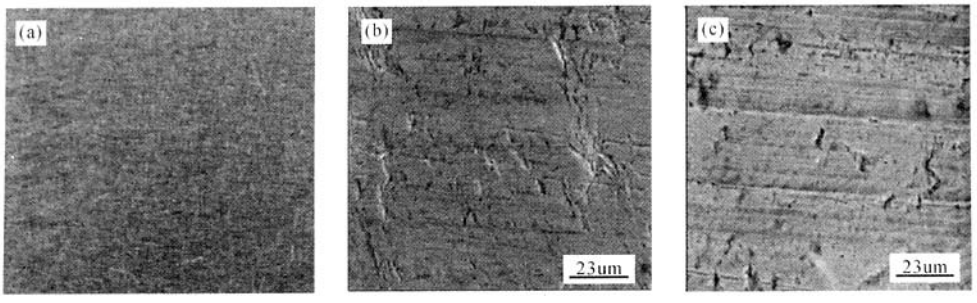

Fig. 1 Surface topography of the products

(a)—macroscopic pattern of the deficient product; (b)—the surface of the deficient one; (c)—the surface of the acceptable one

The defect of rough surface exists at both sides of the strips and stretch along rolling direction. The macroscopic pattern of the defect product is shown in Fig. 1 (a). It appears like fog and distributes uniformly on the surface and has no luster. You will feel it smooth and just like the acceptable sample when you touch with your fingers.

The surface topography of the defect product in the SEM is shown in Fig. 1 (b) and the acceptable one is shown in Fig. 1(c). We find that there are lots of thick and regular pitting of the defect product in the microstructure. The pitting surface which like micro dimpling are very thin and disperse around. And there are very small and very less dimpling on the surface of the acceptable sample.

2.2 Microstructure of the rough surface

The component of the defect surface has been analyzed by energy spectrum analysis. It is not difference with the normal one. It shows that the pitting surface is not caused by the wrong component. The microstructure of the rough surface is shown in Fig. 2. It is evidence that the microstructure is working phase and there are some bigger crystal grains and it is not uniform. The grains are thinner at the boundary and are bigger in the middle. It shows that the strips are heated non-uniform or the temperature is too low to recrystallize. The structure does not recrystallize completely.

There are much minute pits at the boundary in Fig. 2 (c). The small pit may be several microns and the big pit is more than decadal microns. It is main reason that the temperature is non-uniform or the temperature is too low in the annealing furnace. When the bell cover annealing furnace is being adopted to an-

neal in batches, the anneal temperature is 600℃, the heating time is about 8 h and the holding time is about 5 h. Several strips lie in the muffle furnace along the height direction. The circular heated air is from the top to the bottom by the fan. There are convection cells which have varying-area channels between the strips. Through the channels, the protective gas enters the inner of the strips and loopback to the fan. The study on these annealing furnace shows that the strips at the bottom have the worst heating and cooling conditions. So the strips with rough surface usually emerge at the bottom[4].

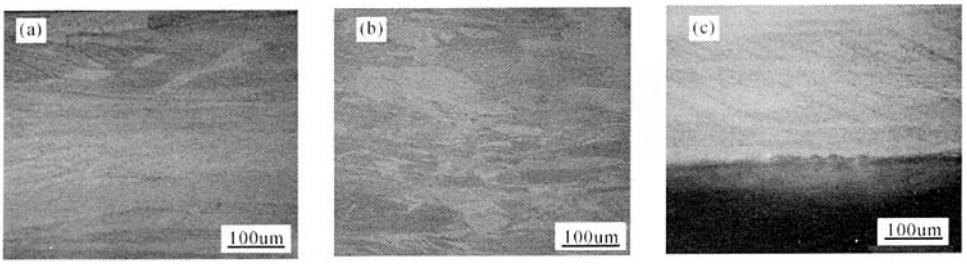

Fig. 2 Microstructure of the rough surface
(a) transverse direction; (b) longitudinal direction; (c) the boundary

The statistics about recrystallization annealing temperature shows that the best annealing temperature of nonferrous metal alloys is about 70 percent of the melting temperature[5,6]. The recrystallization annealing temperature of KFC copper alloy is about 780℃ from calculation. The temperature in practical production is lower and it is unfit. When the anneal temperature is 600℃, the strips at the top of the annealing furnace have completely recrystallized because the temperature rise rapidly and the holding time is relatively long at the top, but the strips at the bottom of the annealing furnace have partly recrystallized and easily appear the defect of rough surface because the temperature is non-uniform and the holding time is relatively short at the bottom.

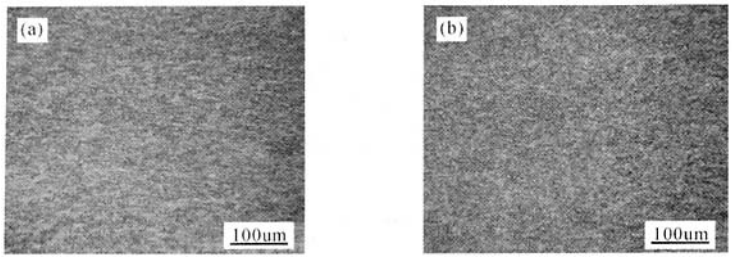

Fig. 3 Microstructure of the experimental sample
(a) transverse direction; (b) longitudinal direction

2.3 Experimental investigation

The box-type electrical resistance furnace is adopted in the experiment. The sample is taken from the product with rough surface. The anneal temperature is 700℃, the heating time is 2.5 h and holding time is 0.5 h.

After annealing, the defect of rough surface disappears and the sample has not any difference with the good products. The microstructure of the experimental sample is shown in Fig. 3. It is shown that the grains of the experimental sample are thin and uniform distribution. So the experimental temperature is better than the temperature in the practice production.

3 Conclusion

To compare the component of the rough surface of KFC copper strip with one of the normal copper strip, the component abnormity has not been found. But to observe its microstructure of the rough surface, there are thinner and regular dimpling in the surface before the polishing, and bigger crystal grains are found after the polishing. The coarse structure vanished when the sample is heated higher than 700℃. It is shown that current annealing technique is not reasonable and should be improved and optimized, such as the annealing temperature can be higher than 650℃ or the annealing time can be more than 2 h.

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