

Twist Test Report
扭曲试验报告

——**Interface Bonding State Analysis**
Report on Twist Samples
——**暨扭曲后界面结合状态分析报告**

Type: TLM-YR-15x4 (Soft)
产品规格: TLM-YR-15x4 (软态)

Test Date: Dec.17-18 2015
试验日期: 2015.12.17~18

Tested by: Liu Hongchang
测试人: 刘洪昌

Approved by: Lan Zhanjun
批准人: 兰占军

目 录

1. Purpose 试验目的.....	1
2. Content 试验内容.....	1
2.1 Selecting Materials 选料.....	1
2.2 Twist Test 扭曲测试.....	1
2.3 Saw Cutting 锯切.....	2
2.4 Sample Preparation 试样制备.....	2
2.5 Metallography Test 金相测试.....	3
2.6 Penetration Test 渗透测试.....	6
3. Conclusion 结论.....	8

Twist Test Report
扭曲试验报告**1. Purpose 试验目的**

Analysis the interface bonding state on the twist samples of copper clad aluminum flat bars.分析铜铝复合排扭曲后的界面结合状态。

2. Content 试验内容**2.1 Selecting Materials 选料**

The requirement specification is 15x4mm, length is 60mm, the actual process of selecting materials see below.选取规格 15x4 铜铝复合排（软态）锯切分料，长度为 60mm，选料过程见下图。

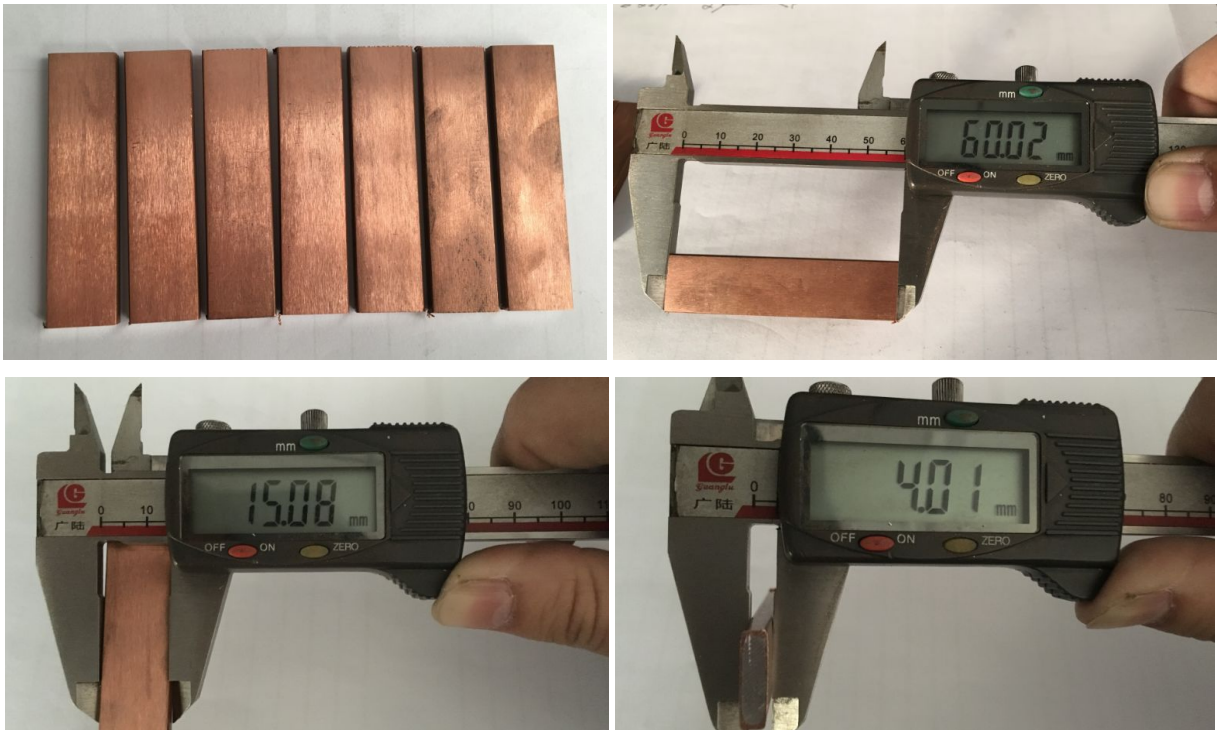


Fig.1 The process of selecting materials

图 1 选料过程

As shown in the above, the measured size is 15.08x4.01x60.02mm.如上图所示，本试验选料的实测尺寸为 15.08x4.01x60.02mm。

2.2 Twist Test 扭曲测试

Select randomly 4 piece of the samples to twist according to the drawings, and twist samples see below.按照图纸参数随机选取 4 块选料进行扭曲测试，扭曲试样见下图。

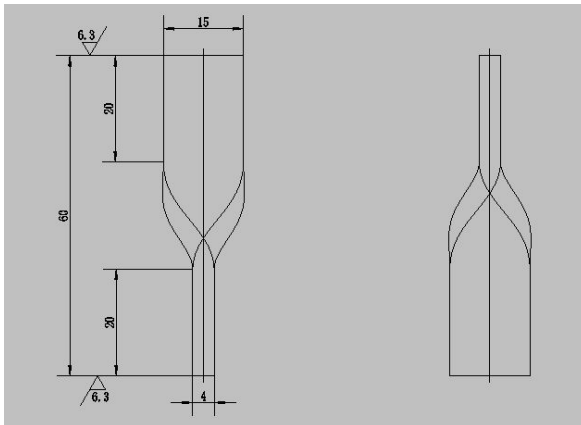
Twist Test Report
扭曲试验报告

Fig.2 Twist drawings

图 2 扭曲图纸



Fig.3 Twist samples

图 3 扭曲试样

2.3 Saw Cutting 锯切

Saw twist samples along the center of the twist samples, see below.沿扭曲中心将扭曲试样锯切，见下图。



Fig.4 Transverse cutting photos

图 4 横向锯切照片



Fig.5 Longitudinal cutting photos (additional test)

图 5 纵向锯切照片（附加试验）

As shown in the above, penetration test use the red and black tag samples; metallographic test use the blue and white tag samples.如上图所示，红色和黑色标记的样块做渗透测试；蓝色和白色标记的样块做金相测试。

2.4 Sample Preparation 试样制备

Polish the blue and white tag samples, the polishing process see below.将蓝色和白色标记的试样进行磨抛，磨抛过程见下图。



Fig.6 MP-2 polishing machine

图 6 MP-2 磨抛机

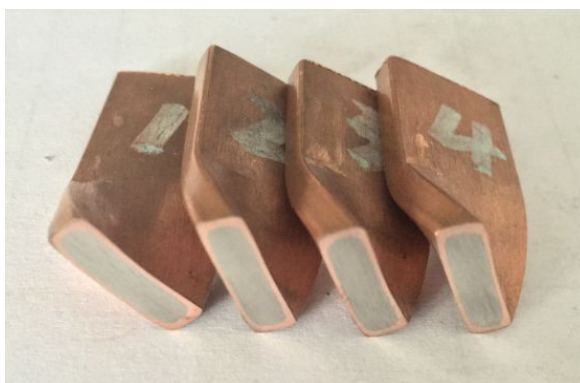


Fig.7 Cross section of the polishing samples

图 7 磨抛后试样的横截面

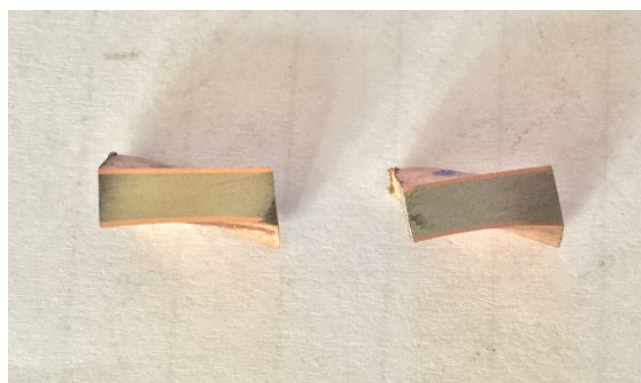


Fig.8 Longitudinal section of the polishing samples

图 8 磨抛后试样的纵截面

2.5 Metallography Test 金相测试

Observe the polishing samples with the metallographic microscope, and take photos with the computer. 将磨抛试样放置在显微镜的载物台上进行观察，并用计算机拍照。

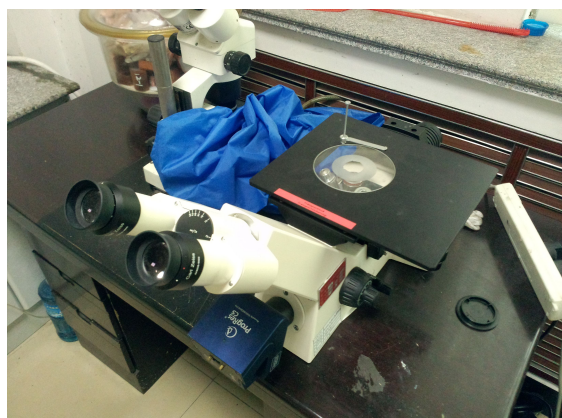


Fig.9 Metallographic Microscope (Axiovert 40 MAT)

图 9 金相显微镜 (Axiovert 40 MAT)

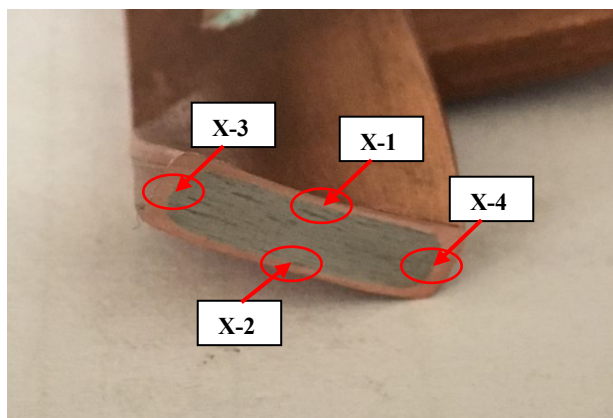


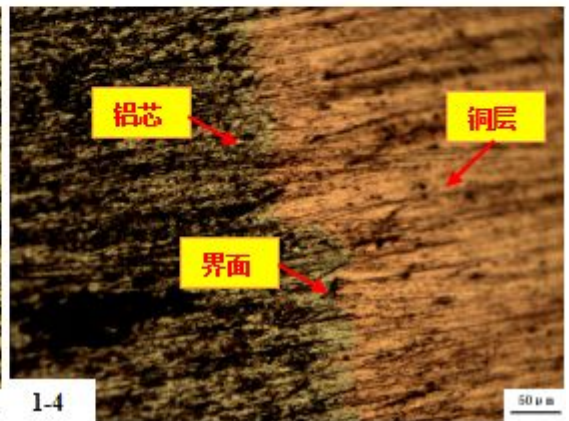
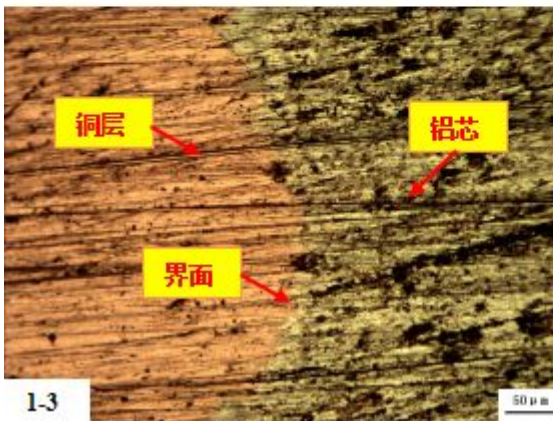
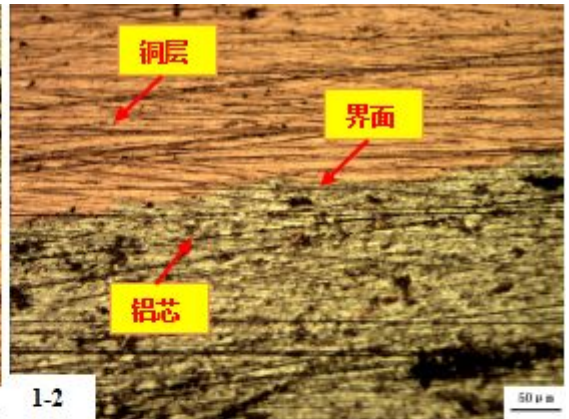
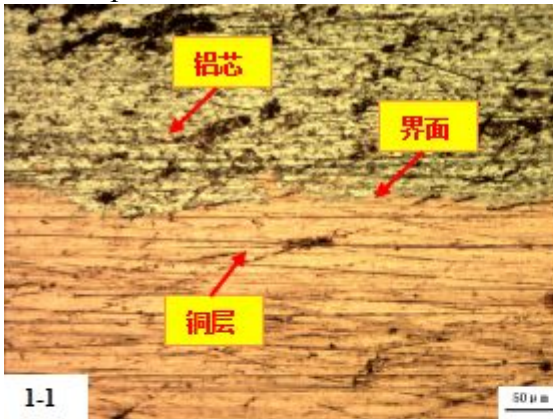
Fig.10 Photo scope diagram

图 10 横截面金相照片取照位置示意图

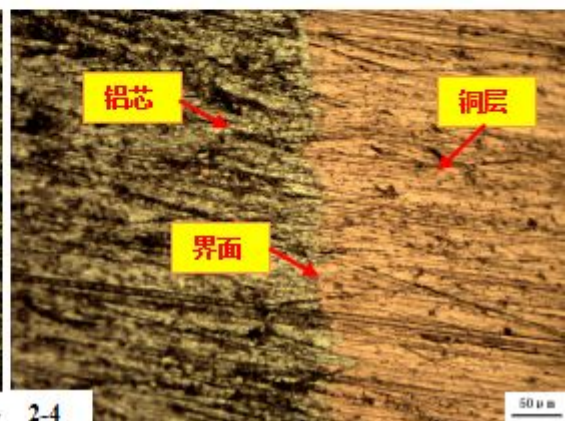
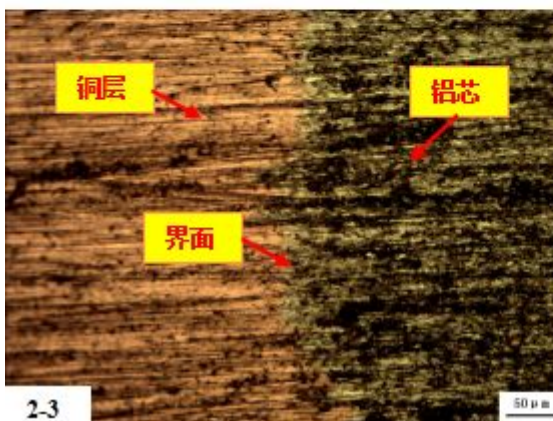
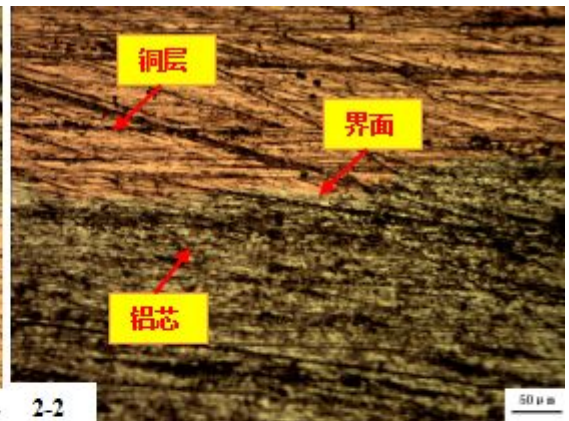
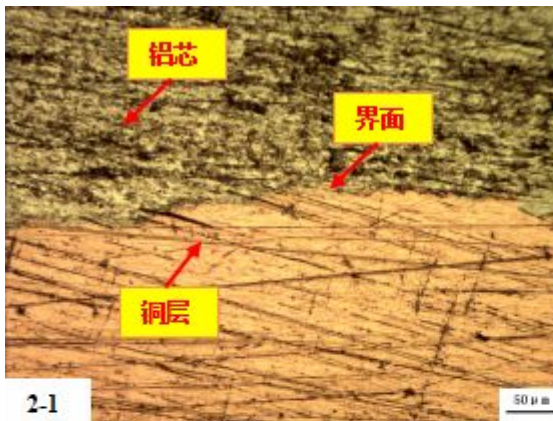
Four different position (Fig.10) were taken photos for each sample, metallographic pictures as shown below. 每个试样的拍照位置如图 10 所示，金相照片如图 11 所示。

Twist Test Report 扭曲试验报告

1# sample as follows: 1#试样如下:

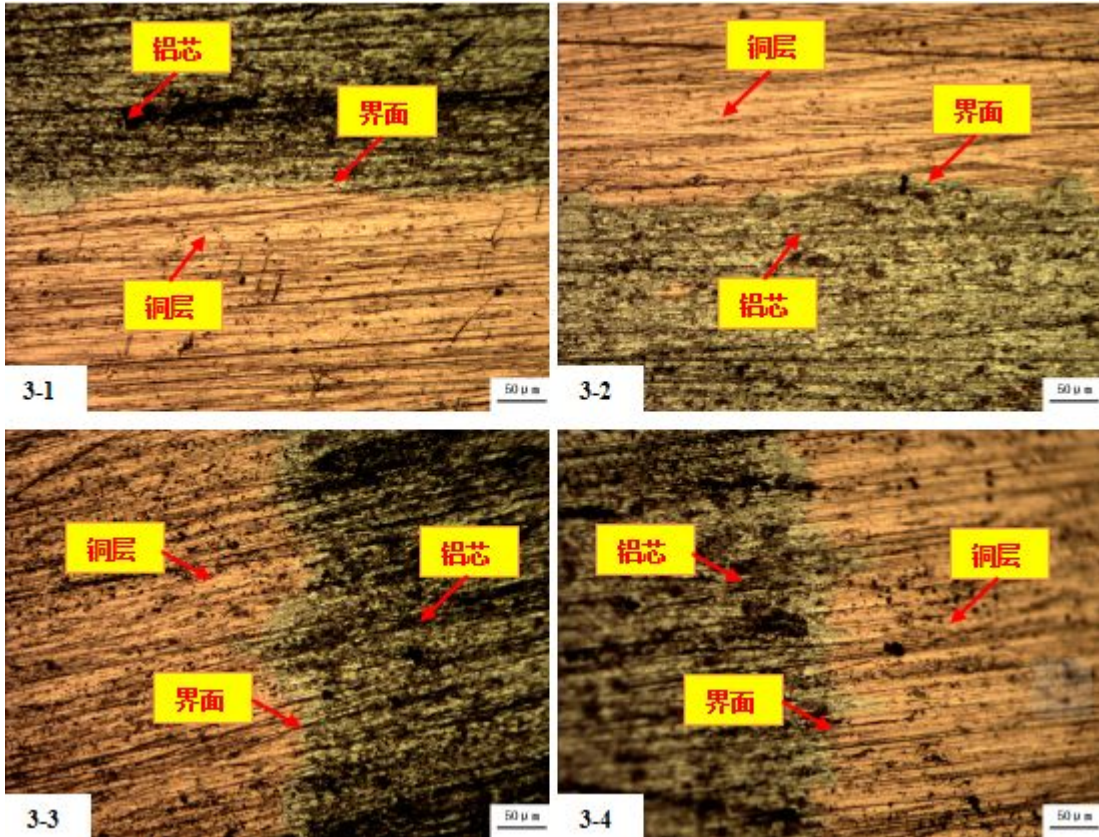


2# sample as follows: 2#试样如下:



Twist Test Report 扭曲试验报告

3# sample as follows: 3#试样如下:



4# sample as follows: 4#试样如下:

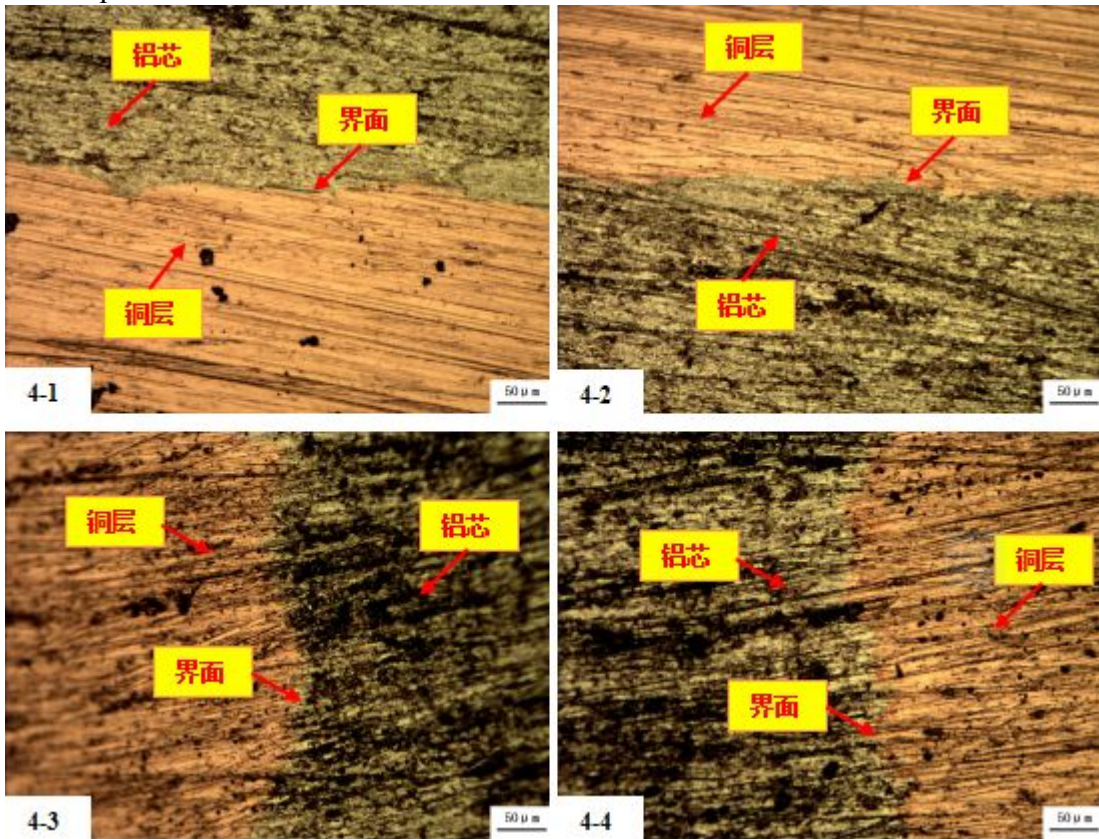
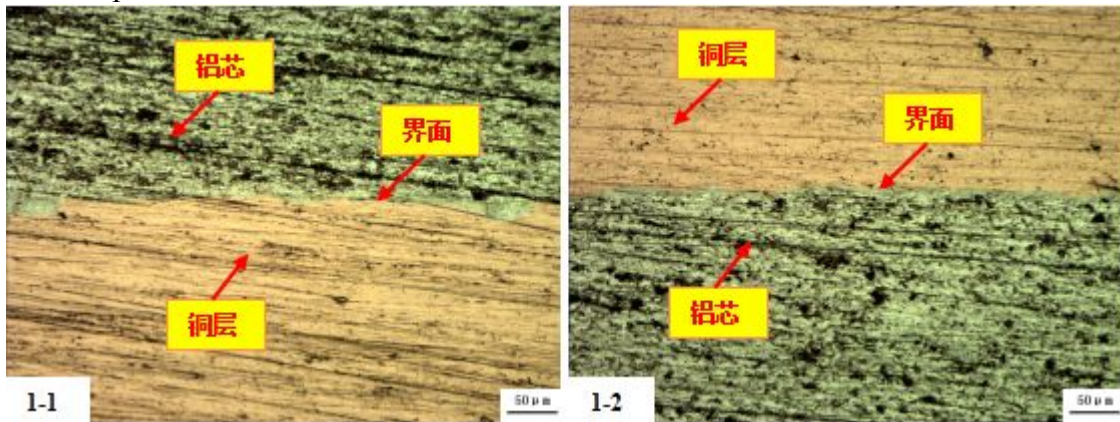


Fig.11 Metallographic photos of the cross section (200X) 图 11 横截面金相照片 200X

Twist Test Report
扭曲试验报告

Metallographic photos of the longitudinal section for 1# and 2# as follows: 1#和 2#的纵截面金相照片如下（附加试验）：

1# sample as follows: 1#试样如下：



2# sample as follows: 2#试样如下：

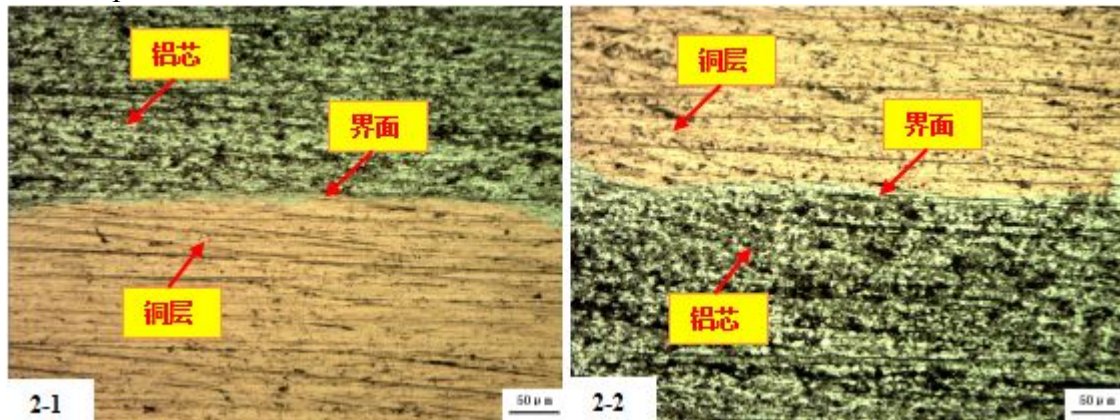


Fig.12 Metallographic photos of the longitudinal section (200X)

图 12 纵截面金相照片 200X

2.6 Penetration Test 渗透测试

Use the red and black tag samples to do the penetration test with reference to JB/T4730.5-2005, the testing process see below.将红色和黑色标记的试样进行渗透测试，参照 JB/T4730.5-2005 渗透检测，见下图。



Fig.13 Test solvent
图 13 测试溶剂



Fig.14 Penetration test of the cross section
图 14 横截面渗透测试



Fig.15 Penetration test of the longitudinal section

图 15 纵截面渗透测试

Test method: Spray penetrant on the surface of samples and keep wet about 15-20 minutes; wipe the excess penetrant on the sample surface, then clean with the detergent; spray imaging agent (imaging agent needs to shake well before using, spraying distance from 150mm to 300mm) on the surface of samples after sample surface drying, 10 minutes later it can show the state of copper and aluminum combination.

测试方法: ① 用渗透剂喷涂试样截面表面，保持湿润约 15~20 分钟；② 擦去试样表面多余的渗透剂，用清洗剂清洗干净；③ 试样表面干燥后喷涂显像剂（显像剂使用前需摇匀，喷涂距离 150~300mm），约 10 分钟后即能显示铜铝结合状态。

Discrimination: If the interface of copper clad aluminum flat bars occur delamination after twisting, red penetrant solvent will permeate into the interface between copper and aluminum when doing penetrant test, the red penetrant can slowly precipitate and permeate into the delaminated interface after spraying white photographic developer, it is concluded to be unqualified; If the interface of copper clad aluminum flat bars bonded well, red penetrant can't permeate into the interface, and it can't appear red precipitation after spraying white photographic developer, it is concluded to be qualified.

判定: ① 如果扭曲后铜铝界面分层，在做渗透测试时，红色的渗透剂将渗透到铜铝界面之间，喷白色显像剂后，红色渗透剂会慢慢析出，缝隙处变为红色，则判定为不合格；② 如果扭曲后铜铝界面结合状态良好，红色渗透剂无法渗透铜铝界面之间，喷白色显像剂后，不会出现红色析出，则判定为合格。

3. Conclusion 结论

1) Interface bonding state of copper clad aluminum flat bars is good after twisting 90° based on metallographic photos (as shown in figure 11 and 12), the cross and longitudinal section of copper clad aluminum flat bars don't occur delamination.

1) 根据金相照片（如图 11 和图 12 所示），所选取试样在扭曲 90° 后，试样扭曲处的铜铝界面结合状态良好，横截面与纵截面均无铜铝分层现象。

2) Sample no red penetrating agent, it is that interface bonding state of copper clad aluminum flat bars is good after twisting 90° based on percolation test photos (as shown in figure 14 and 15), the cross and longitudinal section of copper clad aluminum flat bars don't occur delamination.

2) 根据渗透测试照片（如图 14 和图 15 所示），试样并无红色的渗透剂渗出，表明试样铜铝界面结合状态良好，横截面与纵截面均无铜铝分层现象。

The above test shows that interface bonding state of copper clad aluminum flat bars by fiseend product is good after twisting 90°, the cross and longitudinal section of copper clad aluminum flat bars don't occur delamination.

以上试验说明孚信达生产的 TLM-YR-15x4 铜铝复合排扭曲 90° 后铜铝结合状态良好，并无铜铝分层。