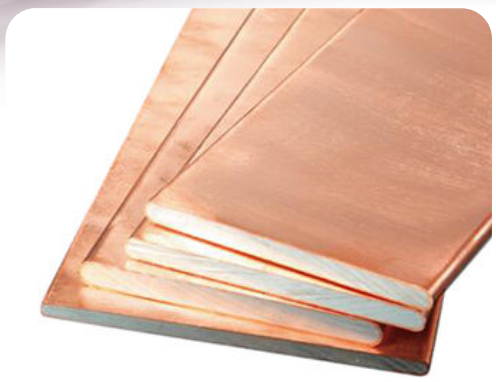
DATA SHEET



COPPER CLAD ALUMINUM COPPBAR™

COPPBAR™ Authorized distributor in Turkey

COPPBAR™ is a bimetallic composite busbar engineered to provide an economic alternative to solid copper. It is a Copper Clad Aluminum Composite – comprised of cladding copper, aluminum core, and interfacial bonding layer – that delivers cost savings and weight advantages yet retains the surface properties of a copper busbar.

The Current – Carrying – Capacity of CCAC is equivalent to 86% of copper bus with a 20% volume ratio of copper.

Its light weight, low cost, and mechanical processing properties make it an excellent overall performance material.

FEATURES

- COPPBAR™ is a lightweight, low cost engineered alternative to pure copper busbars.
- Reduces costs by 40%.
- Reduce weight by up to 60%.
- High electrical and thermal conductivity.
- Anti-blast, anti-vibration fatigue and strong corrosion resistance.
- Excellent soldering, welding and electroplating properties.
- Current carrying capacity is 86% / 83% of copper bar.
- Easy to bend, drill, cut and punch.
- Superior bonding strength and uniformity.

APPLICATION

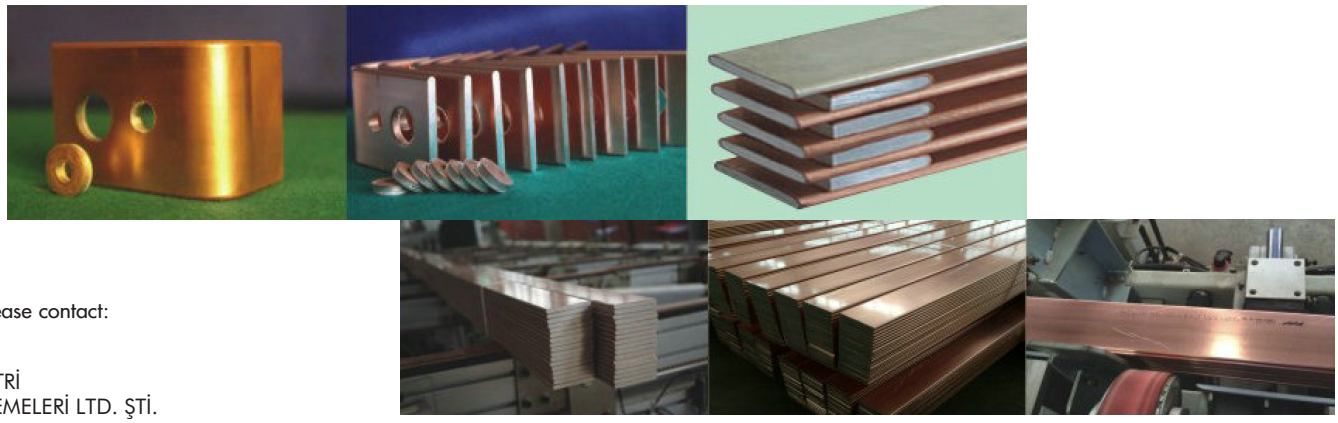
CCAC has far-reaching applications in multiple industries. Due to its light weight and low cost, it has been increasingly utilized in the automotive, aerospace, defense, electronics, refrigeration, and many other industries.

With its advantageous physical properties and significant economic benefits, CCAC is an excellent material that has much potential for a variety of applications.

TEST REPORT

- R2 - NPL Test Report
- T4 - China National Test Center
- T6 - China National Test Center

* Click the see test reports.



For this product, please contact:

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ERANOVA
Endüstri ve Elektrik Malzemeleri Ltd. Şti.
Dynamic Solutions Worldwide

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DATA SHEET COPPER CLAD ALUMINUM COPPBAR™

COPPBAR™ Authorized distributor in Turkey

COPPBAR™ BUSBARS - AC/DC CURRENT RATINGS (20% COPPER VOL.)

Size	Corner Radius	Cross Sectional Area	Weight (Approx)	DC Resistance at 20ºC	DC Resistance at 85ºC	Current Rating (Amps): 50ºC Rise Over 35ºC Ambient Temp. (No. of Buses)							
						n =1		n =2		n =3		n =4	
mm	mm	mm²	kg/m	µOhm/m	µOhm/m	DC	AC	DC	AC	DC	AC	DC	AC
3x30	0.8	89.45	0.352	288	364	336	336	609	609				
3x40	0.8	119.45	0.471	216	272	431	430	771	768				
3x50	0.8	149.45	0.589	172	218	521	517	923	918				
3x60	0.8	179.45	0.707	144	181	608	602	1063	1056				
4x30	0.8	119.45	0.471	215	271	395	395	724	723				
4x40	0.8	159.45	0.628	161	203	506	505	917	915				
4x50	0.8	199.45	0.786	128	162	613	609	1098	1092				
4x60	0.8	239.45	0.943	107	135	716	710	1268	1260				
4x80	0.8	319.45	1.259	80	101	814	802	1427	1417				
5x30	0.8	149.45	0.589	172	216	449	449	830	828	1210	1198	1590	1567
5x40	0.8	199.45	0.786	131	166	573	572	1047	1039	1518	1496	1987	1934
5x50	0.8	249.45	0.983	105	132	692	689	1252	1238	1809	1774	2349	2260
5x60	0.8	299.45	1.180	87	110	807	804	1447	1429	2084	2036	2706	2582
5x80	0.8	399.45	1.574	66	83	917	907	1629	1603	2345	2283	3023	2865
5x100	0.8	499.45	1.968	52	66	1024	1008	1801	1769	2593	2517	3326	3131
6x30	0.8	179.45	0.707	148	187	501	501	933	928	1364	1348	1794	1759
6x40	0.8	239.45	0.943	110	139	636	635	1170	1158	1701	1669	2230	2094
6x50	0.8	299.45	1.180	87	111	769	765	1401	1379	2029	1968	2655	2520
6x60	0.8	359.45	1.416	74	93	903	897	1632	1596	2355	2258	3077	2867
6x80	0.8	479.45	1.889	55	69	1164	1147	2084	2036	3010	2878	3857	3577
6x100	0.8	599.45	2.362	44	56	1419	1381	2518	2462	3637	3469	4632	4297
6x120	0.8	719.45	2.835	37	46	1667	1585	2930	2868	4230	4026	5259	4869
8x30	1.2	238.76	0.941	110	138	592	591	1117	1104	1641	1609	2165	2091
8x40	1.2	318.76	1.256	82	104	748	745	1392	1390	2033	1964	2673	2521
8x50	1.2	398.76	1.571	66	82	902	894	1659	1624	2413	2390	3166	2907
8x60	1.2	478.76	1.886	55	68	1053	1040	1921	1853	2785	2591	3646	3256
8x80	1.2	638.76	2.517	41	51	1349	1323	2434	2304	3509	3131	4581	4143
8x100	1.2	798.76	3.147	32	41	1639	1594	2933	2728	4213	3612	5488	4439
8x120	1.2	958.76	3.778	27	34	1920	1840	3406	3164	4890	3780	6079	4389
10x40	1.2	398.76	1.571	67	84	858	851	1614	1572	2367	2251	3120	2871
10x50	1.2	498.76	1.965	53	67	1029	1016	1914	1842	2794	2598	3673	3265
10x60	1.2	598.76	2.359	44	55	1198	1178	2207	2097	3210	2902	4212	3621
10x80	1.2	798.76	3.147	32	41	1529	1488	2779	2580	4021	3452	5259	4263
10x100	1.2	998.76	3.935	26	33	1854	1786	3339	3035	4809	3948	6276	4866
10x120	1.2	1198.76	4.723	22	27	2174	2074	3887	3467	5582	4417	7271	5431
12x40	1.2	478.76	1.886	55	70	957	946	1818	1752	2677	2496	3536	3166
12x50	1.2	598.76	2.359	44	55	1144	1125	2148	2038	3148	2844	4146	3564
12x60	1.2	718.76	2.832	36	46	1329	1299	2469	2307	3606	3159	4740	3926
12x80	1.2	958.76	3.778	27	35	1508	1452	2467	2207	4012	3342	5058	1220
12x100	1.2	1198.76	4.723	22	27	2048	1952	3712	3286	5362	4243	7008	5236
12x120	1.2	1438.76	5.669	19	22	2399	2259	4314	3742	6210	4736	8100	5829
15x40	1.2	598.76	2.359	44	55	1100	1081	2115	2005	3130	2828	4143	3563
15x50	1.2	748.76	2.950	35	44	1310	1278	2486	2306	3660	3182	4834	3972
15x60	1.2	898.76	3.541	29	36	1516	1466	2848	2586	4177	3505	5504	4359
15x80	1.2	1198.76	4.723	22	27	1924	1834	3574	3314	5228	4428	6518	4958
15x100	1.2	1498.76	5.905	18	22	2320	2200	4256	3796	6182	5222	7699	5689
15x120	1.2	1798.76	7.087	15	18	2712	2507	4915	4095	7101	6029	9281	6375

Note: Recalculation graphs should be used for design conditions different than those stated. For compatibility, recalculation graphs computed for the same base

The calculated values on this data sheet are based on the following parameters:

Ambient Temperature: 35 °C
Busbar temperature: 85 °C
Temperature rise: 50 °C
n = number of bars in parallel

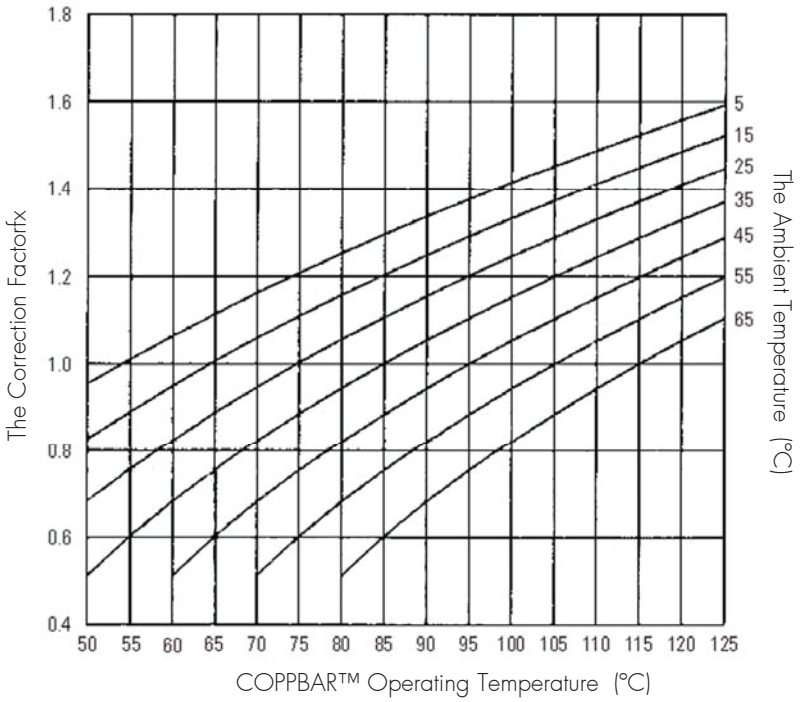
Current ratings assums still but unconfined air, with busbars mounted on edge current ratings are based on "Temperature Rise of Busbars" for multiple bars arrangement, the space between the bars is equal to busbar thickness.

THE TEMPERATURE CORRECTION GRAPH

Alternative Temperature Conditions

Obtain the temperature correction factor Fx by following:

1. Locate the new ambient temperature
2. Locate the COPPBAR™ operating temperature on the x-axis
3. Read out the temperature correction factor Fx from the y-axis



The temperature correction factor fx could be determined from the graph in order to correct the COPPBAR™ current ratings for diferent design parameters. The following is a sample:

Specification	80 x 10
The new ambient temperature °C	35
The new COPPBAR™ temperature °C	65
DC current (from table) Idc	1529
AC current (from table) Iac	1488
The temperature correction factor (from graph) fx	0.75
New DC current Idc	1147
New AC current Iac	1116

For this product, please contact:

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Test Report

BINDING STRENGTH OF COPPER CLADDING ON ALUMINIUM BUSBARS USING THE ELCOMETER PULL-OFF TEST

Restricted – In Confidence

By
A. S. Maxwell
NPL Materials Division

Summary

Elcometer pull-off tests were conducted to assess the binding strength of copper cladding on aluminium busbars. Tests were conducted using standard 12.7 mm diameter stubs attached to the copper cladding with FM1000 adhesive from Cytec Engineering. Three sets of copper clad specimens were examined which had been exposed to -40 °C to + 110 °C for 0, 50 and 100 cycles. None of the claddings were found to delaminate in the pull-off tests indicating that their binding strengths were all greater than that of the adhesive used to attach the stubs (>61 MPa).

For: Name Dr Jay Song
Company Applied Composite Material Co., Ltd.
319 N. Harvard Ave., Suite 103
Claremont 91711
United States

Telephone: +1 714 602 5737
Email: jaysong12345@yahoo.com
Order No: 2014070246

CONTRACT

The contract between NPL and Applied Composite Materials Ltd was as follows:

Initial and final binding force tests on copper clad aluminium busbars to be conducted.

Start: 7 October 2014

Completion: 14 October 2014

Customers artefacts:

Table 1 ***Copper clad aluminium busbars with different environment exposure cycles have been given the following NPL codes.***

NPL code	Environmental exposure
AAKJZ232A	0 cycles
AAKJZ232B	50 cycles (-40 °C to + 110 °C)
AAKJZ232C	100 cycles (-40 °C to + 110 °C)

1. INTRODUCTION

NPL was instructed by Applied Composite Materials to conduct a series of pull-off tests using the Elcometer pull-off tester to determine the binding strength of copper clad aluminium busbars exposed to -40 °C to + 110 °C for 0, 50 and 100 cycles. This report describes the tests and the results obtained.

2. TEST PROCEDURE

Adhesion tests were conducted by attaching aluminium stubs (12.7 mm diameter) to the copper cladding using FM1000 adhesive. The tests were conducted using a commercially available Elcometer Patti 100 test rig with a F12 piston (Figure 1). The tests involved screwing a pull-off stub into the top platen of the rig which could be moved freely relative to the lower platen. The stub was then pulled from the copper cladding by inflating a pneumatic bladder that pushes the two platens apart. The peak pneumatic pressure at failure was recorded and converted to a value of tensile stress (binding strength) through look-up tables supplied with the equipment.

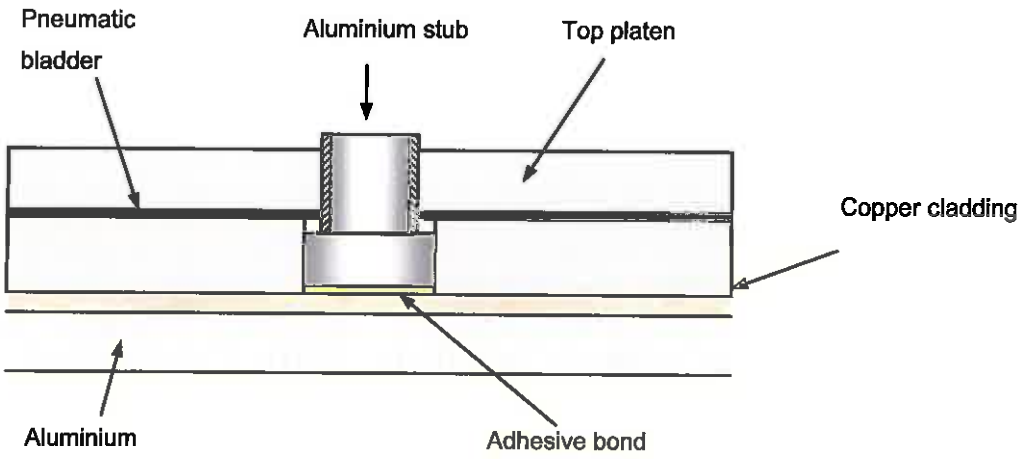

Figure 1 ***Schematic Representation of Pull-Off Test Equipment***

3. RESULTS AND DISCUSSION

The binding strengths obtained from the pull-off tests are shown in Table 2 with three repeat tests conducted on each bar.

After a stub had been pulled from the surface, the fracture surface was visually examined. In each case it was found that the FM1000 adhesive had failed with no sign of any of the claddings delaminating (Table 2). This indicates that the binding strength of the cladding is greater than the adhesive used to attach the stubs for each of the specimens examined. The variability in the results is due to variability in the adhesive rather than the cladding and it would appear valid to assume that the binding strength of the cladding is greater than the maximum value obtained using the pull-off test of 61 MPa. Increasing the number of exposure cycles the busbars were subjected appears to have no effect on the binding strength of the copper cladding (Table 2).

4. CONCLUSIONS

None of the claddings were found to delaminate in the pull-off tests indicating that their binding strengths were all greater than that of the adhesive used to attach the stubs (>61 MPa). Increasing the number of cycles the specimens were exposed to had no significant effect on the binding strength of the specimens up to 61 MPa.

Table 2 ***Pull-off tests results for copper clad aluminium busbars***

Disc Number	NPL Material Code	Exposure cycles	Tensile strength (MPa)
1	AAKJZ232A	0	55.60
1	AAKJZ232A	0	60.90
1	AAKJZ232A	0	59.10
2	AAKJZ232B	50	58.10
2	AAKJZ232B	50	59.20
2	AAKJZ232B	50	61.00
3	AAKJZ232C	100	59.10
3	AAKJZ232C	100	60.10
3	AAKJZ232C	100	58.10

Appendix 1 Interfacial strength test

An additional test was conducted for the customer, which was outside the main measurement service contract. This involved conducting an interfacial strength test on a busbar prepared by the customer. The specimen was rectangular shaped with a width of 20mm and precisely drilled with a 4mm long channel cut from the upper copper layer through the sample leaving just the bottom copper layer. A second channel was then cut parallel to the first through the bottom copper layer leaving a bimetallic connecting area (Figure 2). The bars were tested using an Instron 5500 K8026 tensile machine fitted with a calibrated load cell (load cell no. UK034, E11809111310). The specimens were placed in the grips, taking care to align the longitudinal axis of the test specimen with the axis of the testing machine. Tests were conducted at a rate of 1 mm/min and the tests continued until the specimens fractured. Load-cell force measurements were automatically recorded throughout the experiments. The load-displacement results for this test are shown in Figure 3, with the maximum load at fracture recorded as 2.945 kN.

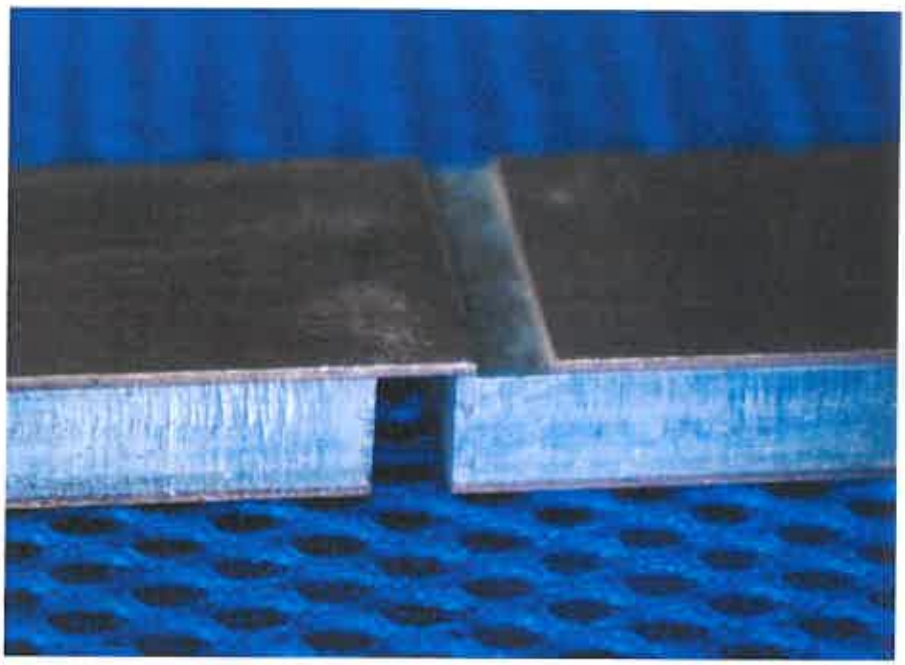

Figure 2 ***Typical busbar specimen used for the interfacial strength test***

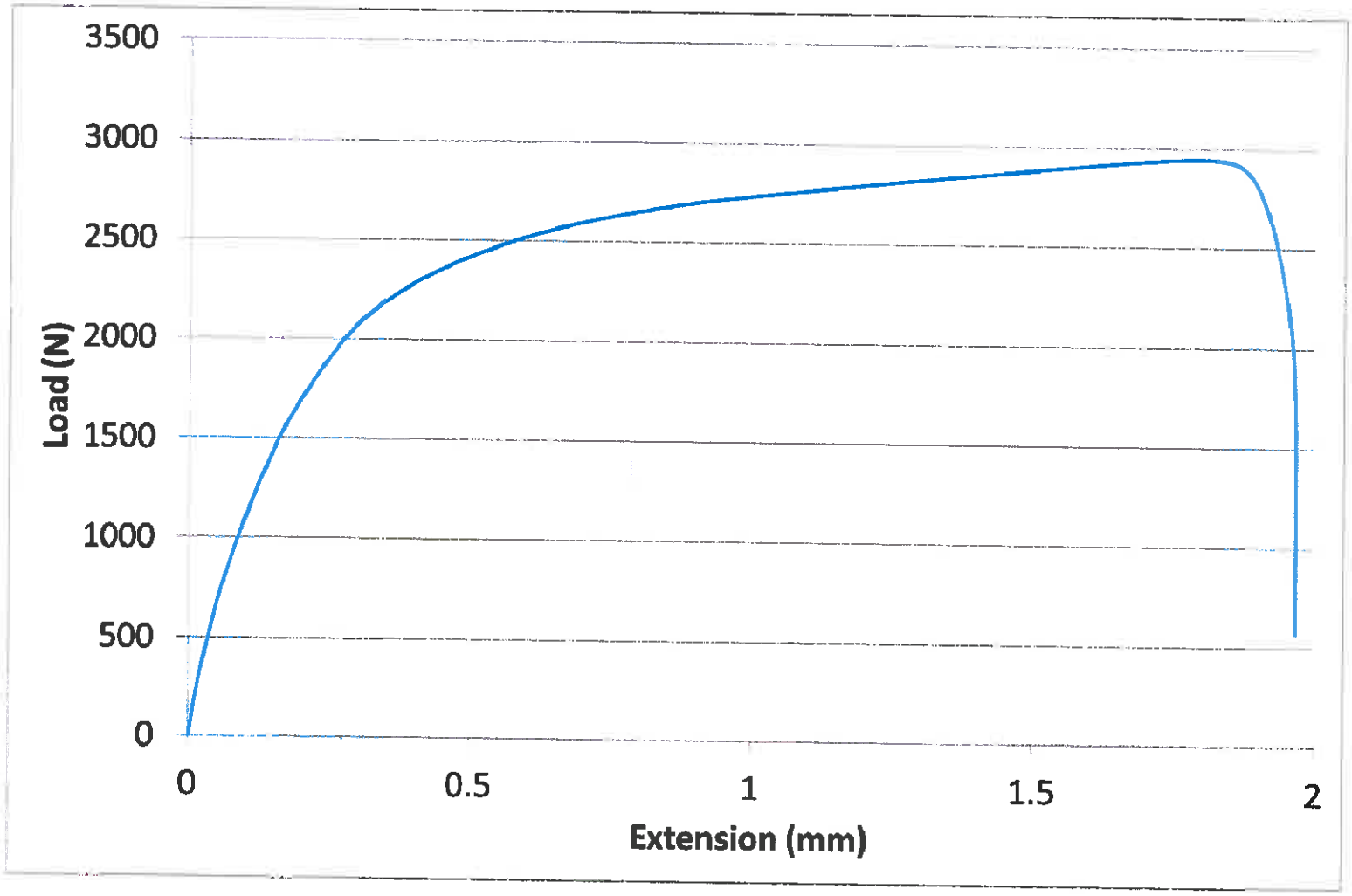

Figure 3 ***Load-displacement results obtained from interfacial strength test.***

Reference: 2014070246

Checked by: MLGower

2012000369Z (2012)国认监认字(093)

CNAS L0207

报 告 编 号
Reference № CT15-1274

检 验 报 告
Test Report

样 品 名 称 Name of sample	Copper Clad Aluminum Composite Bus 输变电设备用铜包铝母线
样 品 型 号 Type of sample	TBLM-QR（COPPBAR）
委 托 方 Consigner	Applied Composite Material Co., Ltd. 艾洛益(杭州)材料科技有限公司
试 验 类 型 Kind of test	Type Test 型式试验

国家电线电缆质量监督检验中心
CHINA NATIONAL CENTRE FOR QUALITY
SUPERVISION AND TEST OF ELECTRIC WIRE AND CABLE

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报告查询网址：www.ticw.com.cn 电子信箱：ewec@ticw.com.cn 邮编：200093

SAMPLE TYPE & SPEC.	TBLM-QR-6.0x60.0 (COPPBAR™)	CODE	CT15-1274

NO.	ITEMS	UNIT	TECHNICAL REQUIREMENT	TEST RESULTS	UNIT EVALUATION
1	Appearance		Cu clads the Al-core tightly, evenly and constantly to form metalogical bonding, with no gap between Cu-Al, clean and flat surface, no defects such as hollow, crack, leaking, and rust.	Pass	P
2	Size & Deviation				
2.1	Narrow side & Deviation -a	mm	6.00 ± 0.12	5.94	P
2.2	Wide side & Deviation -b	mm	60 ± 0.80	59.66	P
2.3	Radius of Full Circled Edge -R	mm	3 ± 0.75	3	P
3	Volume Ratio of the Cu Layer	%	18~22	21	P
4	Deviation of the thickness of Cu	%	± 10	8	P
5	Flateness				
5.1	Narrow side -a	mm/m	≤ 0.02554	0.8	P
5.2	Wide side -b	mm/m	≤ 0.02554	1	P
6	Density (20°C)	g/cm³	3.94 ± 0.13	3.94	P
7	Mechanical Property				
7.1	Interfacial Shear Tensile Strength Test - after 100 cycles of thermo-shock (-40°C~110°C)	Mpa	≥ 35	49	P
7.2	Tensile Strength	MPa	≥ 90	128	P
7.3	Elongation	%	≥ 11	23	P
7.4	Bending (D=24mm, Bend 90°)		It shall not appear wrinkle or crack on surface	No wrinkle or crack on surface	P
7.5	Interfacial Shear Tensile Strength	MPa	≥ 35	52	P
8	Resistivity (20°C)	Ω·mm²/m	≤ 0.02554	0.025	P
9	Conductivity (20°C)	%IACS	≥ 67.5	69	P

Meaning of the "Unit Evaluation": P: Test Passed; F: Test Failed; N: Not required for judgement; "/" means not required for test.

报告编号 Reference № CT14-2422-2(R)

CNAS 检测 CNAS L0207

2012000369Z (2012)国认监认字(093)号

检 验 报 告
Test Report

样品名称 Name of sample	Copper Clad Aluminum Composite Bus 电工用铜包铝母线排
样品型号 Type of sample	/
委托方 Consigner	Applied Composite Material Co., Ltd. 艾洛益(杭州)材料科技有限公司
试验类型 Kind of test	Client Request Test 委托检验

国家电线电缆质量监督检验中心
CHINA NATIONAL CENTRE FOR QUALITY SUPERVISION AND TEST OF ELECTRIC WIRE AND CABLE

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报告查询网址：www.ticw.com.cn 电子信箱：ewec@ticw.com.cn 邮编：200093

SAMPLE TYPE & SPEC.	Copper Clad Aluminum Composite Bus 6.0X60.0 (mm)	CODE	CT14-2422-2 (R)

NO.	ITEMS	UNIT	TECHNICAL REQUIREMENT	TEST RESULTS	UNIT EVALUATION
1	Tensile Strength	MPa	Minimum 90	122	P
2	Elongation (L0=250mm)	%	Minimum 8	23	P
3	Cu & Al_Interficial Bonding Strengt	MPa	Minimum 30	76	P
4	Current-Carrying -Capacity (For environmental temperature of 25℃, bus increased bus temperature of 40℃, to reach the current under stable temperature of 65℃)	A		714	N

Meaning of the "Unit Evaluation": P: Test Passed; F: Test Failed; N: Not required for judgement; "/" means not required for test.