The Analysis for the Contrast of Salt Fog Test of Typical Nonmetallic Material with GJB150 and GJB50A

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***Abstract*—GJB150 has been the main criterion for the environmental adaptability design in China since its publication. In 2009, GJB150A was released as an alternative criterion for GJB150. The method of salt fog test of GJB150A is different from GJB150. The spray method in GJB150A is alternate and the spray method in GJB150 is continuous. In order to compare the difference of the corrosion degree for typical non-metallic materials of the two test methods, the paper chose the material of typical and representative rubber of organic polymer and PCB specimens coated with different organic coatings and the test applied GJB150 and GJB150A respectively. The results of two tests were compared and analyzed and it demonstrated that salt fog test in GJB150A has higher corrosion degree when applied to rubber and PCB coated with organic coating. At the same time, rubber and acrylic coatings are less susceptible to salt spray corrosion.**

Keywords-GJB150; GJB150A; salt fog test; PCB; coating；rubber

I. INTRODUCTION

As it known to us all, the influence of salt fog environment on the corrosion degree of different materials and products has drawn the public attention extensively [1~2]. The salt fog test can be an essential part for the criterions of testing the environment and an indispensable part for the environmental adaptability of products [3~4]. Since China released GJB150 in 1985, it has become the major standard for the design for the environmental adaptability. In 2009, GJB150A was released and the spray method of salt fog test is different from the spray method of GJB150. The method of GJB150 is continuous while the method of GJB150A is alternate [5]. The salt fog test in GJB150A indicates that the alternate spray method is more relevant to the real field test and the degree of destruction can be higher [6]. However, this assumption is insufficient in data.

In accordance with the revised rules of the standard specification, GJB150A as an alternative to GJB150 should be more realistic in terms of standard setting and test setting, and the test conditions are more severe. However, in the actual test, the testers have doubts about whether the salt spray test of GJB150A can completely replace GJB150, which leads to the unclear application range of the two standards. Does the test piece that has been tested for salt spray according to GJB still need to conduct a salt spray test in accordance with GJBA? The salt spray test is questionable.

Aiming to the above questions, the paper chose the specimen of rubber which is a type of typical organic polymer and PCB coated with different organic coatings [7]. Through comparing the functional differences of the rubber and PCB with two different salt fog methods, the research analyzed and contrasted the corrosion degree of these two different methods so as to reveal the differences of the continuous spray and alternate spray. The research can be of great significance to promote the craft of environmental standards, save the research costs for products and shorten the updating cycle of products. In short, the research can be critical for the research and development of all kinds of products in China.

II. EXPERIMENT METHODS

A. Preparation for Samplings

The specimen of the test adopted the material of aircraft tires and PCB with different coats. The rubber was made into dumbbell-shaped specimens accordance with the method specified in GB/T 2941, and the rubber was cleaned and wiped by the absorbent cotton soaked with steamed water. The rubber was dried in the dried oven and applied the rubber tension testing machine to test the degree of the tension and elongation at break. The PCB was also cleaned and wiped by the

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absorbent cotton soaked with steamed water and dried in the dried oven. At the same time, it applied high insulation resistance test to measure the original insulation resistance.

The detailed information of specimens of rubbers and the PCB are demonstrated in I and Table II.

TABLE I. TATAILS OF RUBBER SPECIMEN

Type	Source	Test Standard	Quantity
A	Vulcanization specimen of tread compound for aircraft tire	GJB150	2
A	Vulcanization specimen of tread compound for aircraft tire	GJB150A	2
B	specimen pieces cut from aircraft tire	GJB150	2
B	specimen pieces cut from aircraft tire	GJB150A	2

TABLE II. DETAILS OF PCB SPECIMEN

Code	Surface treatment material	Test Standard	Quantity
1-1	Interpenetrating Polymer Network	GJB150	1
1-2	Interpenetrating Polymer Network		1
1-3	Interpenetrating Polymer Network	GJB150A	1
1-4	Interpenetrating Polymer Network		1
2-1	Parylene	GJB150	1
2-2	Parylene		1
2-3	Parylene	GJB150A	1
2-4	Parylene		1
3-1	Hydrophilic coating	GJB150	1
3-2	Hydrophilic coating		1
3-3	Hydrophilic coating	GJB150A	1
3-4	Hydrophilic coating		1
4-1	Acrylic	GJB150	1
4-2	Acrylic		1
4-3	Acrylic	GJB150A	1
4-4	Acrylic		1
5-1	Hydrophobic coating	GJB150	1
5-2	Hydrophobic coatings		1
5-3	Hydrophobic coating	GJB150A	1
5-4	Hydrophobic coating		1

B. Experiment Condition

The salt fog test condition of GJB150 and GJB 150A are shown in the Table III. The sedimentation rate of the salt fog in GJB150A can be 1~3mL/80cm2•h^{-1}. However, in order to ensure that only the spray method is different in the comparison test, the sedimentation rate of the salt fog should be 1~2mL/80cm2•h^{-1}. In order to prevent the corrosion performance of non-metallic materials after the 96h salt fog test is not obvious, the test time is extended to 192h.

TABLE III. SALT FOG TEST CONDITION FOR GJB150 AND GJB150A

Standard		GJB150	GJB150A
Temperature（℃）		35	35±2
saline solution	Composition	NaCl	NaCl
	Potency（%）	5±1	5±1
	PH value	6.5~7.2	6.5~7.2
Precipitation of the salt fog mL/80cm^2•h^{-1}）		1~2	1~2
Method of fog		continuous spray for 48h, dry for 48h	Two cycles; each cycle has continuous spray for 24h and dry for 24h.
Duration of time （h）		96	96

III. TEST RESULT AND ANALYSIS

A. The Test Results and Analysis of the Rubber Specimens

The tensile strength and elongation at break of rubber specimens was measured by Shenyang Sanxiang Tire Limited Liability Company. The measure of data took the standards of GJB108B-98 as the reference. The result of the salt fog test for the rubber specimens are demonstrated in the Table IV.

TABLE IV. COMPARISION OF TEST RESULT OF GJB150 AND GJB150A

Type	Pre-test		GJB150		GJB150A	
	Tension (Mpa)	*Rate of elongation at break (%)*	*Tension (Mpa)*	*Rate of elongation at break (%)*	*Tension (Mpa)*	*Rate of elongation at break (%)*
A	23.6	410	22.4	380	22.3	370
	23.6	410	22.6	380	22.4	370
	23.6	410	22.5	375	22.0	365
B	22.7	460	20.5	405	19.1	370
	22.7	460	19.7	400	19.0	375
	22.7	460	19.6	380	19.2	375

From Table IV, the tensile strength and elongation at break of the rubber decrease slightly after the salt fog test. This indicates that the rubber is less susceptible to salt spray corrosion. If more defects are exposed to rubber, the test time needs to be extended. In addition, the performance of the

rubber specimen subjected to GJB150A salt spray test decreased more than that of the rubber specimen subjected to GJB150 salt spray test. This indicates that the salt fog test in GJB150A has higher corrosion to the rubber specimen

B. The Test Results and Analysis of the PCB Specimens

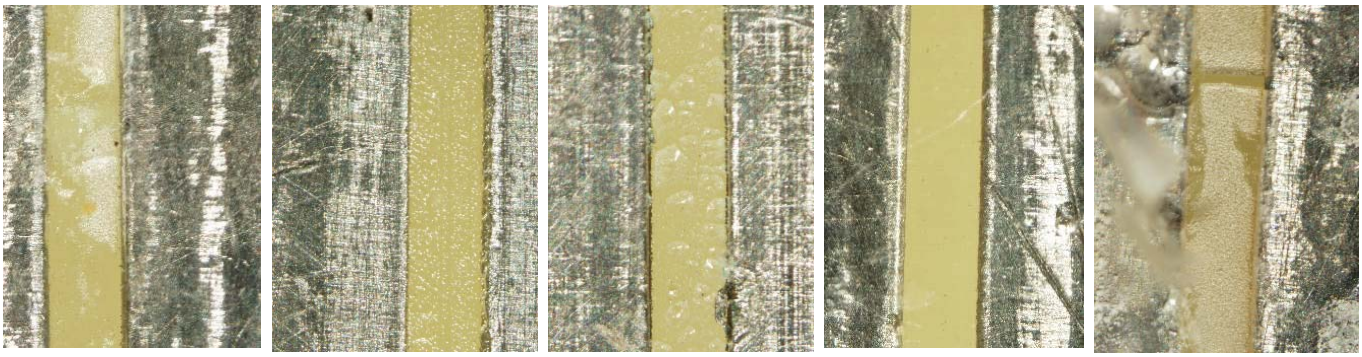
1) Macroscopic Morphology Analysis: Fig.1 and 2 presents the 90 times macrograph of printed circuit board within various coatings tested in accordance with GJB150 and GJB150A. According to the macrograph, there are actually different degrees of corrosion in corresponding coating after 192 hours of salt fog test, especially for hydrophobic coatings, cracking, peeling and chalking have occurred. It is because the hydrophobic coatings could lose the function of protecting once it touches with water. In the process of the salt fog test, the water drops on the surface. At the same time, it can be seen that the acrylic coating has the best protection effect on the PCB.

By comparing the macroscopic morphology after the two tests, it can be concluded that PCB board tested according to GJB150A has a higher degree of corrosion. The reason is that alternating spray gives the material an opportunity to contact the oxygen in the air, causing the corrosion to become more severe. Continuous spraying does not give the material more oxygen, so the corrosion is relatively less severe.

2) The Analysis for the Changes in Insulation Resistance: The variation of insulation resistance of PCB tested in accordance with GJB150 is shown in Table V, The variation of insulation resistance of PCB tested in accordance with GJB150A is shown in Table VI.

TABLE V. CHANGE IN INSULATION RESISTANCE OF PCB AFTER TEST ACCORDING TO GJB150

Code	Surface Treatment Material	Pre-test ($\times 10^9$)	Post-test ($\times 10^9$)	Rate of Change (%)
1-1	Interpenetrating Polymer Network	113.0	11.809	89.55
1-2	Interpenetrating Polymer Network	203.9	19.680	90.35
2-1	Parylene	156.0	59.02	62.18
2-2	Parylene	44.35	16.33	63.17
3-1	hydrophilic coating	139.0	23.07	83.40
3-2	hydrophilic coating	70.47	9.703	86.23
4-1	Acrylic	74.40	40.95	44.96
4-2	Acrylic	82.73	39.50	52.25



Interpenetrating Polymer Network | Parylene | Hydrophilic Coating | Acrylic | Hydrophobic Coating

Figure 1. The test Result of GJB150 for PCB within various coatings

Interpenetrating Polymer Network | Parylene | Hydrophilic Coating | Acrylic | Hydrophobic Coating

Figure 2. The test Result of GJB150A for PCB within various coatings

TABLE VI. CHANGE IN INSULATION RESISTANCE OF PCB AFTER TEST ACCORDING TO GJB150A

Code	Surface treatment material	Pre-test ($\times 10^9$)	Post-test ($\times 10^9$)	Rate of change (%)
1-3	Interpenetrating Polymer Network	115.2	3.680	96.80
1-4	Interpenetrating Polymer Network	106.4	3.127	97.06
2-3	Parylene	88.00	28.05	68.13
2-4	Parylene	89.50	26.75	70.11
3-3	hydrophilic coating	72.90	5.595	92.33
3-4	hydrophilic coating	103.6	5.855	98.97
4-3	Acrylic	79.25	31.40	60.38
4-4	Acrylic	78.90	30.60	61.22

As can be seen from the data of the two tables, under the salt fog environment, the acrylic coating has the best protection for PCB. In addition, the comparison for the two figure demonstrates that the GJB150A has a higher corrosion degree for the PCB with different paint coats from the perspective of the amplitude of decreasing in insulation resistance.

IV. CONCLUSION

By analyzing the test results of GJB15O and GJB150A, and comparing the differences between the two test methods on the corrosion degree of rubber and PCB coated with different organic coatings, the following conclusions can be concluded.

- Salt fog test in GJB150A has higher corrosion degree when applied to rubber and PCB coated with organic coating. Therefore, the salt fog test for these materials is recommended according to GJB150A.
- For the materials mentioned herein, alternating sprays give the material an opportunity to contact the oxygen in the air, causing the corrosion to become more severe. Continuous spraying does not give the material access to more oxygen, so the corrosion is relatively less severe.
- Rubber is less affected by salt spray corrosion. If more defects are exposed to rubber, the test time needs to be extended.
- Acrylic coatings are less susceptible to salt spray corrosion, and under the salt fog environment, the acrylic coating can protect PCB better than other organic coatings.
- Acrylic coatings are prepared by adding advanced long-life chlorosulfonated polyethylene rubber, weather-resistant filler and weathering additive to Chinese and foreign countries. Therefore, it is more resistant to salt spray corrosion.
- The parylene coating is also less susceptible to salt spray corrosion, but it is less resistant to salt spray corrosion than the acrylic coating.
- The hydrophobic coatings could lose its function and it appeared cracking, peeling and chalking phenomenon after encountering water.

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