关于抗硫化试验可靠性设计与试验标准

Reliability design and test standard for anti -sulfurization tests

§0．摘要 Abstract

在电阻家族中,厚膜貼片電阻是應用最廣及數量最多的一種电阻,厚膜電阻的电極均是由銀膏或低含鈀量銀膏製作燒結而成的,在一些火山爆發區,農場,通訊基站,化工廠,橡膠廠,停車場等,由於 SO2,H2S 等硫化氣體的濃度相對較高,电阻在使用一段時間後,由於硫化會造成失效,因此了解電阻的失效機理,建立抗硫化的可靠性測試方法及試驗標準,是提升抗硫化的能力的必要保証.

In the resistor family, thick film chip resistors are the most widely used and the most numerous types of resistors. The electrodes of thick film resistors are made and sintered from silver paste or low palladium content silver paste. In some volcanic eruption areas, farms, communication base stations, chemical plants, rubber factories, parking lots, etc., due to the relatively high concentration of sulfide gases such as SO2 and H2S, the resistors will fail due to sulfurization after a period of use. Therefore, to understand the failure mechanism of resistors and to establish reliable test methods and standards for anti-sulfurization is a necessary guarantee for improving the ability of anti-sulfurization.

§1．抗硫化電阻的種類及應用 Types and applications of anti-sulfurized resistors

抗硫化電阻因電子產品的應用場所及電子產品本身的價值不同,因此會有不同的电阻產品來應對不同的應用.目前市面上的厚膜抗硫化產品有分為 3 類.第一類:是金电極產品,這類產品是完全抗硫化的產品;第二類:是高含鈀量銀膏製做的电阻,這類電阻的含鈀量通常在 20%~30%左右;第三類:是通過材料的匹配及結構保護達到抗硫化的目的.

Due to the different application locations and values of electronic products, there will be different resistors to cope with different applications. Currently, there are three types of anti-sulfurized thick film chip resistors in the market. The first type is gold electrode resistors, which are completely anti-sulfurized resistors; the second type is resistors made from silver paste with high palladium content, usually with a palladium content of around 20% to 30%; the third type is resistors which achieved anti-sulfuration through material matching and structural protection.

前兩類產品抗硫化性能穩定,但成本很高;第三類產品的特徵是成本低,產品因材料選擇及製程工藝而有所差異,因此客戶在選擇抗硫化電阻產品時,也需識別供應商目前的客戶群與銷售量,同時確認抗硫化的測試條件.抗硫化產品的種類、特點與應用具體如下表:

The first two types of products have stable anti-sulfuration performance, but the cost is high; the characteristic of the third type of products is its low cost, which varies depending on the material selection and manufacturing process. Therefore, when selecting anti-sulfurized resistors, customers also need to identify the supplier's current customer group and sales volume, and confirm test conditions for anti-sulfurized resistors. The types, characteristics, and applications of anti-sulfurized products are shown in below table:

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序號 No.	種類 Type	特點 Characteristics	應用說明 Applications
1	金电極 Gold electrode	完全抗硫化,成本很高; Complete anti-sulfurization, with a high cost	應用於航天,航空及軍事工業 Applied to aerospace, aviation, and military industries
2	高含鈀量 High palladium content	含鈀量 20%~30%,具有較高的抗硫化性能,成本很高; Containing 20% to 30% palladium, it has high anti-sulfurization and high cost	應用於軍工,特種勘探設備,汽車引擎,ABS,油箱油量檢測等控制單元; Applied to control units such as military industry, special exploration equipment, automotive engines, ABS, and tank oil level detection;
3	結構保護型 Structural protection	通過結構保護及材料匹配來達到抗硫化性能; Achieving anti-sulfurization performance through structural protection and material matching	通訊基站,空調,汽車周邊,醫療器械,化工廠,農場設備,工控設備等. Communication base stations, air conditioning, car peripherals, medical equipment, chemical plants, farm equipment, industrial control equipment, etc.

§2．電阻抗硫化測試方法的可靠性設計
Reliability Design of Resistor Anti-Sulfurization Test Method

電阻抗硫化不是一個新的問題,但抗硫化被普遍認同還是在近 10 年內,被電子產品製造及生產商所普遍認知的,目前电阻行業中,針對抗硫化測試主要有兩種流派,一種是以歐美為代表的电阻生產商,採用的是 ASTM-B809 的硫化試驗方法,另一種是以日系為代表的电阻生產商,使用的油浴試驗.期試驗方法是在金加工油中+3.5%硫粉,將电阻浸入金加工油中,然後將电阻放置在 105℃的環境中進行 500H 的放置.

Anti-sulfurization is not a new issue, but it has been widely recognized by electronic product manufacturers in the past 10 years. Currently, there are two main schools of anti-sulfurization test in the resistor industry. One is resistor manufacturers represented by Europe and America, using the anti-sulfurization test method of ASTM-B809, and the other is resistor manufacturers represented by Japan, The oil bath test used is to immerse the resistor in gold processing oil with 3.5% sulfur powder, and then place the resistor in an environment of 105 ℃ for 500H.

上面兩種試驗方法是市場較為認同及接收的方法,但從電阻的結構,應用及試驗的可靠度設計角度來講,直接採用上面的試驗條件來對電阻進行抗硫化測試還存在一定的缺陷,這主要是由於电阻是由不同的材料所構成的,各材料之間的結合在不同的環境應力下可能會產生缺陷,因此,在進行可靠性設計時,需要從電阻的安裝及應用環節來考量电阻有可能承受的最大環境應力.在抗硫化試驗測試前應進行安裝及應用中最大環境應力的預置試驗,這樣更能確保產品的品質及減少產品失效的可能性.厚聲的抗硫化預置試驗是,對測試電阻先進行 3 次回流焊焊

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接,然後再進行-55℃ 30min 與 155℃ 30min　100Cycle 的冷熱衝擊.前者應對的是安裝中可能存在的缺陷,後者是針對應用環節中电阻存在的最大環境應力.

The above two test methods are widely recognized and accepted by the market. However, in terms of the structure, application, and reliability design of resistors, directly using the above test conditions for anti-sulfurization test still has certain drawbacks. This is mainly because resistors are composed of different materials, and the combination of different materials may produce defects under different environmental stresses. Therefore, when designing reliability, it is necessary to consider the maximum environmental stress that the resistor may withstand from the installation and application aspects. Prior to the anti-sulfurization test, a preset test of the maximum environmental stress during installation and application should be conducted to ensure product quality and reduce the possibility of product failure. UR’ s anti-sulfurization preset test involves three reflow soldering tests on the tested resistors, then thermal shock tests at -55 ℃ for 30 minutes and 155 ℃ for 30 minutes for 100 cycles. The former corresponds to potential defects during installation, while the latter corresponds to the maximum environmental stress present in the resistors during the application process.

§3．厚聲電阻抗硫化測試方法
UR’ s Anti-Sulfurization Test Method on Resistors

針對行業中流行的兩種抗硫化測試方法,厚聲都可以進行測試,其測試方法具體如下:

Both of the two popular anti-sulfurization test methods in the industry can be tested in UR, and the specific test methods are as follows:

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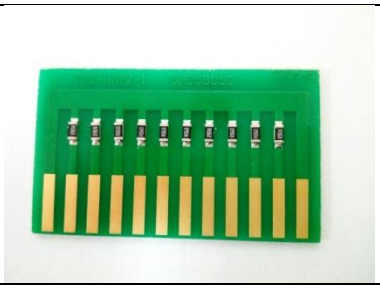
A. 油浴室驗方法:此方法主要針對 NS 及 NQ 產品.
Test method for oil bath: this method mainly applies to NS and NQ products

序號 No.	試驗步驟 Test steps	圖　片 Pictures	試驗要求 Test requirements
1	PCB 板的要求 Requirements for PCB board		1.PCB 板要選擇化金或鍍鎳的 PCB 板; PCB board should be ENIG or Nickel plating 2.電阻焊接要採用回流焊焊接,且銲錫高度應不超過 C1 面為好. Resistor welding should use reflow soldering, and the soldering height should not exceed C1 surface
2	回流焊 Reflow soldering		1. 回流焊爐按標準進行溫度及速度的設定; Set the temperature and speed of the reflow soldering furnace according to standards; 2. 試驗 PCB 板需經過 3 次回流焊 The test PCB board needs to undergo 3 reflow soldering cycles
3	冷熱衝擊 Thermal shock		冷熱衝擊 Thermal shock:100 Cycles 步驟 Step 1:-55℃±3℃ 30min; 步驟 Step 2:室溫 room temperature, 10min~15min; 步驟 Step 3:155℃±2℃ 30min 步驟 Step 4:室溫 room temperature, 10min~15min
4	油浴試驗 Oil bath test		1.在金加工油中加入 3.5%的升華硫,並攪拌; Add 3.5% Sublimation sulfur into gold processing oil. 2.將完成預置是驗的 PCB 板浸入金加工油中. Immerse the PCB board that has been pre-tested into gold processing oil. 3.將燒杯放入烤箱並加熱到 105℃,並持續加熱 500H. Place the beaker in the oven and heat it to 105 ℃, then continue heating for 500H. 4.判定標準:≤±5%; Judgment standard: ≤ ± 5%

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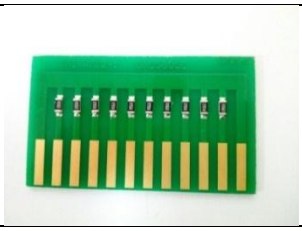
B. ASTM-B809:此測試主要針對 HQ 及 CQ 產品.

B. ASTM-B809: this test is mainly applies to HQ and CQ products

序號 No.	試驗步驟 Test steps	圖　片 Pictures	試驗要求 Test requirements
1	PCB 板的要求 Requirements for PCB board		1.PCB 板要選擇化金或鍍鎳的 PCB 板; PCB board should be ENIG or Nickel plating 2.電阻焊接要採用回流焊焊接,且銲錫高度應不超過 C1 面高度. Resistor welding should use reflow soldering, and the soldering height should not exceed C1 surface
2	回流焊 Reflow soldering		1.回流焊爐按標準進行溫度及速度的設定; Set the temperature and speed of the reflow soldering furnace according to standards; 2.試驗 PCB 板需經過 3 次回流焊 The test PCB board needs to undergo 3 reflow soldering cycles
3	冷熱衝擊 Thermal shock		冷熱衝擊 Thermal shock:100 Cycles 步驟 Step 1:-55℃±3℃ 30min; 步驟 Step 2:室溫 room temperature, 10min~15min; 步驟 Step 3:155℃±2℃ 30min 步驟 Step 4:室溫 room temperature, 10min~15min
4	ASTM -B809		1.在乾燥器底部加 200g 水和 200g 硝酸鉀; Add 200g of water and 200g of potassium nitrate to the bottom of the dryer 2.將撒滿硫粉的托盘放到乾燥器隔板上; Place a tray filled with sulfur powder on the dryer partition 3.將完成前置式驗的 PCB 板掛到硫粉的上方; Hang the PCB board that has been pre-tested above the sulfur powder 4.將乾燥器蓋子蓋上後放到 60℃烤箱內,其內部溫濕度條件為 60℃ 85%RH±4%RH; Put a lid on the dryer and place it in a 60 ℃ oven, with an internal temperature and humidity condition of 60 ℃ 85% RH ± 4% RH; 5.測試 1000H 後取出測試阻值; Take it out and measure resistance value after 1000H; 6.判定標準:≤±1%. Judgment standard: ≤ ± 1%