Cross-Section Analysis Case

1.Case Background：

The failure symptom was a short-circuited capacitor, and the test result showed no capacitance.The defect rate was approximately 0.5% (five per thousand).

Tested Model:CL21A226KOQNNNE

2.Analysis Method:

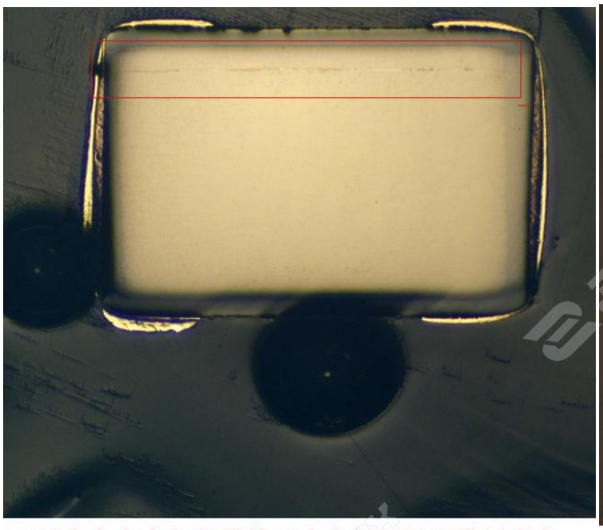
Visual inspection did not reveal any obvious damage or cracks on the samples. However, after removing the capacitor from the PCB, it was observed that the solder surface exhibited clear oxidation along with pits and scratches. This is likely caused by the customer using a probe tip to contact the solder layer during capacitor performance testing, or by thermal stress damage or mechanical damage resulting from improper handling during desoldering.



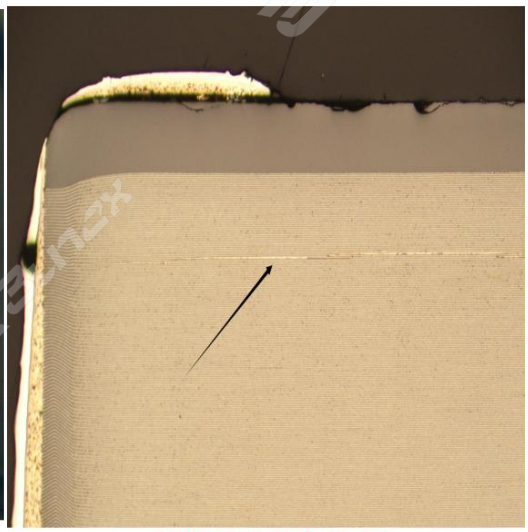
Impedance testing was performed on the failed MLCCs, and NG-1, NG-2, and NG-3 all exhibited short-circuit behavior.

	NG-1	NG-2	NG-3
阻值（欧）	334.29	1.6653K	2.0263K

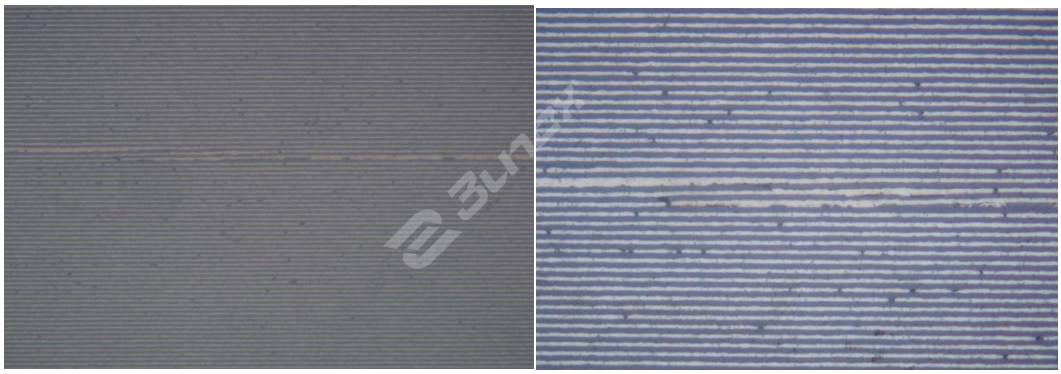
The samples were then subjected to cross-sectioning. Observation using a metallographic microscope revealed typical electrical overstress damage inside the failed MLCCs.



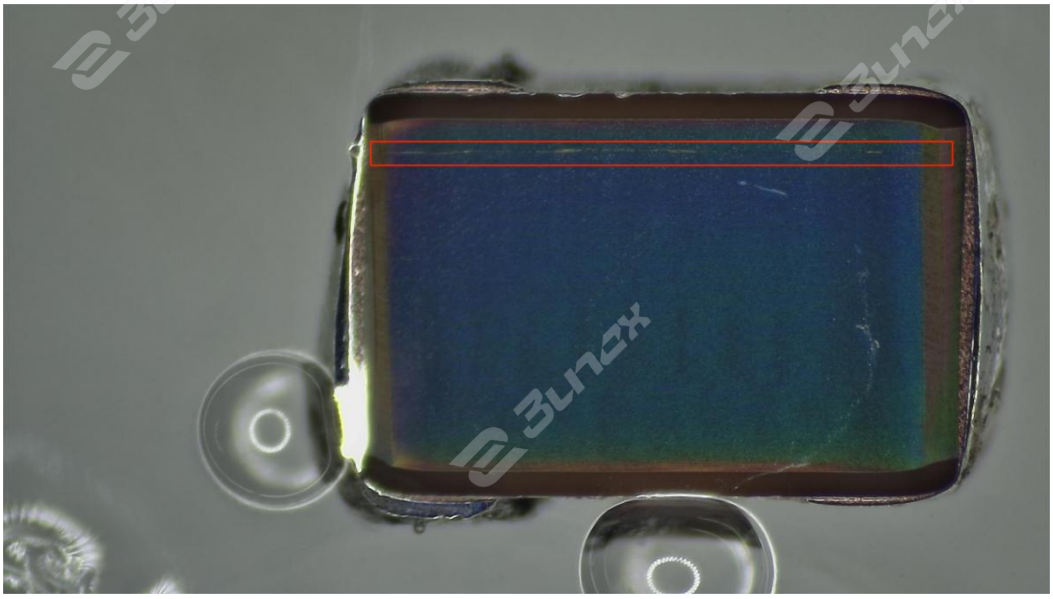
可见电容在金相显微镜下上电极层呈现发黑现象



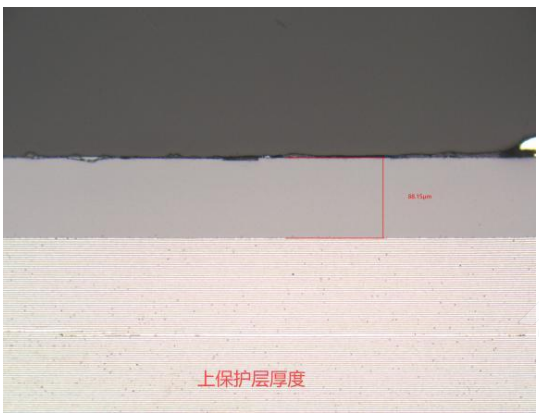
放大后发现电极有膨胀现象、扭曲现象

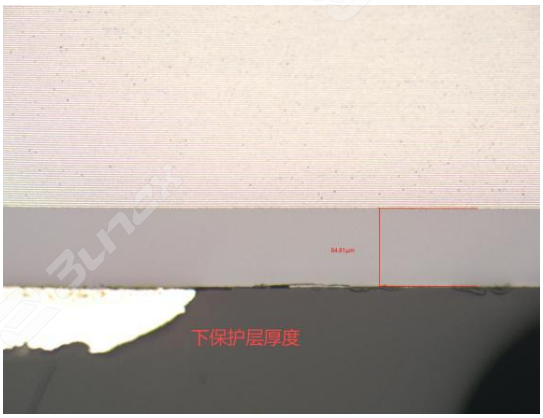


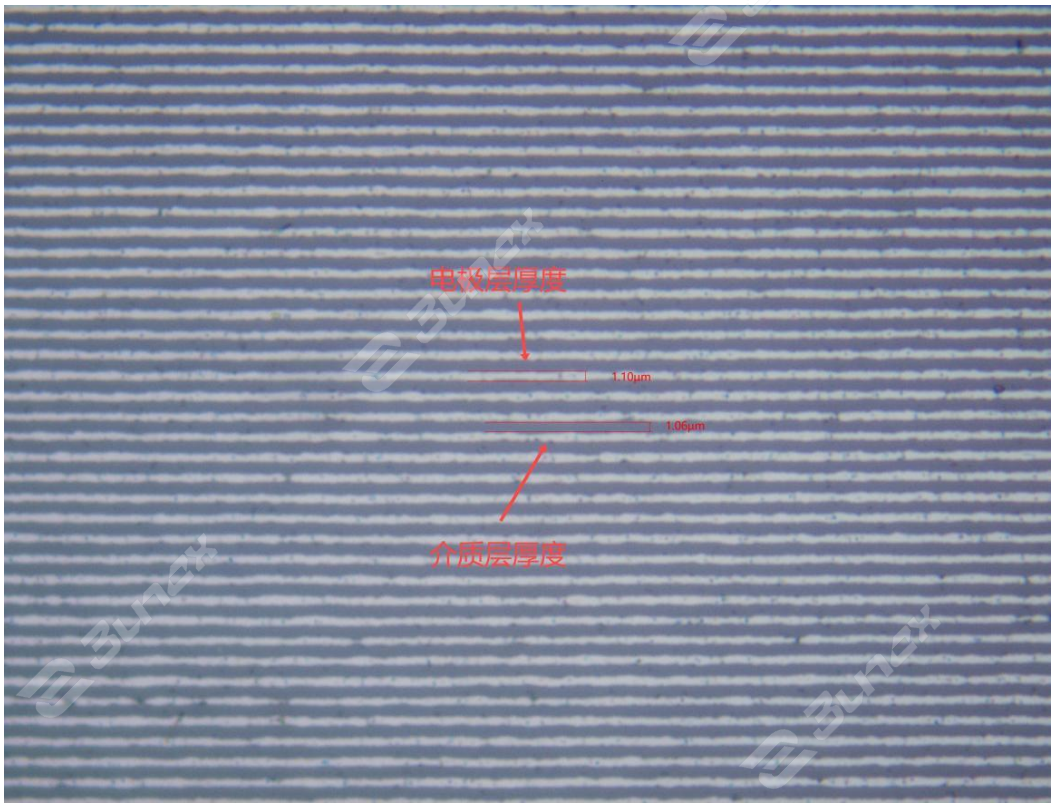
This was even more evident under an optical microscope:



Dimension measurements (electrode layer thickness, dielectric layer thickness, and protective layer thickness) and electrode layer counting were performed on the polished samples (to ensure the number of electrode layers matched the genuine product specifications).







3.Analysis and Discussion：

Multilayer ceramic capacitors (MLCCs) inherently possess excellent reliability and can operate stably for extended periods. However, if the component itself contains defects or if defects are introduced during the assembly process, reliability can be severely co mpromised. The causes of breakdown failure in MLCCs can generally be divided into external and internal factors.

Internal factors include: voids in the ceramic dielectric, electrode nodules, and dielectri c layer delamination.

External factors include: thermal stress cracks caused by temperature shock, mechanica l stress cracks induced by mechanical stress, and breakdown caused by electrical overst ress.

4.Conclusion：

The primary cause of the sample failure is the presence of thermal stress cracks within the MLCC, and the formation of these cracks is most likely closely related to the handli ng and operations during its application. In principle, multilayer ceramic dielectrics hav e high brittleness and poor tolerance to thermal shock. When the temperature changes t oo rapidly, the internal stress distribution within the ceramic dielectric becomes uneven , which can easily lead to distortion of the electrode layers. Distorted electrode layers m ay degrade the electrical performance of the capacitor, such as reduced capacitance, dec reased insulation resistance, and may even cause short-circuit or open-circuit failures.

5.Recommendations：

(1) In circuit board design, avoid placing MLCCs in areas of concentrated stress.

(2) Avoid using MLCCs in environments with drastic temperature changes.

(3) Enhance the heat dissipation capability of the PCBA during operation.

(4) Follow proper handling procedures.