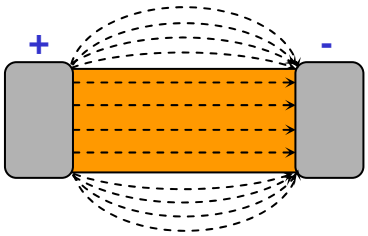
MLCC Arc Prevention – Hi-Pot Testing

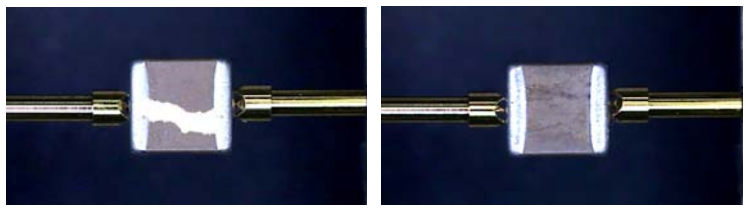
When performing Hi-pot tests on ceramic capacitors, various factors (temperature, moisture, relative pressure, termination creepage distance, and PCB layout...etc.), can affect surface arcing potential. This surface arcing becomes more of a factor in high dielectric constant materials such as X7R and Y5V
Holy Stone has developed an arc prevention solution for MLCC products.

Typical Applications for telecommunication devices(IEEE802.3) in LAN interface, Ballast...

Surface arcing phenomenon

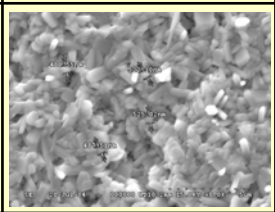
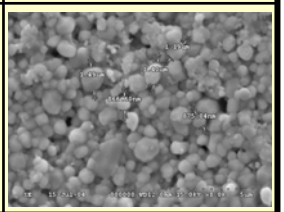
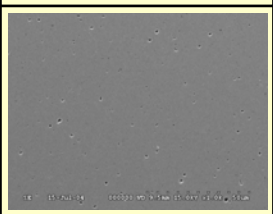
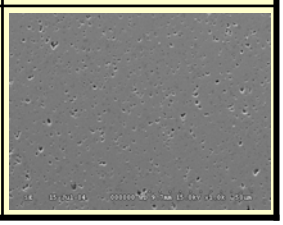


Electric field flux is generated upon applying voltage to the capacitor as shown in Fig. above



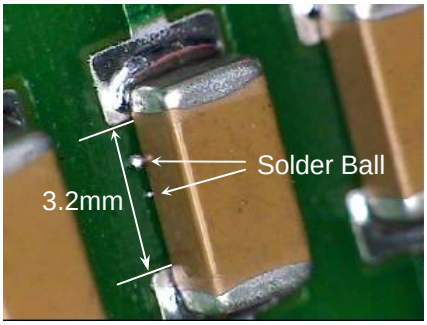
Typical surface arcing on MLCC's between termination-to-termination (show in polarized lighting)

NPO & X7R Material Content & Characteristic Comparison

Item	NPO	X7R
Dielectric Constant	30 ~ 100	2000 ~ 4000
I. Resistance	$>10^{13}\ \Omega$	$>10^{11}\ \Omega$
B.D. Voltage	70~80 Vdc/um	40~50 Vdc/um
Grain Size	< 500nm	900nm ~ 1500nm
Grain Size (x8000)		
Porosity (x1000)		

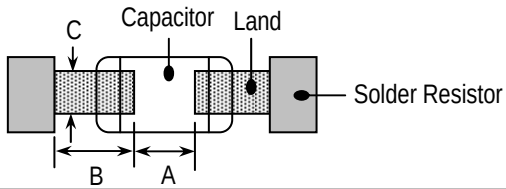
- Different grain sizes result in differing grain densities after the sintering process.
- Because NPO grain sizes are thinner & longer, than X7R, the resulting structure is tighter and more dense, especially due to porosity differences between NPO & X7R.
- Greater surface porosity will entrap more dust and moisture.
- When voltage, specifically high voltage, is applied, the surface porosity will readily attract electrical charge. When the applied voltage is increased and reaches the inception voltage, electrical arcing will occur.

Creepage distance vs. Arc effect



Residual solder will reduce creepage distance and Insulation resistance.

Recommend Land Requirement



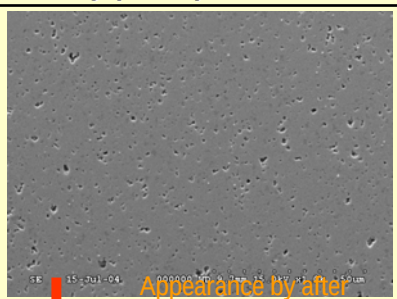
EIA Code	Chip (mm)		Land (mm)		
	L	W	A	B	C
1808	4.6±0.3	2.0 ±0.2	3.2~3.6	1.2~2.4	1.5~1.8
1812	4.6±0.3	3.2 ±0.2	3.2~3.6	1.2~2.4	2.3~3.0
2208	5.7±0.4	2.0 ±0.2	4.0~4.6	1.2~2.4	1.5~1.8
2211	5.7±0.4	2.0 ±0.3	4.0~4.6	1.2~2.4	2.0~2.6
2220	5.7±0.4	5.0 ±0.4	4.0~4.6	1.2~2.4	3.5~4.8

The metal-to-metal distance could affect the arcing phenomenon. Therefore, the above land layout is recommended to minimize arcing potential in high voltage capacitors.

Coating solution for surface arcing prevention

To prevent surface arcing due to surface porosity in X7R capacitors, an insulated gel (high insulation material) process is introduced to provide a smooth and less porous surface. The following tests describe the difference between coated & non-coated products.

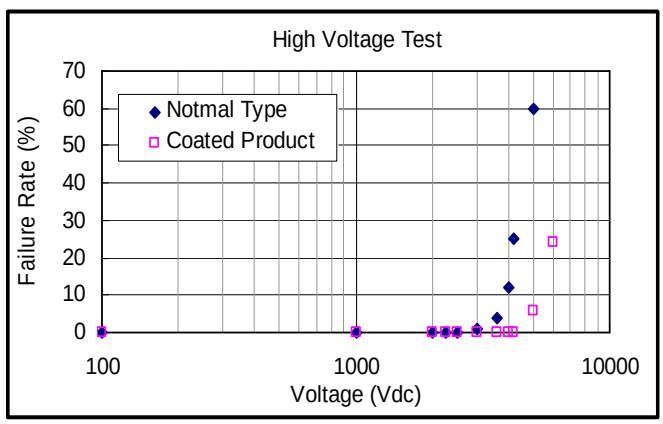
Surface Handling Comparison

Item	Porosity (x1000)
Before	
After	

Appearance by after coated product.

High Voltage Testing Comparison

P/N: C1808X102K302T v.s. C1808X102K302TO(Coated Product)



- The coating will "fill-in" the X7R surface porosity and provide a smooth surface that minimizes the arcing potential.
- The Hi-pot endurance level will increase ~ 1000Vdc after coating for individual and on-board hi-pot test.

The hi-pot test voltage will be increased by 1000Vdc for X7R coated products. Due to the inherent reduced porosity of NPO capacitors, the coating process is typically not required. However, Holy Stone can apply the same coating solution for both NPO and X7R capacitors.

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