

Reliability and Safety of Specialty Polymer Aluminum Electrolytic Capacitor

- **Reliability**

More difficult to short-circuit than a tantalum capacitor

- **Safety**

More difficult to "smoke" and ignite than tantalum capacitor



Reliability

The Specialty Polymer Aluminum Electrolytic Capacitor (SP-Al) is a capacitor more difficult to short-circuit than a tantalum capacitor.

Reliability test

A capacitor was investigated for possible short-circuit or burnout when voltage is applied in a high temperature environment.

● Test conditions

- Test temperature: 85 to 145°C
- Applied voltage : Rated voltage (W.V.) x (0.8 to 1.25)
- Test time : 1,000 hours (without protective resistance)
- Quantity of specimens: n = 20 for each condition

● Test results

The number of products short-circuited or burned out are shown below.

Specialty polymer aluminum electrolytic capacitor 6.3V 47μF(7.3 x 4.3 x 1.8)

	0.8 x W.V.	W.V.	1.1 x W.V.	1.25 x W.V.
85°C	0	0	0	0
105°C	0	0	0	0
125°C	0	0	0	0
145°C	0	0	0	0

During the test, short-circuits did not occur under each of all the conditions.

Tantalum capacitor 6.3V 220μF(7.3 x 4.3 x 2.8)

	0.8 x W.V.	W.V.	1.1 x W.V.	1.25 x W.V.
85°C	0	0	0	0
105°C	0	0	0	1
125°C	0	0	0	3
145°C	1	0	0	0

The short-circuited products were all burned out.

Normally, when the atmospheric temperature and voltage become higher, a product tends to short-circuit.

Predicted failure rate of SP-Al

- By our reliability test, the following data could be obtained.
Failure rate obtained by the temperature accelerated test: **46 Fit or less** (Predicted failure rate when the temperature is 105°C and the rated voltage is applied)
- Predicted market failure rate: **0.13 Fit or less** (c = 0, predicted failure rate when reliability level is 60%)

*This failure rate is for your reference only and actual failure rate may vary on actual application.

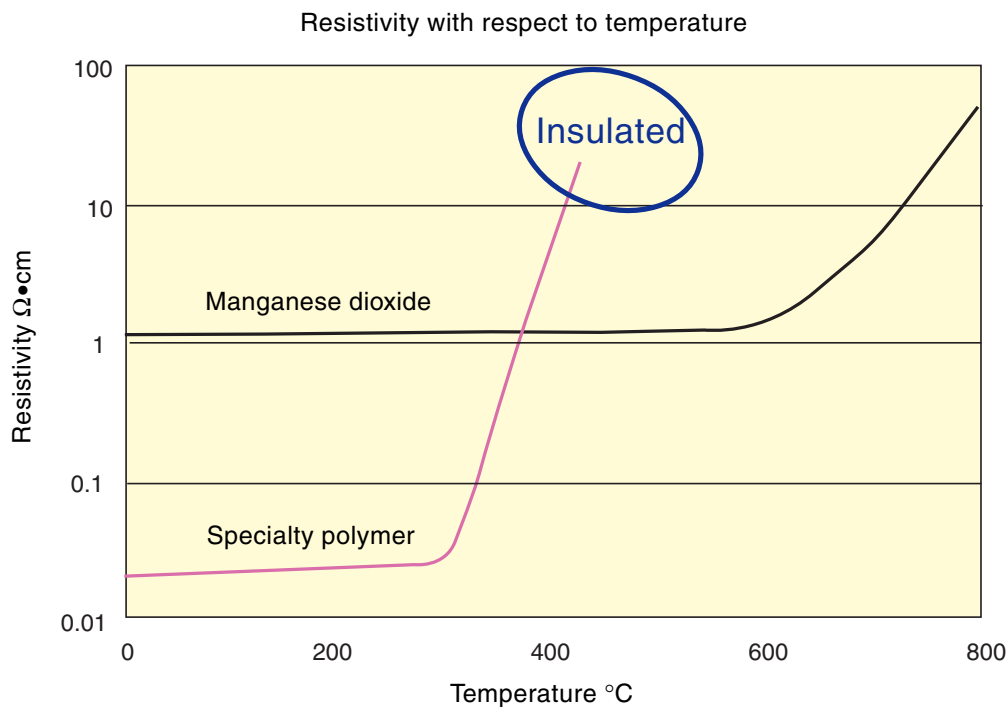


Why is the capacitor difficult to short-circuit?

The specialty polymer is a substance (electrolyte) insulating itself to shut off a current flowing through a defective part in a dielectric substance.

Insulation of specialty polymer itself

The specialty polymer insulates itself with the joule heat of current flowing through a defective part of oxide film and, therefore, the polymer shuts off the current selectively through the defective part.



The specialty polymer insulates itself at a low temperature as compared with manganese dioxide.
As a result, SP-Al is more difficult to short-circuit than a tantalum capacitor.



Safety

The specialty polymer aluminum electrolytic capacitor (SP-AI) is a capacitor more difficult to "smoke" and ignite than a tantalum capacitor.

Safety test

A constant current was passed through a short-circuited product, and the product was observed to check for smoking and ignition.

● Test conditions

To short-circuit, an overvoltage of 30 V DC was applied to a capacitor at room temperature, and then a constant current was applied to the capacitor for two minutes.

● Test results

The presence or absence of smoke and the number of products red-heated and ignited are shown below (unit: piece)

Specialty polymer aluminum electrolytic capacitor 6.3V 33μF (7.3 x 4.3 x 1.8)

Current (A)	Test times	Not smoked	Smoked	Red-heated and ignited
1	50	50	0	0
3	50	50	0	0
5	50	35	15	0
7	50	8	42	0
10	50	2	48	0

In the conditions shown above, red-heating and ignition were not identified.

The smoke emitted in the tests above was analyzed. As a result, harmful substances were not detected.

(Detail: carbon dioxide <0.34mg, carbon monoxide <0.53mg, methane gas < 0.19mg/piece)

Tantalum electrolytic capacitor 6.3V150μF (7.3 x 4.3 x 2.8)

Current (A)	Test times	Not smoked	Smoked	Red-heated and ignited
1	50	50	0	0
2	50	25	25	0
3	50	8	8	34
4	50	0	0	50
5	50	0	0	50

* This test data is simply the results obtained from the reference tests and actual data may vary on actual application.

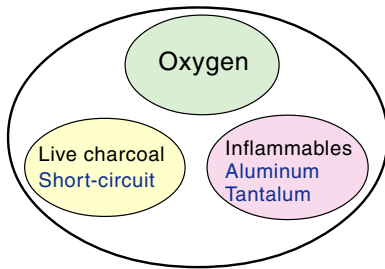


Why is the capacitor difficult to smoke and ignite?

It is because:

- * Aluminum is more difficult to burn than tantalum.
- * Specialty polymer emits less oxygen than manganese dioxide.

Three elements of combustion



* For substances to burn, the three elements of live charcoal, inflammable, and oxygen are mandatory. If one of them is not supplied, burning will not occur.

Aluminum is more difficult to burn than tantalum.

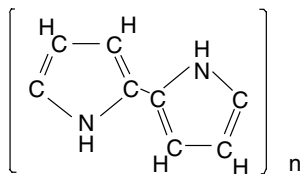
	SP-Al	Tantalum capacitor
Burning reaction	$\text{Al} + \text{O}_2$	$\text{Ta} + \text{O}_2$
Reaction start temperature	400°C ~ 600°C	250°C ~ 450°C
Activation energy	170kJ/mol	115kJ/ mol

* Reaction becomes easier when the activation energy is lower.

→Tantalum is easier to be bound to oxygen (O₂), and to be burned at low temperatures.

Specialty polymer does not produce oxygen.

Specialty polymer



Manganese dioxide

MnO_2
Example of the oxygen release reaction of manganese dioxide



* Specialty polymer does not contain oxygen (O₂).

→Manganese dioxide releases oxygen to cause combustion.

Aluminum is more difficult to bind with oxygen than tantalum, and specialty polymer does not release oxygen as in manganese dioxide.
As a result, SP-Al is more difficult to smoke and ignite than a tantalum capacitor.

5 Reliability & Safety