2. Summary of Capacitors

2-1 Principle of Capacitors

Capacitor consists of two metal plates with good transmittance in parallel, and dielectric (insulator) which does not transmit electricity between them.

The name of capacitors is decided by the kinds of electrode material and dielectric.

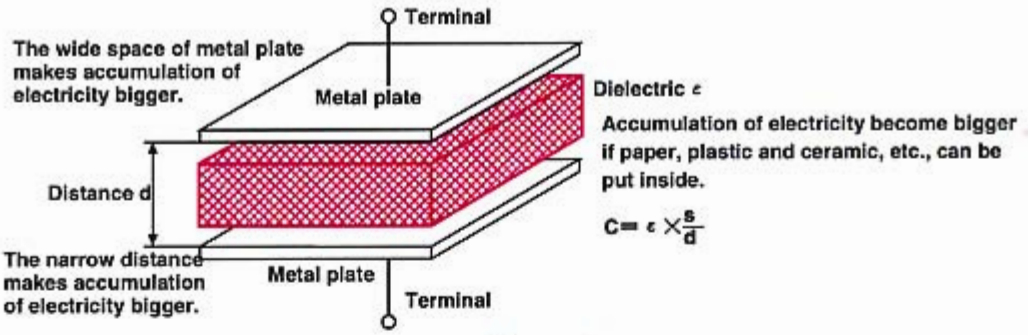

Fig.2 Principle of Capacitor

Electrolytic capacitors are distinguished from other capacitors by the uniqueness of their electrode materials and dielectric. Fig.3 shows the principle diagram of electrolytic capacitor.

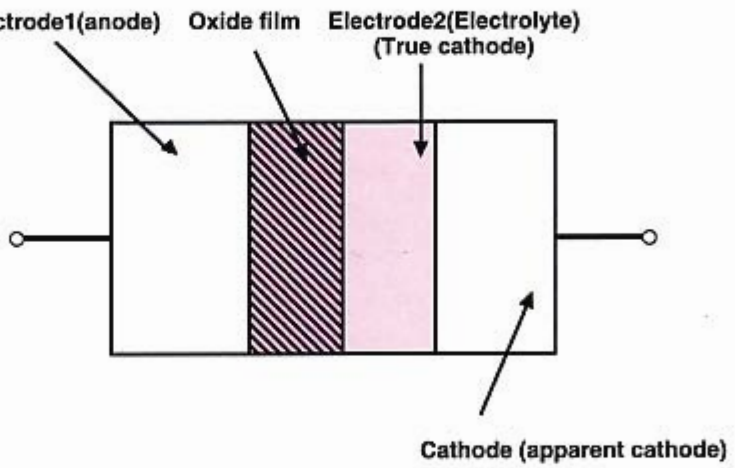

Fig.3 Principle Diagram of Electrolytic Capacitor

Electrolytic capacitor names after using oxide film formed electrochemically on electrode surface as dielectric.

Aluminum (Al), tantalum (Ta), niobium (Nb), titanium (Ti), zirconium (Zr), hafnium (Hf) and other metals can form a fine, highly insulative oxide film. Currently, the only two metals in practical application are aluminum and tantalum.

Oxide film formed on the surface of electrode 1 becomes an electrical insulator and functions as a

☆ Point:Electrolytic capacitors have polarity.

2–2 Types of Electrolytic Capacitors

The types of capacitors in practical application are those shown in Fig.4.

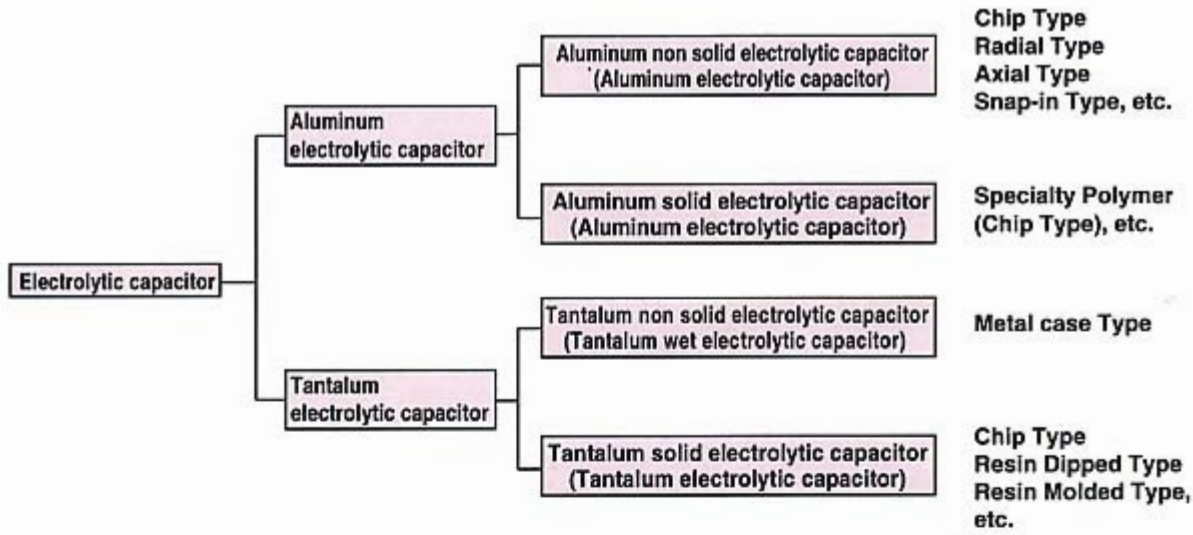

Fig.4 Types of Electrolytic capacitors

Since the applications of tantalum non solid electrolytic capacitors are limited and extremely specialized and they are produced in only small numbers, aluminum electrolytic capacitors and tantalum solid electrolytic capacitors (tantalum electrolytic capacitors below) may be considered to be the only two main types of electrolytic capacitors.

Table-1 Features and Differences

	Aluminum electrolytic capacitors	Tantalum electrolytic capacitors
Voltage range	2 ~ 500V	2 ~ 50V
Capacitance range	0.1μF ~ 1000mF	0.047μF ~ 470μF
Miniaturization	Advantageous in high capacitance range	Advantageous in low capacitance range
tan δ	High	Low
Leakage current	Relatively large	Relatively small
Temperature characteristics	Not very good	Good
Frequency characteristics	Not very good	Good
Failure mode	Wear failure (limited life), open	Random failure, increase in eakage current, short circuit
Solder heat resistance	Relatively weak	Relatively strong
Voltage delating	No big influence on reliability (life)	Influence on failure rate (low voltage is good)
Ripple resistance	Relatively strong	Can not take large ripple current
Reverse voltage resistance	Can take it on both polarities	Can not take it
Solvent resistance	Weak	Strong
Price	Relatively inexpensive	Relatively expensive

a liquid electrolyte, while tantalum electrolytic capacitors use a solid electrolyte.

These structual differences in aluminum electrolytic capacitors and tantalum electrolytic capacitors have a large influence on their performance and reliability.

The biggest difference of them is in their electrolytes (liquid • solid).

Such properties as temperature characteristic and frequency characteristic are not as good with the liquid electrolyte as with the solid electrolyte because the variation in conductivity is great. In contrast, the recoverability of the oxide film is not as good with solid electrolytes as it is with liquid electrolytes, and so the development of a flaw in the oxide film could easily result in a failure mode such as an increase in leakage current or a short circuit. Solid electrolyte capacitors do not have as good a ripple current resistance and charge-discharge resistance, and do not stand up as well to reverse current due to the difference in recoverability.

The life of liquid electrolyte capacitors is limited because the electrolyte gradually permeates through the seal and diffuses, causing the capacitor to dry up and lose capacitance and resulting in an open condition.

☆ Point:Aluminum electrolytic capacitor have a life.

2 – 3 Construction of Aluminum Electrolytic Capacitors

The construction of aluminum electrolytic capacitors is shown in Fig.5.

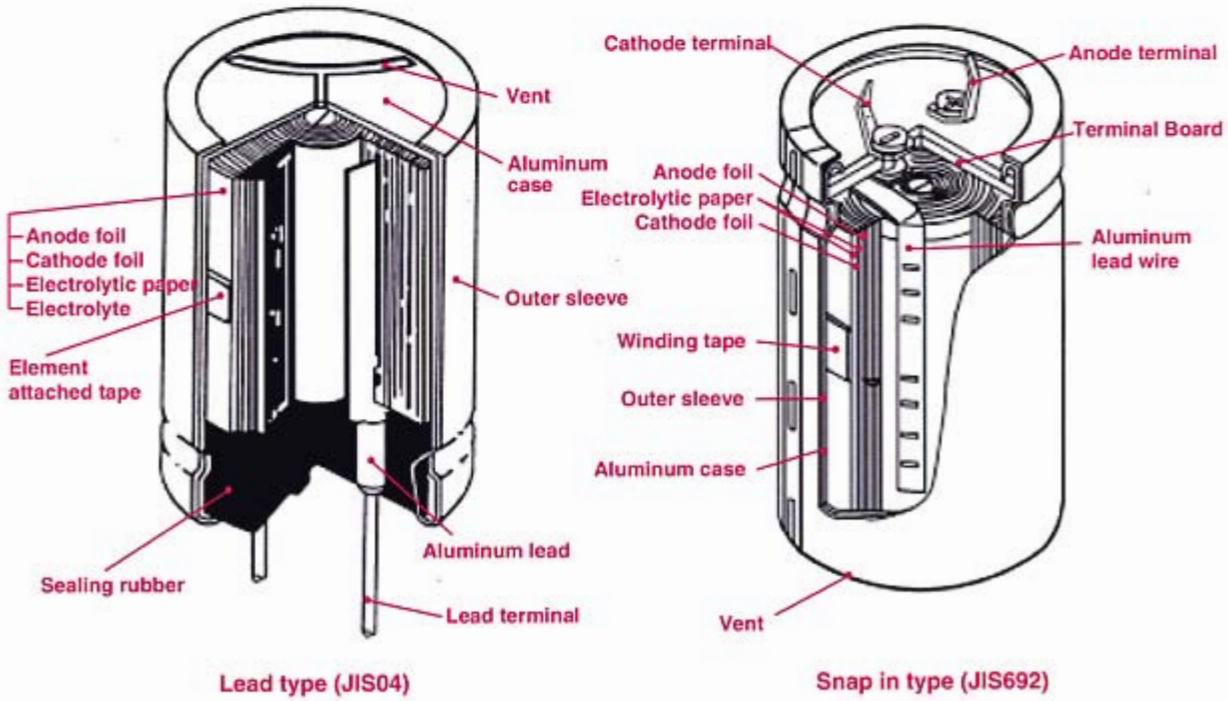

Fig.5 Construction of Aluminum Electrolytic Capacitor