

BUILDING AN ELECTROLYTIC CAPACITOR

APPLICATIONS

A capacitor is an electrical component that stores a quantity of electrical charge defined with a linear relationship as:

$$Q = C \times V$$

where: Q = electrical charge [Coulomb]

C = Capacitance [Farad]

V = Voltage [Volt]

Usually values are indicated in a smaller unit called micro Farad [μF] that is one million times smaller. An aluminium electrolytic capacitor is composed of one anode of aluminium foil (or one aluminium foil anode) having a dielectric oxidation on its surface, with semiconductor characteristics to prevent the current flow in one direction, and another aluminium foil cathode. There is also an electrolyte impregnated paper layer positioned between the anode and the cathode in order to avoid short circuits. Both the aluminium foils have been etched to obtain active surfaces, increasing their effective area. Aluminium tabs are then connected to the two foils to act as terminals. When in use the impregnated section is then closed inside an suitable case and sealed with a deck. The matching of thin dielectric and a large surface area allows to create capacitors with exceptional high capacitance per volume.

European (CECC) and International standards (IEC) have classified the capacitors in two categories. Electrolytic capacitors for high reliability applications (Long Life Grade): in addition of the possible over anodization (the difference between forming voltage and operating voltage) must generally satisfy high endurance requirements and a careful selection on materials is needed.

Such efforts are not required for capacitors standard version used for less severe reliability (General Purpose Grade).

The whole manufacturing process requested to build a Kendeil electrolytic capacitor could be reasonably split into the following phases:

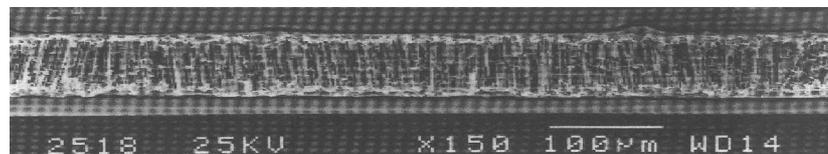
- * Etching
- * Winding
- * Impregnation
- * Sealing
- * Ageing
- * Production Inspections

ETCHING

Plates or electrodes are made of high purity, very thin aluminium foil (0.05 to 0.1 mm thickness). To get the maximum capacitance for a given electrode surface area, an electrochemical process called "etching" is used to dissolve metal and increase the surface area of the foil in the form of a dense network of microscopic channels.

The etching process consists of continuously running aluminium foil through a chloride solution with an AC, DC or AC/DC voltage applied between the etch solution and aluminium foil.

The increase in surface area is referred to as foil gain and can be increased as much as 100 times for foil being used in low voltage capacitor applications and 20 to 25 times for higher voltage applications. The dielectric of the aluminium electrolytic capacitor is composed of a thin layer of aluminium oxide (Al_2O_3) which "forms" on the surface of the etched aluminium foil during a process called "formation."



MICROGRAPHS VIEW OF ETCHED ALUMINIUM FOIL

Since capacitance is inversely proportional to the dielectric thickness and this is proportional to the forming voltage, the following relation is applicable:

$$\text{Capacitance} \times \text{Forming Voltage} = \text{Constant}$$

This is true for high voltage foils with a relatively coarse etch structure. However, for foils with extremely fine structures, the process to convert aluminium to aluminium oxide has a significant smoothing effect on the structure that might be described by a non-linear relationship.

