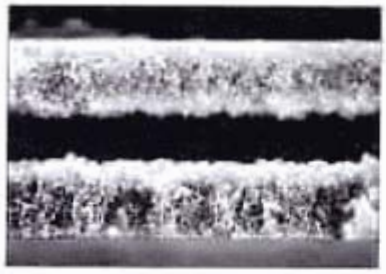
3. Production of Aluminum Electrolytic Capacitors

3–1 Electrodes and Dielectric Film of Aluminum Electrolytic Capacitors

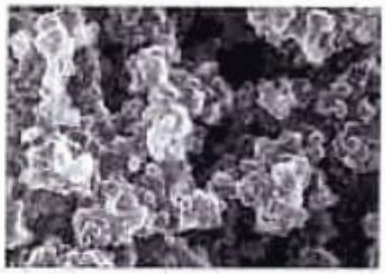
Aluminum Electrode Foils

To increase the surface area, the surface of aluminum electrode foils is electrochemically roughened (etched).

[Etched Foil for Low Voltage]



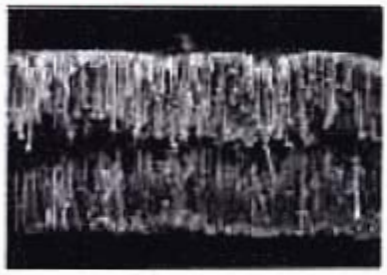
(Cross Section) (X500)



(Replica) (X10,000)

For low voltage, a sponge-like pitted surface isobtained by AC etching. (multiplying facto:80 to 100 fold)

[Etched Foil for High Voltage]

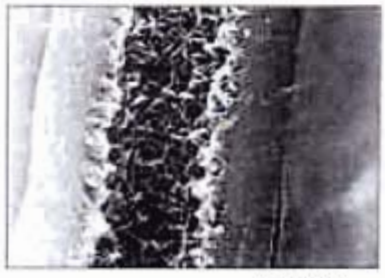


(Cross Section) (X500)

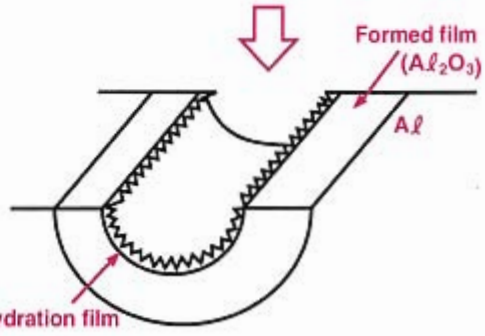
For high voltage, a tunnel-like pitted surface is obtained by DC etching. (multiplying factor:20~30 fold)

Dielectric Film

An aluminum oxide film is electrochemically formed on the etched aluminum foil to serve as the dielectric.



(X50,000)



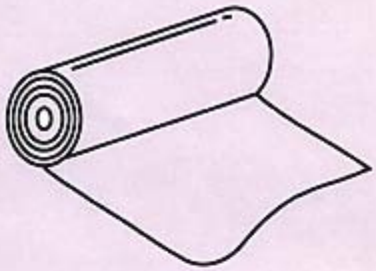
The oxide film in the figure is a cross section of formed film in the pits of etched foil for medium to high voltage.

3 – 2 Production method of Aluminum Electrolytic Capacitors

Etching

(1) Anode Aluminum Foil

Aluminum foil normally 40 to 100 m thick and more than 99.9% pure is used for the anode foil.



(2) Etching

This process electrochemically roughens the smooth surface of the rolled aluminum foil to increase its effective surface area. The ratio of the capacitance of the smooth foil to that of the etched foil at a certain forming voltage is referred to as multiplying factor, and it normally reaches 20 to 50 fold.

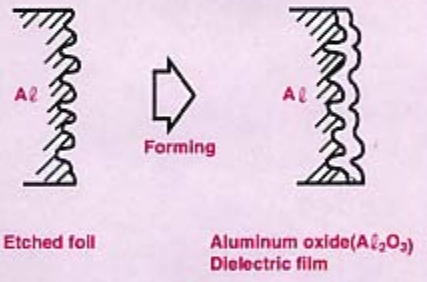
Most companies are placing empha-

Forming

(3) Forming

In this process, which greatly determines the performance of the capacitor, electrolysis is performed in an electrolyte (differs from the electrolyte impregnated in element with respect to purpose and composition and is normally referred to as formation liquid) with the etched foil as the anode (anodic oxidation), thereby electrochemically forming an aluminum oxide film on the aluminum foil surface to serve as the dielectric.

One aspect of this capacitor that distinguishes it from others is the ability to change the withstand voltage (i.e., thickness of the aluminum oxide film) and the capacitance as required by the intended use by adjusting the forming



Slitting

(4)Slitting (5)Attaching Leads(6)Winding

The formed electrode foils are cut to prescribed dimensions depending on the required capacitance of the product, and then after attaching the leads, the anode foil is wound up with the cathode foil and the electrolytic paper (separator) in between to form a cylinder.

Winding

* The electrolytic paper is specially made for electrolytic capacitors and serves two functions.

a. It separates the anode foil and the cathode foil so they will not short-circuit.

b. It is saturated with the electrolyte and retains it. For this reason, a superior paper of uniform thickness, density, water absorption, tensile strength, etc., is required. The principal materials used

Impregnation

(7) Impregnation

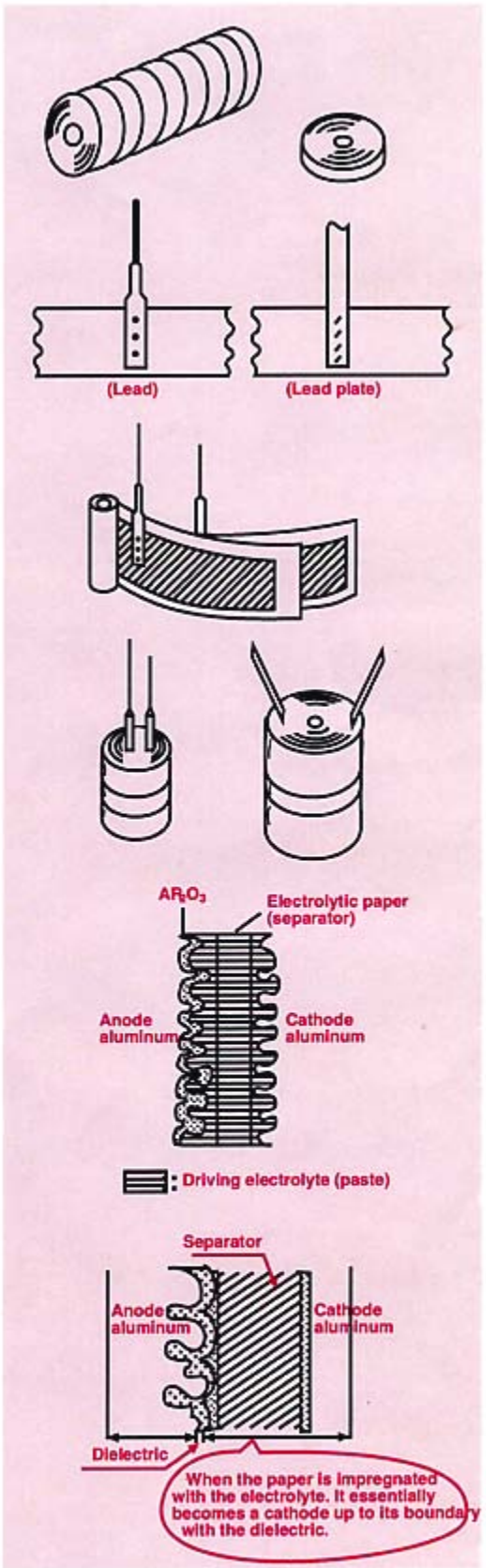
Impregnation is the process of saturating the wound element with electrolyte. The type of electrolyte used varies with the characteristic application of the product.

* About the Electrolyte

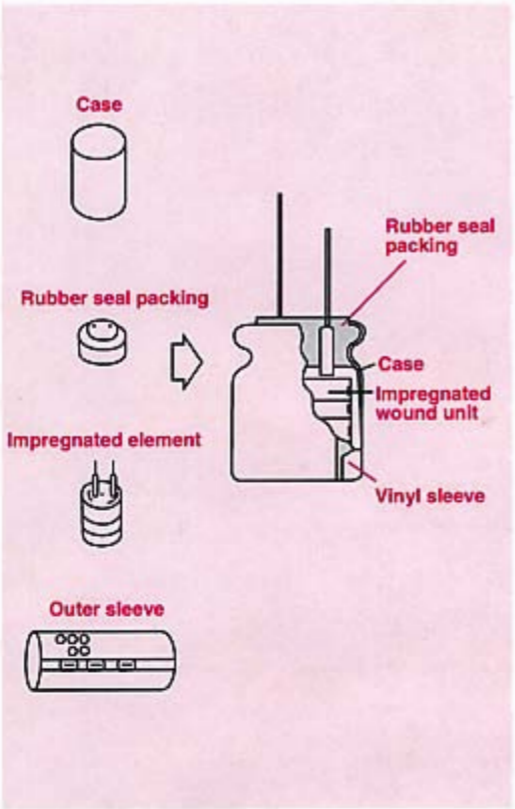
The electrolyte impregnated in the element is referred to as driving-electrolyte and performs the following two functions

a. It impregnates and adheres to the surfaces of the anode and cathode foils to extract 100% of their capacitance (essentially a cathode action).

b. Repairs defects in the anode oxide



The characteristics of the electrolyte greatly influence the temperature characteristic, frequency characteristic, high temperature load life, etc. of the capacitor, and so an electrolyte with a composition different from that of the formation liquid and one that also satisfies economic, other requirements is, of



Assembly

(8)Assembly

Wound unit impregnated with electrolyte already have the function of a capacitor, to avoid deterioration of the characteristics of the capacitor due to evaporation or moisture absorption of the electrolyte, they must be inserted in a metal case and sealed with rubber packing or other sealing material. The capacitor also receives a vinyl sleeve noting such necessary information as

Reforming (Aging)

(9)Reforming (Aging)

This process impresses a prescribed voltage on the assembled product to stabilize its characteristics.

Upon assembly, the slit surface of the electrodes, lead connections and other unformed places and places where the film has been damaged must be reformed.

This process also permits confirmation of the withstand voltage and screening of defective products. It is important in raising the reliability of capacitors in the initial stages so that

Completion Inspection

(10)Completion Inspection

Products that have undergone reforming are inspected for capacitance, tanδ, leakage current, external appearance, etc., to ensure they will perform as required, and then they are pack-