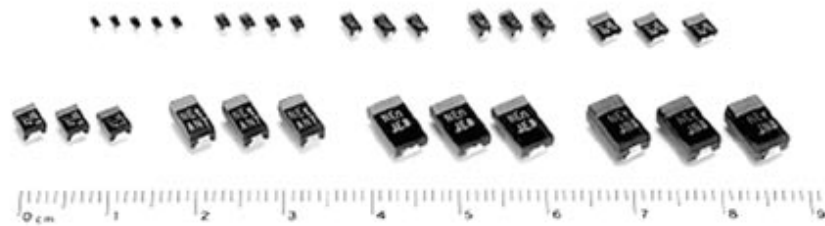




Tantalum Capacitor
Outline
Applications
Outline of NeoCapacitor
Applications of NeoCapacitor

Tantalum Capacitor



Outline

An Old yet New Device that Continue to Evolve

As with resistors and coils, a capacitor is a device (component) that is surely used in electronic circuits. This circuit component is incorporated in all electronic equipment and as in the case of air and water, it is a component that is normally taken for granted.

Being such a component, the capacitor has a long history of use and it is natural to assume that there is very little leeway for new types of capacitors to be developed.

However, given the overall trend towards downsizing and towards greater speeds of electronic equipment, it is precisely these components that need to undergo change and evolution that are appropriate to the age.

About 25 years ago, the mainstay of home electronics equipment consisted of televisions, video decks and other such equipment.

The capacitors used in such equipment consisted overwhelmingly of ceramic capacitors with capacity in the range of several μF (micro Farad) or less, and in the capacity range of $10\ \mu\text{F}$ or more, aluminum electrolytic capacitors formed the mainstay.

Currently however, equipment that is in demand has shifted to such equipment as mobile telephones, digital cameras, and notebook personal computers that require high speed operation and ultra high density mounting. Given this change, a new trend has become active in capacitors in the large capacity range.

Though the aluminum electrolytic capacitor that formed the mainstay in the past is low priced, it is susceptible to high temperatures due to the fact that it is a wet type that uses electrolytic solution. Structurally, such capacitors have been difficult to downsize and have not been appropriate for surface mounting that is the method of use most often found in recent equipment. It is in such a situation that the use of tantalum capacitors has increased at a rapid pace.

While tantalum that is used in tantalum capacitors is high priced and since a larger amount of tantalum is required for capacitors with larger capacity, in the past such capacitors have been unable to compete with aluminum electrolytic capacitors due to the cost involved.

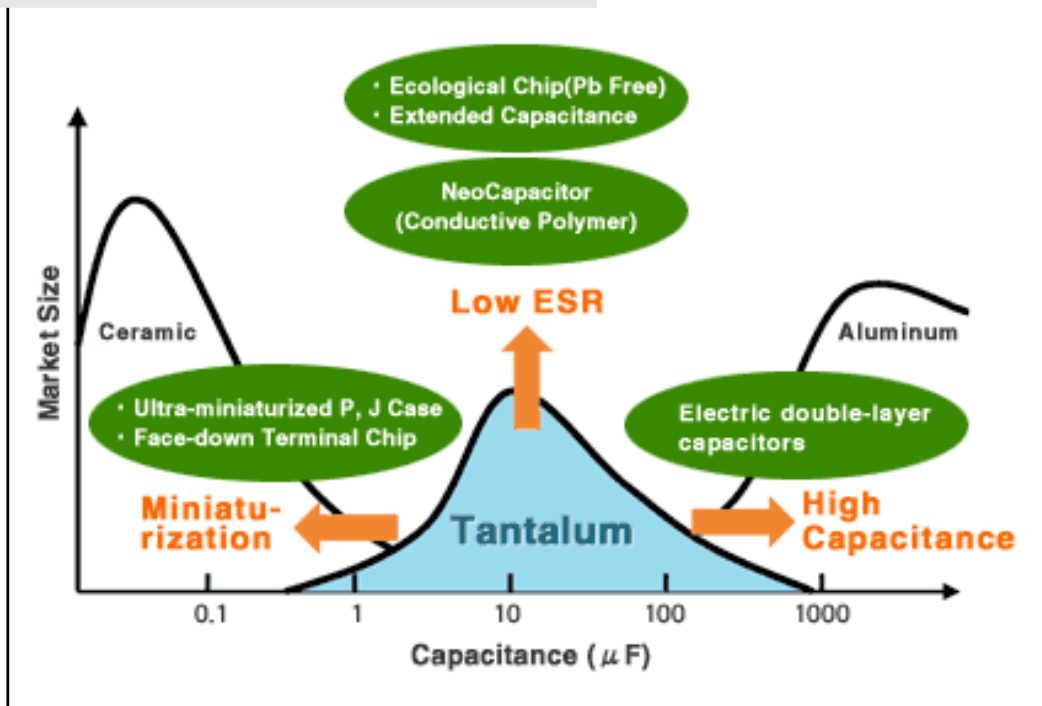
However, tantalum capacitors have been downsized rapidly in approximately the last 10 years and for a given capacity, it has become possible to produce tantalum capacitors with size that is about one fiftieth of aluminum electrolytic capacitors. In other words, as a result of the reduction in the ratio of tantalum used, the cost has been decreased to within acceptable limits.

Moreover, since no liquid is used, tantalum capacitors are resistant to high temperatures and since downsizing is simple, such capacitors are perfect for surface mounting.




In addition to this, tantalum capacitors exhibit characteristics that are far superior to aluminum electrolytic capacitors at higher frequencies.

As a result of these advantages, the current status is one in which tantalum capacitors are rapidly taking the place of aluminum electrolytic capacitors in the $10\ \mu\text{F}$ to $1000\ \mu\text{F}$ capacity range.

Main Targets of Capacitors Market



Size comparison of Capacitors at 22 μF

Capacitor Type	Quantity	Volume Comparison
 Tantalum Capacitor 6.3V / 22 μF 1.6 × 0.8 × 0.8	1	Reference
 Multilayer ceramic capacitor 6.3V / 10 μF 1.6 × 0.8 × 0.8	3	Size, as same as Tantalum Capacitor, but needs 2 to 3 pieces for 22 μF
 Aluminum electrolytic capacitor 6.3V / 22 μF 4.0 × 3.9 × 4.3	200	22 μF capacitance in one piece, but its volume is 200 times and mounting area is 50 times of Tantalum Capacitor.

There is another reason why tantalum capacitors are currently in demand. This is the fact that this component is most effective in resolving the issue of power source consistency.

As is widely known, the operation of semiconductors is becoming increasingly high speed and in recent years the operating frequency has begun to shift from the 1GHz (giga hertz) range to the 3GHz or more range.

An operating frequency of 1GHz means that in switching from 0 to 1, the voltage must increase from 0 volts to the required voltage in 1 nano second, or an astonishingly short one billionth of a second, in order for the semiconductor to operate normally.

On the other hand, electronic equipment as represented by personal computers reduce the high voltage from home power source or batteries to between 1 to 3 volts that a semiconductor is capable of utilizing and for this reason, utilize power source circuits called power source converters or switching power source.

However, the operating speed of a power source circuit is a few micro seconds even for the fastest circuit.

In other words, merely directly connecting the power source to the semiconductor results in the phenomenon of the power source being unable to supply power when the semiconductor attempts quickly to switch from 0 to 1.

In fact, this issue has been identified as the main cause of occurrence of noise that is a major problem in recent years. According to detailed experiments, an astounding 90% of noise that occurs in electronic equipment is caused by the inconsistency of the timing with which power is supplied to the equipment.

From empirical results, it has always been claimed that tantalum capacitors are effective in limiting noise and this is understandable when viewed from the perspective of the issue of electricity supply. In other words, if the supply of electricity is represented as tap water supply, the switching power source would be the water reservoir located upstream in the river. On the other hand, the capacitor would be the water tank installed at condominiums and other structures.

In the hottest summer months, for example, when the residents of the condominium simultaneously use tap water, were the supply of water to be controlled by the opening or closing of the water reservoir, there is no way that the system could keep up with the downstream needs. However, if there is a water storage tank at the condominium, required water may be supplied quickly and there is no danger that the water pressure will decrease thus causing disruption in the water supply.

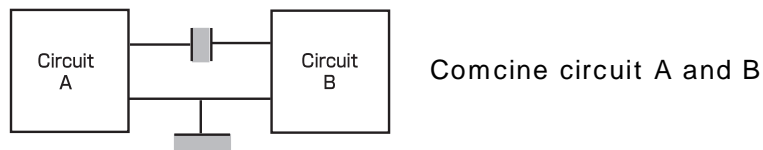
In the same way, capacitors speedily supply electricity when semiconductors require power and act to fill the approximately 10 micro second gap required for the power source to catch up with the semiconductor's requirement.

From this perspective, the capacitors of the future need not only to have a large capacity but must also have low internal resistance in order to be able speedily to discharge electricity when required.

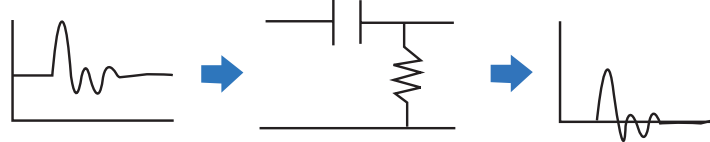
Applications of capacitors

1. Coupling
2. Bypass (Decoupling)
3. Relief of current change
4. Smoothing for Power supply output
5. Resonance (filter circuit)
6. Timer circuit (CR timer)
7. Time constant circuit
8. Back up for microcomputer

1. Coupling



Example circuit



Remove the disorder of the bias voltage (direct current voltage) of Circuit A, and transmit the signal voltage (exchange voltage) to Circuit B.

In many cases, it is used near the output circuit of AV equipment.

Demanded Characteristic

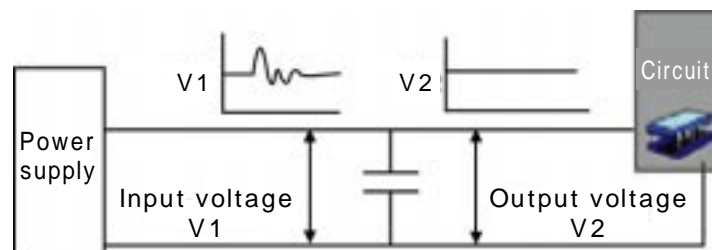
- Few Leakage current
- Low ESR

Suitable Capacitors

- Tantalum Capacitors
- Ceramic Capacitors

2. Bypass (Decoupling)

Absord the voltage change (noise)



Circuit of Power supply lines for LSI, ASIC

Demanded Characteristic

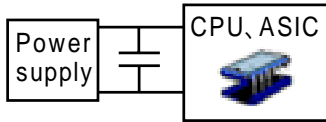
- Low ESR and Low ESL
- Chip Package
- High capacitance for LSI and ASIC

Suitable Capacitors

- Tantalum Capacitors
- (especially Conductive polymer type)
- Ceramic Capacitors
- Aluminum electrolytic capacitor

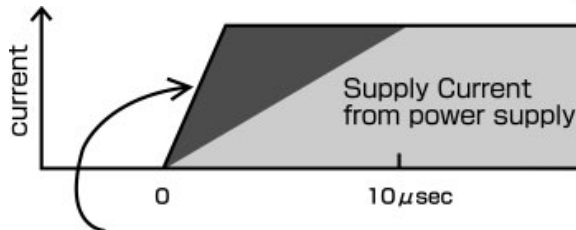
3. Relief of current change

Since high-speed and highly efficient, IC and LSI with big consumption current have the function to change mode of operation rapidly, in order to stop power consumption. For this reason, the current change of a power supply line becomes very large with change in mode of operation, and the capacitors are needed for easing this change.



For PCs with highspeed, and Imageprocessing boards

Supply Current for CPU, ASIC

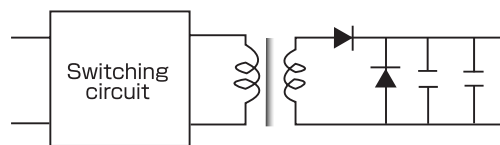


Supply Current by Capacitors
 current few : Ceramic Capacitors
 current much : Ceramic Capacitors plus Tantalum Capacitors

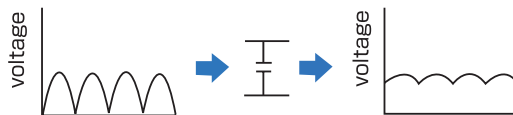
Suitable Capacitors

- Tantalum Capacitors
- (especially Conductive polymer type)
- Ceramic Capacitors
- Alminum electrolytic capacitors

4. Smoothing for Power supply output



(Power supply circuit) Smooth the switched pulse voltage, and change it into the stable voltage (a direct current) .



Control of smooth voltage, or relief of pulse style voltage.

Demanded Characteristic

- High capacitance
- Low ESR and Low ESL
- high permissible ripple current

Suitable Capacitors

- Conductive polymer type Tantalum Capacitors
- High capacitance Ceramic Capacitors
- Alminum electrolytic capacitors (for power supply)

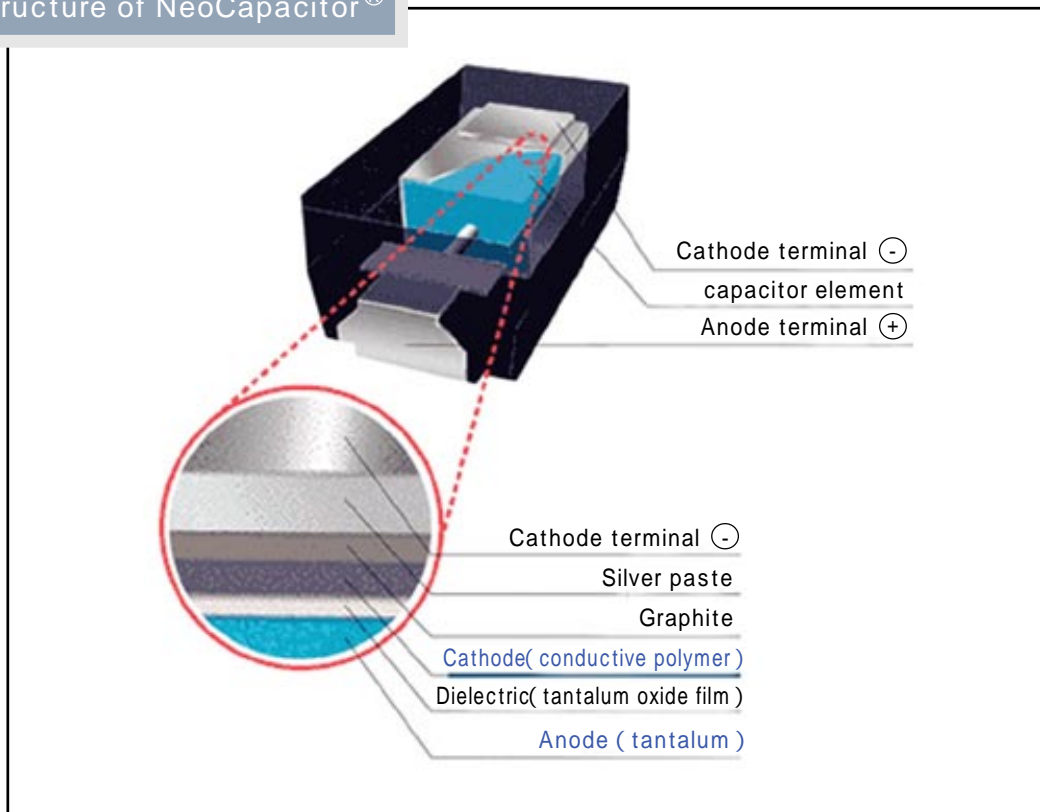
The tantalum capacitor is made by forming a rectangular parallelepiped from tantalum powder around metallic tantalum wire and sintering this into a solid at more than 1,000 degrees centigrade in vacuum. The particles of powder are about 0.3 μm in the most advanced applications and through sintering into a solid, multi-porous material with pores of 1 micron or less is produced. In general, the capacity of a capacitor is larger as the surface area of the electrode becomes larger and the multi-porous material provides a large capacity in ratio to the volume of the material.

This multi-porous material is submerged in a liquid and a metal oxide layer is created on the surface. This layer becomes an insulating layer and the multi-porous tantalum assumes the role of the anode.

However, a problem here is what to do about the material for the cathode. The cathode material is in the 1 micron pores of the multi-porous material and must cover the majority of the surface of these holes.

Legacy tantalum capacitors used manganese dioxide produced by soaking the multi-porous material in liquid manganese nitrate as cathode. However, with this method, there is a clear limit to the extent to which internal resistance may be reduced.

On the other hand, a significant characteristic of the NeoCapacitor[®] of NEC TOKIN Corporation is the use of conductive polymer as cathode material.

Structure of NeoCapacitor[®]

Conductive polymers gained widespread recognition after Dr. Hideki Shirakawa received the Nobel Prize for Chemistry for 2000 due to his research on this subject and today, use in this type of capacitor is the most common practical application for conductive polymer.

Through using this conductive polymer, it has become possible to reduce internal resistance significantly. In fact, while internal resistance was between 60 and 70 milli-ohms in 1994 when the product was first shipped, improvements to conform to the greater speeds realized by semiconductors have subsequently been made and products with reduced internal resistance have been developed at the rate of once every half a year or a year. Today, as an application for the CPU chip set for the most advanced notebook personal computers, products that are adaptable to ranges of 10 milli-ohms or less are being manufactured.

NeoCapacitor have a large capacity despite being small and have such superior features as being appropriate for surface mounting and having low internal resistance.

In particular, the fact that internal resistance is low has been utilized and NeoCapacitor are used in chip sets around CPU used most widely in the world.

Moreover, in computer related applications, this type of capacitor is also widely used in the IC of graphic related devices in which significant progress has been made in achieving high speed.

Furthermore, in the last 1 to 2 years, the operating speed of semiconductors used in general home electronics has reached a level that was prevalent among CPU about 5 years ago and demand for is growing in this application as well. Interest in this type of capacitor is also increasing in such applications as noise reduction in the vicinity of power ICs such as the operating circuit of motors.

In the future, it is believed that NeoCapacitor will be used widely in all product applications that require downsizing and high speed.

Application fields of NeoCapacitor

