

November, 2020

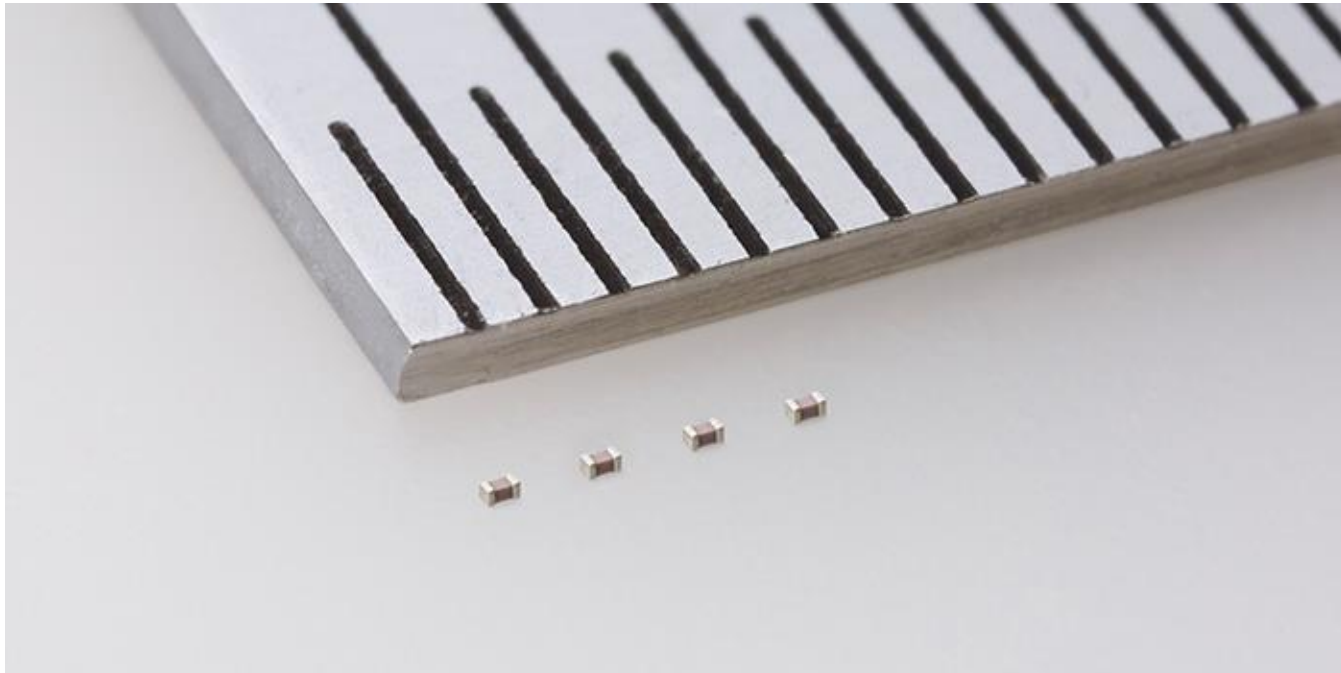
## **"Technological innovation through Multilayer Ceramic Capacitors"**

### **A story of constantly evolving mobile devices and capacitors that promote their miniaturization and performance enhancement**

Capacitors are electronic components, with those used in mobile devices being very small. Some of you might have heard the name before. However, do you know where they are used and what roles they play? We will explore the story of capacitors, which are essential in today's technological world.

**01** About 1,000 pieces in the palm of your hand!  
They play important roles behind the scenes.

Do you know what is this picture?



This is a photo of multilayer ceramic capacitors (MLCCs). A large number of these small pieces are used in our smartphones.

MLCCs are essential electronic components for mobile devices, home electric appliances, and automobiles.

A single smartphone contains more than 1,000 micro-sized MLCCs. It's a small world of wonder! Performance enhancement of semiconductors has been evolving smartphones, which has led to growing requirements for MLCCs.

## **02** Our fundamental question: What are capacitors?

A capacitor is a fundamental electronic component used in various electronic devices.

It has two major functions: temporarily storing electricity, and eliminating noise in an electric circuit.

Mobile devices and other electronic products operate on electric energy, but rather than directly using the energy supplied from the power supply (a wall outlet or battery), they regulate the current and voltage to suit the requirements of each device.

In the case of a smartphone, when an applet starts, the semiconductor circuit instantaneously consumes a large amount of electricity (electric current), which is supplied from capacitors.

In addition to MLCCs, various types of capacitors such as aluminum electrolytic capacitors and film capacitors, are used for different purposes.

The demand for MLCCs is approximately 5 trillion pieces per year, which is estimated to grow to 6 trillion pieces in several years. (Forecast by TAIYO YUDEN)

MLCCs are electronic components with enormous demand. How is an MLCC built?

To put it simply, a capacitor such as an MLCC has a dielectric sandwiched between two metal plates (electrodes). Applying a voltage between these plates stores electrical charges.

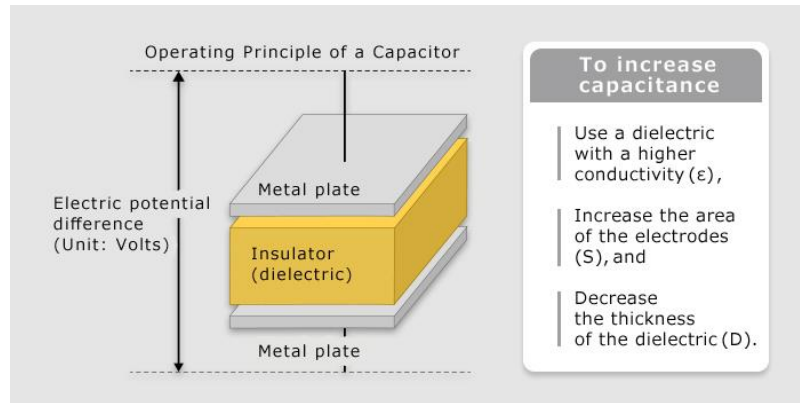
One of the characteristics of a capacitor is capacitance.

Capacitance is determined by

- (1) Dielectric constant of the dielectric material,
- (2) Area of the electrodes, and
- (3) Thickness of the dielectric.

For a detailed description of capacitors, please refer to the following link:

[https://www.yuden.co.jp/resource/data/basics/basics\\_jp.pdf](https://www.yuden.co.jp/resource/data/basics/basics_jp.pdf)



▲ Structure of a Capacitor and Method for Increasing Capacitance

## 03 Microscopic world of capacitors as small as a grain of sand

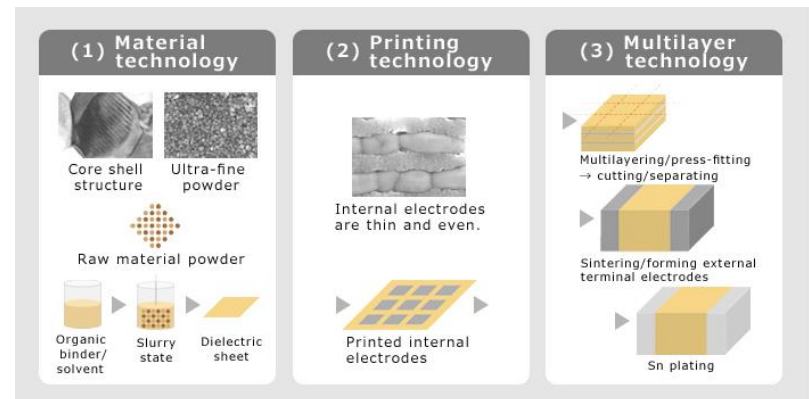
A single smartphone contains more than 1,000 MLCCs.

Currently, the smallest MLCC from TAIYO YUDEN on the market is 0.25 mm in length and 0.125 mm in width, and the thinnest MLCC has a thickness of 0.064 mm!

This is the size of a grain of sand, which is said to be 0.0626 (1/16) to 2 mm. Now you know how small they are.

How can such small MLCCs be created?

There are three technologies that have enabled TAIYO YUDEN to manufacture such MLCCs. (See the figure below.)



TAIYO YUDEN utilizes proprietary techniques in the three dominant technologies for manufacturing MLCCs. We develop materials on our own, and with ultra-fine and even materials, it is possible to create dielectric sheets with a thickness of  $1\mu\text{m}$  (1/1,000 mm) or less, which is approximately 1/100 the thickness of a human hair.

In the world's capacitor industry, there are only a few companies that develop these materials, and TAIYO YUDEN is one of them.

With a range of technological competencies, including material development, high-precision printing, and lamination technology, we bring you top-level products in the industry featuring ultra-small, ultra-thin and ultra-large capacitance.

(Nov. 2020)