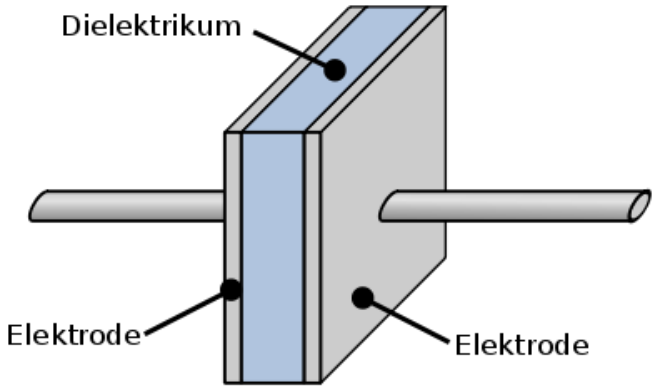
BRÜCKNER MASCHINENBAU

A Member of Brückner Group

A glimpse into the world of super-thin films
What is a capacitor, and what have we got to do with them?

A capacitor is an electrical component in which electrical charges can be saved. It always consists of two electrodes (plus and minus), and a dielectric, which separates the two electrodes. Capacitors are installed in almost every electrical device.



Either ceramic or plastic film is used for the dielectric. Ceramic capacitors are very small, and are used in mobile phones. Film capacitors are used in larger devices, such as in TVs and vacuum cleaners and also in electric trains and wind generators.

BOPP film, which is stretched both longitudinally and transversally (**B**iaxially **O**riented **P**oly**p**ropylene), has proved its worth here. BOPP is relatively cheap and has very good electrical properties. In Brücker-language this is called PPK and stands for “PP Kondensator (capacitor), in other words: Polypropylene Kondesator.
Along with BOPP, BOPET and other films are used, but in considerably smaller quantities. BOPET’s advantages (we logically call it PETK) are, for example, a higher temperature resistance.

What is the difference between PPK and conventional BOPP used in packaging?

1. **The purity of the film**
   A high film purity is necessary to ensure the desired electrical properties. This consists of:

   - *Raw materials*
     The raw material for PPK is much cleaner than for the PP which is used for packaging. Worldwide, only a few companies make it using a very special process in which, during the production, the catalysts are thoroughly washed out.

   - *Additives*
     PPK film cannot include any additives

   - *Production*
     During production, extreme cleanliness must be maintained. Brückner PPK lines are normally in clean rooms.

2. **The film thickness**
   PPK film normally has thicknesses between 4 to 7µm and is therefore 10 times thinner than a human hair. The extremes are from 2 to 15µm, whereby PETK is even processed down to 0.5µm.

Why is capacitor film so thin?
The smaller the distance between the two electrodes, the higher the capacitance of the capacitor. And the thinner the film, the larger the electrode area per kilogramme of film.

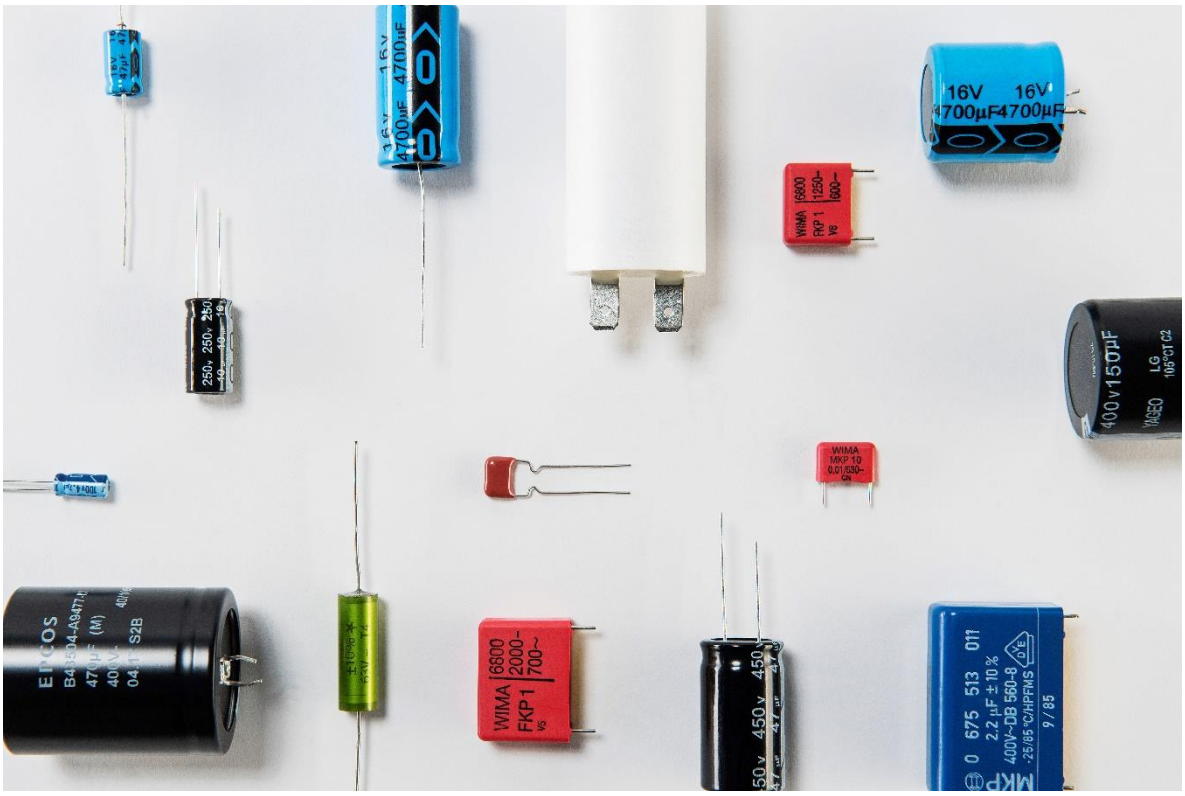
Thin film therefore has two decisive advantages:
- Low cost
- Small installation space

The second reason is especially important for the automobile industry, which is why the thinnest capacitor films are used, even if they are disproportionately expensive due to the complex production process.

The focus during production isn't only on obtaining the absolute lowest thinness. Keeping an extremely uniform thickness is also of the utmost importance.
If the film is too thick, then the wound capacitors will not fit in the housing and must be rejected. If it is too thin then there will be increased amounts of breakdowns. Therefore the film's thickness must always lie within a tolerance of 0.1µm. And it does, from left to right, from the start to the end of the roll.

3. The film's structure

Capacitor film must, as stated above, be free from additives. This includes an otherwise standard additive, which must be thought of as a very fine sand (antiblock). This normally is found in the film's outer layers and prevents the individual film layers from sticking together. How can this sticking together be prevented without antiblock? During the capacitor film production the surface is made intentionally rough. The degree of roughness is a significant quality criteria from capacitor films.



What is the difference between capacitor film lines, and the production lines for packaging films?

The main difference in capacitor film lines is that a lot of the things found on normal packaging film production lines don't exist:

- **No dosing**
  In the dosing area additives are normally added. These aren't allowed in capacitor films.

- **Only one extruder**
  To melt the raw material, only one extruder is necessary. The usual separation of core layer and outer layer which you find with packaging films, is no longer needed, and therefore neither are the extra extruders.

- **No water bath**
  Rapid cooling is necessary with packaging films in order to give them a nice transparency. This isn't the case with capacitor films. On the contrary, it is only without the water bath that the film gets its roughness.

- **No edge trim refeeding**
  Only virgin material is used.

Due to these savings and the relatively low speeds of under 300 m/min, the price of a capacitor film line is generally also under that of a packaging film line.

The capacitor film's self-healing
Towards the end of the production process a higher voltage is applied to the capacitor to activate the self-healing. But what exactly is this? Let's say that the film isn't absolutely even (which it never is in reality). There will be areas which will offer less resistance as other areas if a higher voltage is applied.

If such a voltage is applied to a capacitor, this will result in a rollover at this point. This would be like a small lightning flash between the two electrodes going through our film. This flash generates so much heat that not only does the film evaporate, but also the metal layer in the immediate vicinity. The defect is thus isolated, no more conducting layer leads to this point and the capacitor's function is not measurably restricted.

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