

## Capacitor Quality

Quotations are from Cyril Bateman's articles, found at <https://linearaudio.nl/cyril-batemans-capacitor-sound-articles>

Bateman: “Having tested one capacitor of a make and type, what guarantee does this give about harmonic distortions generated by other similar capacitors in the same batch? In my view that depends totally on the method of manufacture and the particular dielectric used. For the audio perfectionist however, perhaps every signal path capacitor should first be distortion measured.”

I agree.

Bateman: “Some film capacitor makers however do seem remarkably consistent within a batch and from batch to batch. With other makers I have measured some 20-30 dB different harmonic levels, in quite small batches, even when the capacitors have been supplied taped to card strips.”

So far I have one batch with about 30% of the capacitors having much higher distortion. I need to measure more samples of the caps where a single sample tested good.

### **Dielectric materials for film capacitors:**

Polyethylene Terephthalate (PET) aka polyester:

Cheap, widely available, caps have small physical size.  
High dielectric absorption and distortion.

Polycarbonate:

Usually nice, but no longer available.  
But.... caps removed from CP10 had higher distortion than new polypropylene.

Polystyrene:

Very nice dielectric. Poor availability, low temperature rating, fragile.

Polpropylene:

Nice. Low dielectric absorption, low distortion. Wide availability.  
Negative tempco may sometimes be a problem.

Polyphenylene Sulfide:

Dielectric almost as good as polypropylene (slightly higher dielectric absorption.)  
Low distortion. More expensive.  
Much lower tempco than polypropylene, good choice where this is important.

### **Metallized film vs. film & foil:**

Bateman: “For capacitances of 10 nF and smaller, the safe solution is to use C0G ceramic or extended foil/film capacitors made with Polystyrene or Polypropylene dielectrics and with lead wires soldered or welded directly to the extended foil electrodes. Avoiding altogether capacitors made with metallised film dielectrics or using ‘Schoop’ metal spray end connections.”

He's concerned about the method of attaching lead wires to the very thin metal coating on the dielectric film.

Bateman: “An internal non-ohmic connection in the capacitor however, introduces significant levels of odd harmonics, the third having the biggest amplitude.”

So, he prefers capacitors made with separate layers of film and foil, because the foil is much thicker and allows a more secure connection of lead wires. However, these capacitors are much larger than metallized film capacitors. For small capacitance values this may be tolerable, but perhaps not for larger capacitances.

20 years ago, many metallized film capacitors had low current ratings, because of the thin metal layer and the lead attachment problem. Today, because such capacitors are used in switch-mode power supplies and other similar applications, there are “pulse-rated” metallized film capacitors with much higher current ratings. My tests so far indicate that these often exhibit very low distortion, and may be superior to current film/foil types.

### **So, what does dielectric absorption sound like?**

From "Picking Capacitors part II", Walter Jung & Richard Marsh, Audio magazine March 1980

When music is the a.c. signal, the sonic degradation is one of compression or a restriction of the dynamic range. Also, a loss of detail results, and the sharpness is noticeably dulled. With dielectric types which have high DA, there is a definite "grudge" or hashy distortion added to the signal.

It is quite important to describe the sonic thumbprint that DA contributes to subjective audio. The effects of DF and DA can be perceived differently. DF is primarily a contributor to phase and amplitude modulation; DA reduces or compresses dynamic range. This it does by not returning the energy applied all at once. With signal applied to a capacitor with DA present, the amplitude is reduced by the percent DA. When this energy does get returned (later), it is unrelated to the music and sounds like noise or "garbage" being added; the noise floor is also raised. High-frequency and/or transient signals are audibly compressed the most. Signals that look like tail pulses (a lot of transient music information is of this nature) are blunted or blurred in their sound. "Dulling," "loss of dynamics," "added garbage or hash," and "an inability to hear further into the music" have been subjective terms used to describe the DA effect in capacitors.