# POWERAMIC® – P2200

## Glass-ceramic dielectrics for high voltage capacitors

### Product information

POWERAMIC® is a new high performance dielectric material for high voltage capacitors offering an extra-ordinary high energy storage density in combination with excellent temperature characteristics. POWERAMIC® is based on a novel material development: a bulk glass ceramic.

SCHOTT is a world leading supplier for a number of glass ceramic products: ZERODUR®, CERAN®, ROBAX®. By applying the same principle to a different chemical composition SCHOTT created Titanate based glass ceramics with unique properties.

This new class of high performance dielectrics solves the technical restrictions of currently used state-of-the-art ceramics. For example, current dielectrics based on ceramics show a residual porosity which limits their electric breakdown strength. Glass ceramics obtained via a true glassy phase are free of pores. In addition the high homogeneity of glass ceramics allows for tighter product tolerances. Nanocrystallinity allows to apply the materials at high field strength and at elevated temperatures.

### Advantages

The unique set of properties of POWERAMIC® results in smaller and lighter weight capacitors with a significantly improved performance portfolio, e.g. higher capacitance @ rated voltage.

Furthermore, the nano-crystalline structure leads to

- Better performance @ varying operating conditions
- Extended operating temperature range

**POWERAMIC®-P2200** is the dielectric for capacitors with high storage densities. This material makes small and light-weight capacitors possible that can also operate at elevated temperatures. Its positive temperature coeffient allows to compensate the capacity losses occurring in other capacitors when the temperature rises. The dielectric is RoHS compliant, lead- and halogen-free.

### About SCHOTT

SCHOTT is an international technology group with 130 years of experience in the areas of specialty glasses and glass ceramics.

More than 600 scientists and engineers are working for and with SCHOTT customers all over the world, while setting the pace by developing new, cutting edge technologies for the requirements of today and tomorrow.

The SCHOTT Group with a workforce of about 16,000 employees maintains close proximity to its customers with manufacturing and sales units in 35 different countries.

SCHOTT
glass made of ideas

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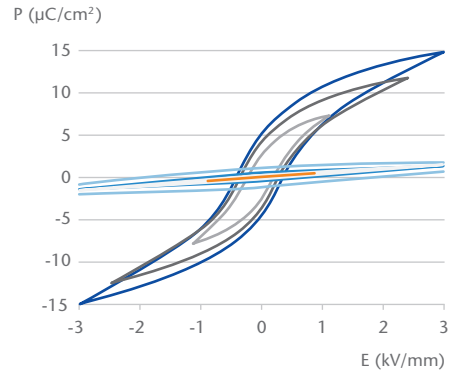
## Glass-ceramic dielectrics for high voltage capacitors

| Quantity | Value/unit | Remark | Measurement |
|---|---|---|---|
| dielectric constant, $\varepsilon$ | 213 | at 1 kHz | dielectric spectroscopy |
| dielectric constant, $\varepsilon$ | 198 | at 1 MHz | dielectric spectroscopy |
| dielectric loss, tanδ | 0.013 | at 1 kHz | dielectric spectroscopy |
| dielectric loss, tanδ | 0.022 | at 1 MHz | dielectric spectroscopy |
| capacity tolerance, ΔC/C | < 3% | not dependent on material, limited by processes | |
| operating temperature range | –55 °C to +200 °C | can be extended depending on application | |
| temperature coefficient, ΔC/C | + 2200 ppm/K | linear in a wide range | |
| saturation polarization | none @ 20 kV/mm | | dielectric characterization |
| DC bias | < 2% @ 1 kV/mm | | dielectric characterization |
| break-down voltage, $U_{BDS}$ | 15.3 kV | thickness d = 0.2 mm | Weibull statistics, 63% break-down probability |
| break-down field strength, $E_{BDS}$ | 76.4 kV/mm | thickness d = 0.2 mm | Weibull statistics, 63% break-down probability |
| accessible energy storage, W | 0.60 J/cm³ | at 33% of $E_{BDS}$ for d=0.2 mm calculated using $W=1/2\,\varepsilon_0\varepsilon\,E^2$ | |
| coefficient of thermal expansion | 9.7 x $10^{-6}$ $K^{-1}$ | in [20, 300] °C | |
| density | 4.61 g/cm³ | | |
| E-modulus | 121 GPa | | |
| thermal conductivity | 2.2 W/(mK) | at 20 °C | |
| available dimensions | thickness: 0.2 mm - 20 mm<br>diameter of round discs: 0.5 mm - 115 mm<br>maximum rectangular shape: 115 mm x 300 mm | | |

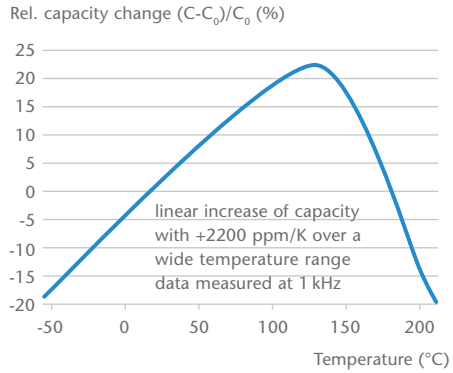
All data refer to the unencapsulated, bare dielectric.

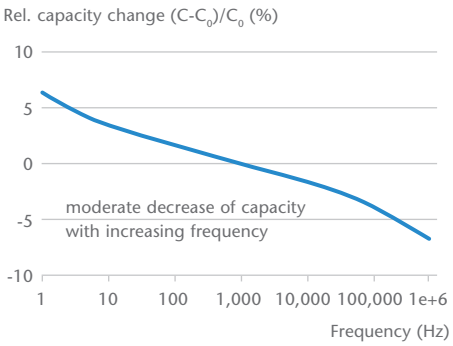


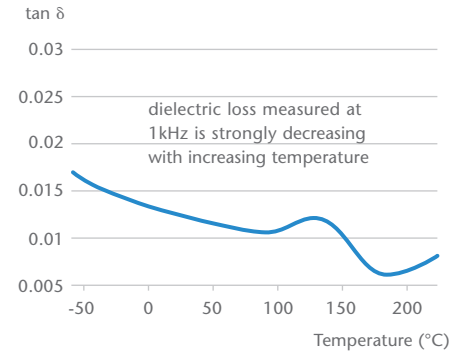

BaTi-ceramic 1 kV/mm
SCHOTT-GC 3 kV/mm
SCHOTT-GC 20 kV/mm
BaTi-ceramic 2 kV/mm
BaTi-ceramic 1 kV/mm
SCHOTT-GC 2 kV/mm
SCHOTT-GC 1 kV/mm

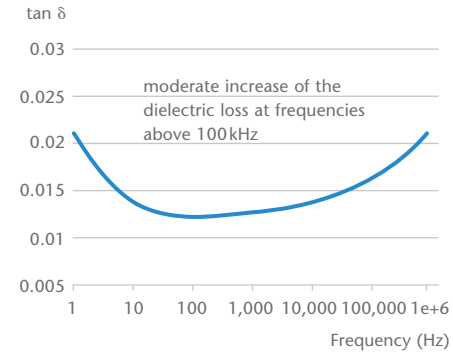
Ceramic BaTiO3:
large hysteresis

SCHOTT Poweramic® P2200
nanocrystalline glass ceramic
shows neglegible hysteresis





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