



A FERRO COMPANY

TECHNICAL DATA SHEET "K"-4000 X7R dielectric "HF-402"

HF-402 is an environmentally friendly high fire X7R dielectric available from MRA Laboratories, Inc. This material is RoHS compliant (not formulated with lead, cadmium or bismuth). HF-402 features a dielectric constant of 3900 ± 300 . It is compatible with up to 70% Pd / 30% Ag electrode systems.

Key Features

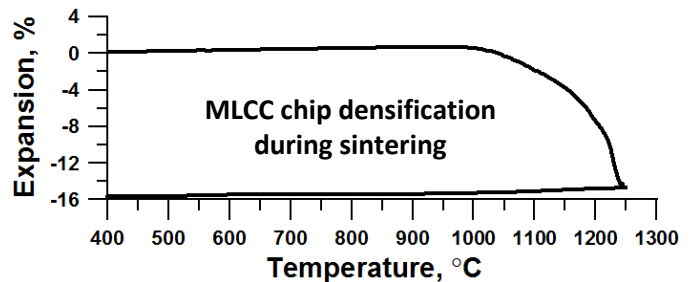
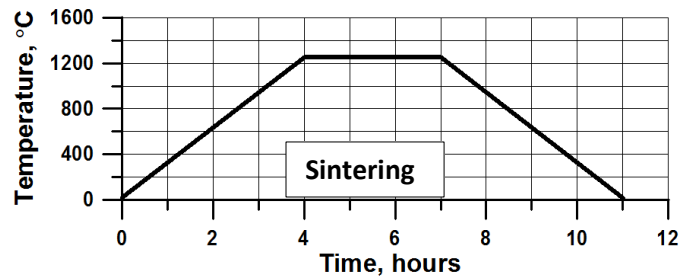
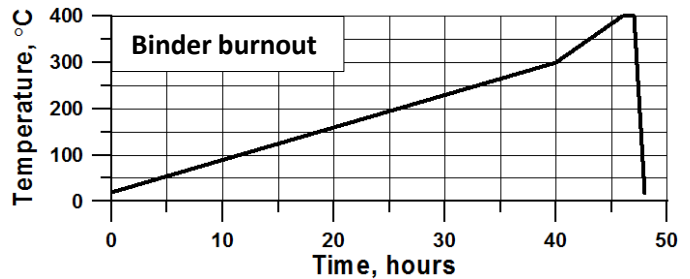
- ❖ Environmentally friendly (RoHS compliant)
- ❖ Low dissipation factor and very stable X7R TCC
- ❖ Excellent high voltage performance for a high dielectric constant material
- ❖ Consistent lot to lot uniformity

Typical powder properties

- Powder density, g/cm³ ≥ 5.85
- Tap density, g/cm³ 2.15 ± 0.25
- Surface area, m²/g 2.55 ± 0.45
- Particle size, μm
 - $D_{90} \leq 2.50$
 - $D_{50} 0.70 \pm 0.30$
 - $D_{10} 0.40 \pm 0.10$
- LOI (650°C, 6 hours), % ≤ 0.30

Sintering conditions

- Binder burnout up to 400°C in air
- Sintering 1250°C $\pm 10^\circ\text{C}$ /3 hours in air
- Heating rate 5°C/min
- Open ZrO₂ setter
- Fired density $\geq 5.75 \text{ g/cm}^3$



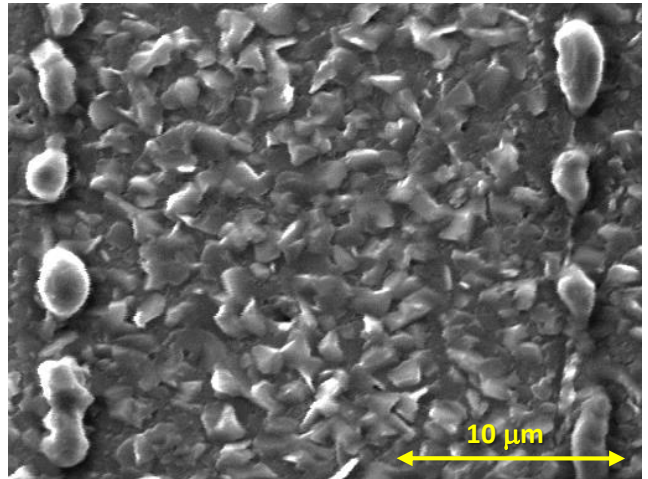
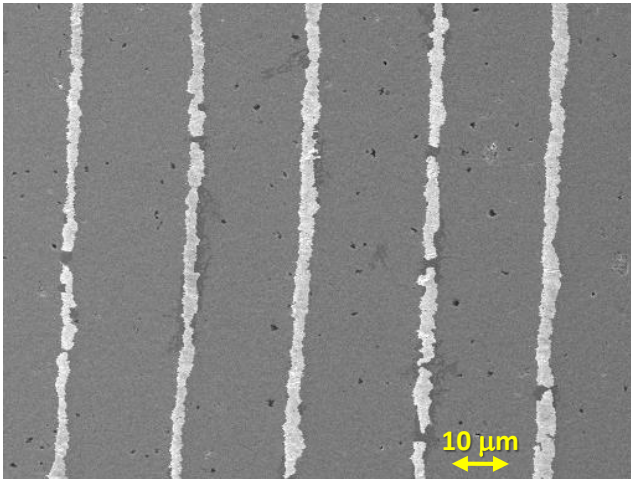
MRA - committed to excellence in
multi-layer ceramic device technology.

ISO 9001:2015

BUREAU VERITAS
Certification



Typical cross-sectional microstructure of sintered MLCC chip



Mechanical properties of the dielectric

- Coefficient of thermal expansion from 200°C to 600°C, $\mu\text{m}/\text{m}^*\text{K}$ **11.2**

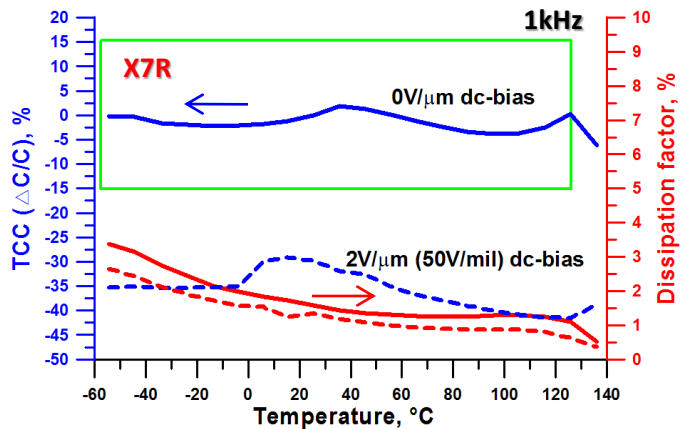
Typical MLCC characteristics

- Chip size **0805**
- Active layers **22**
- Electrode: **30% Ag / 70% Pd**
- Dielectric thickness, μm **~19**
- Dielectric constant **3900 ± 400**
- Dissipation factor, % **≤ 2.0 @ 1kHz, 1Vrms**

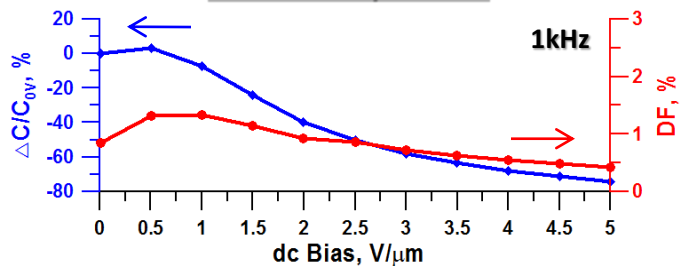
- Insulation resistance at 150V and 125°C, Ω **$> 10^{10}$**
- Dielectric withstanding voltage, V/ μm **≥ 40**

TCC X7R ($\pm 15\%$ from -55°C to $+125^\circ\text{C}$)

Temperature and voltage variation of capacitance (50V rated MLCC chips)



Voltage variation of capacitance at room temperature



The data presented is based on our research and is considered to be fair representation of this product. MRA makes no warranties, expressed or implied, as to its accuracy and assumes no liability out of its use by others.