Extension of the space qualified MLCC's ranges

SPCD, Noordwijk

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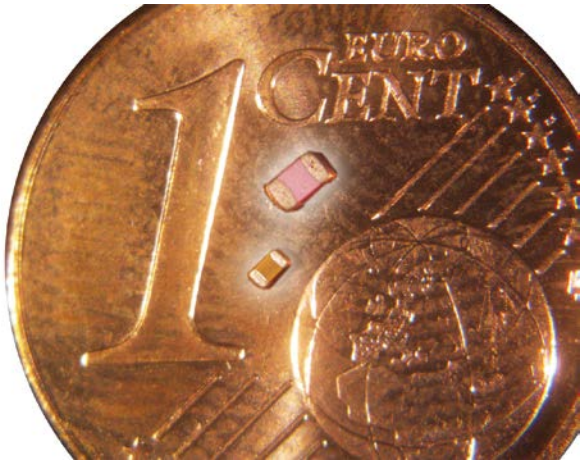
Introduction

Introduction

- Presentation will aim at:
  - ✓Describe qualification status of Exxelia's ceramic products and how it has been achieved
  - ✓Present an overview of the development work (roadmap)
- Results presented correspond to about 10 years development
- Work conducted with the help of CNES. Many thanks.

Introduction

- Driving need : smaller / lighter / cheaper equipments
  - ✓Miniaturization of the components
  - ✓Surface Mounted Devices



- What does it imply?
  - ✓Manufacturing process modifications
  - ✓Materials evolution

- What are the possible ways?
  - ✓To design smaller capacitors with lower rated voltages
  - ✓To design alternative components with reduced lossed in order to minimize heating

Smaller capacitors with lower rated voltages

Smaller capacitors with lower rated voltages

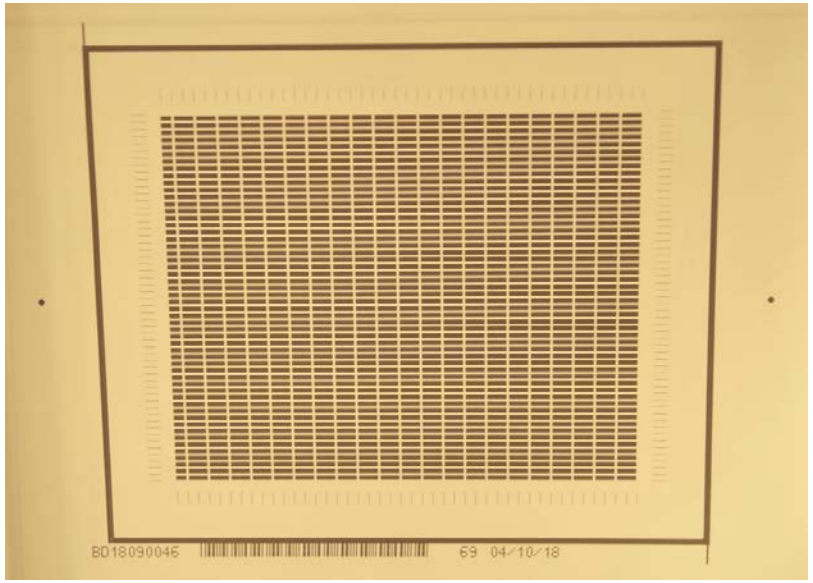
- Goal : to extend chips qualification down to 0402 size and 10V what implies:
  - ⇨ Reduction of dielectric thickness
  - ⇨ Reduction of size margins
  - ⇨ Both actions to increase maximum available capacitance
- Constraint : to maintain a good reliability level
- Implications:
  - ⇨ New dielectrics or better desagglomerated
  - ⇨ New manufacturing equipments
  - ⇨ New (cleaner) manufacturing environment

Smaller capacitors with lower rated voltages

- Dielectric:
  - ✓No change until now, planned for future (see roadmap)
  - ✓Slurry preparation optimization
  - ✓New milling equipment (more powerfull and parameters better tunable)

Smaller capacitors with lower rated voltages

- New manufacturing equipment:
  - ✓Dedicated casting equipment in a clean area
  - ✓Stacking equipment using tape on plastic in order to be able to handle very thin layers
  - ✓New metallization equipment



Ceramic sheet on plastic tape

Casting equipment

Smaller capacitors with lower rated voltages

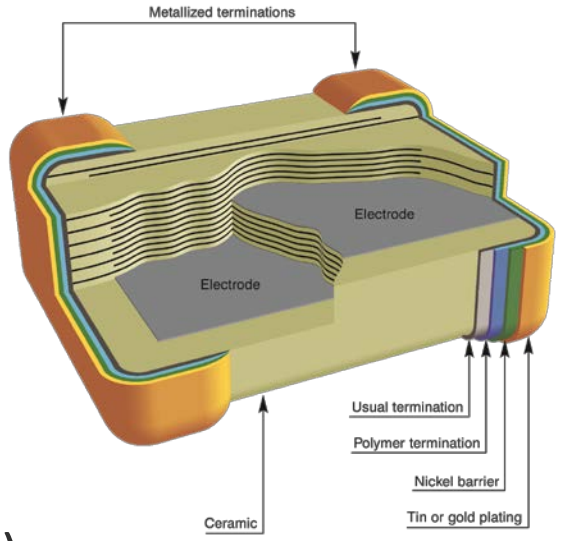
- New manufacturing equipment:

Stacking equipment

Metallization machine

Smaller capacitors with lower rated voltages

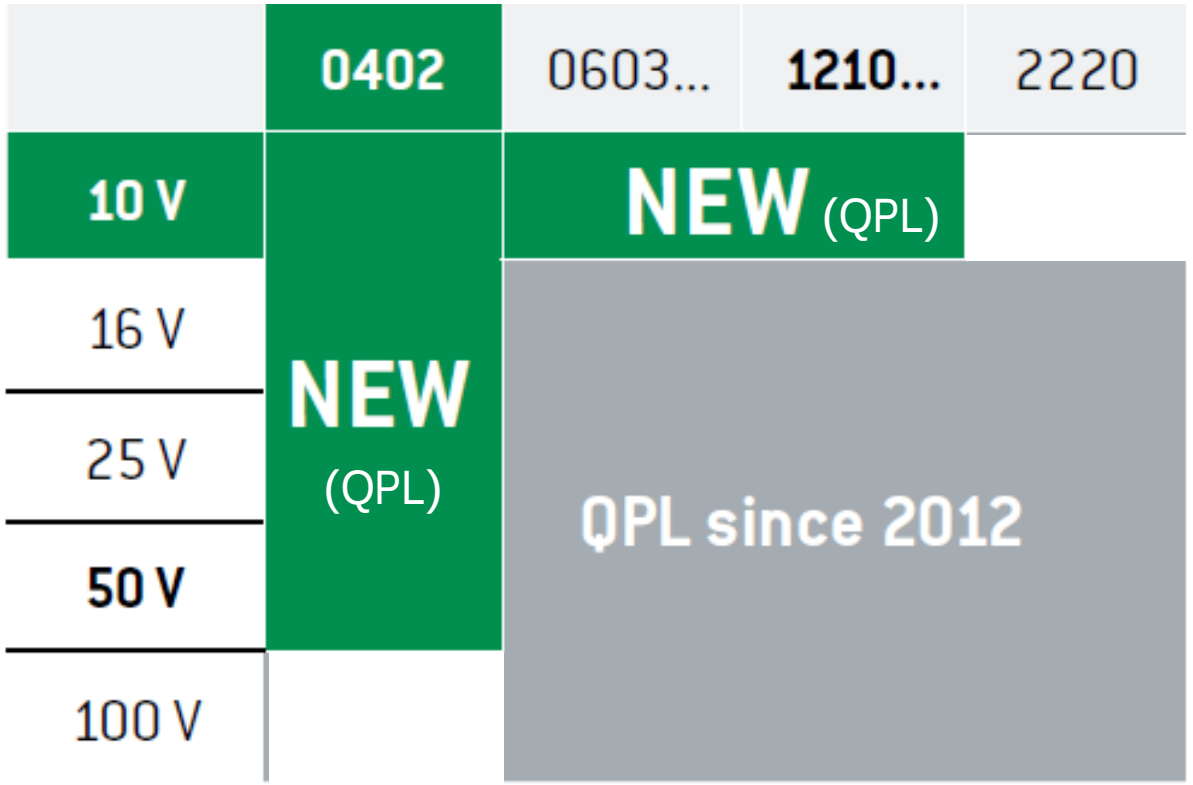
- Parts evaluated / qualified:
  - ✓CEC (NPO) and CNC (BX / X7R)
  - ✓Sizes 0402 to 2220
  - ✓Rated voltage from 10V to 100V
    - Ag/Pd/Pt termination
    - Ag + nickel barrier + Sn/Pb 60/40 (or gold)
    - Ag + Ag filled polymer + nickel barrier + Sn/Pb 60/40 (or gold)



- Tests done according to ESCC 2 263 000 and 3001 + some additionnal tests such as:
  - ✓500 thermal shocks -55°C / +125°C
  - ✓100 thermal shocks -55°C / 125°C + 85/85 damp heat 1000h

Smaller capacitors with lower rated voltages

- Qualification results:



Smaller capacitors with lower rated voltages

- Roadmap for next years:
  - ✓Small sizes : from 0402 to 1210
  - ✓10V rated parts or less
  - ✓Maximum capacitance multiplied by 5 to 10
- Necessary to have:
  - ✓New equipments
  - ✓Printing / stacking in clean environment

Work in progress

Alternative components with reduced losses

Alternative components with reduced losses

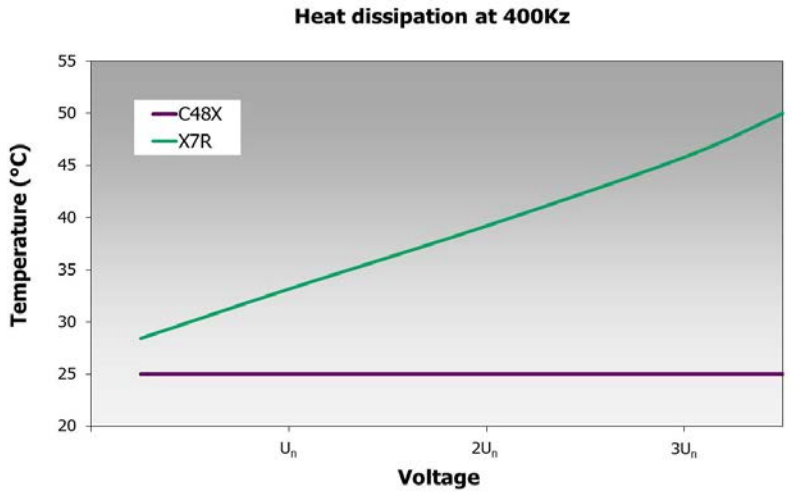
- Goals and constraints:
  - ⇨ To keep the CV product
  - ⇨ To be able to be used in a power / high voltage environment
  - ⇨ To reduce losses
  - ⇨ NPO have low dielectric constant
  - ⇨ BX / X7R have a high DF
- Decision: To use a **N2200 material** which allows to manufacture capacitors which have the same capacitance values left than X7R under voltage but very reduced power dissipation

Alternative components with reduced losses

- C48X main characteristics:

Dissipation factor at 1kHz, $1V_{eff}$:	$\leq 10 \cdot 10^{-4}$
Typical DF at 400Hz, 1Veff :	$\leq 5.10^{-4}$
Insulation resistance at 20°C under $500V_{cc}$:	≥ 20 000MΩ or 500MΩ·µF
Dielectric withstanding voltage :	>1.4 U_{RC}
Temperature coefficient :	-2200 ± 500 ppm/°C

- Power dissipation



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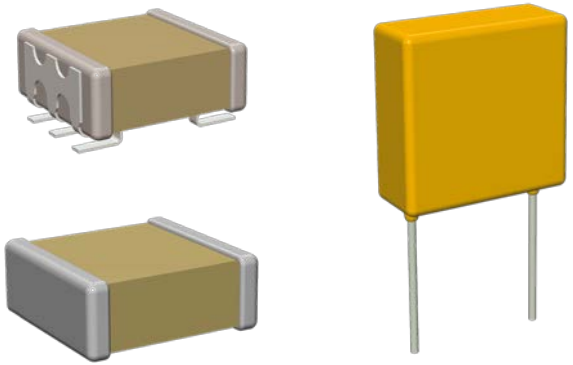
Alternative components with reduced losses

- 2 main driving directions : high voltage and medium voltage
- Evaluation on high voltage (500V to 5kV) parts



  - ✓Families
    - Chips with flexible termination
    - SMD parts (chips with DIL connections)
    - Through hole mounting molded parts
  - ✓ Tests based on ESCC 2 263 000 + additionnal tests
    - 500 thermal shocks -55°C / +125°C
    - 100 thermal shocks -55°C / +125°C - 85/85 damp heat 1000h
    - Partial discharge evaluation
    - Power dissipation measurements
    - Vibrations ….

Positive results

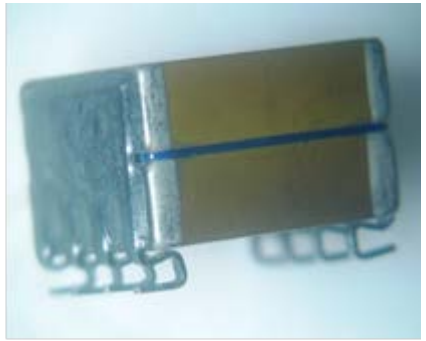
Alternative components with reduced losses

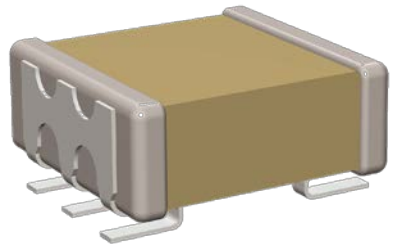
- Extension to medium voltage
  - ✓To increase type 1 ranges (factor 3 to 4 expected)
    - Sizes : 0603 to 1210
    - Voltage : 100V to 1000V
    - SMD chips with Ag/Ni/Sn-Pb terminals
  - ✓ Evaluation based on ESCC 2 263 000 + thermal shocks and 85/85 damp heat test

Positive results

Alternative components with reduced losses

- Administrative roadmap for next years
  - ✓Introduction of C48X high voltage ranges in EPPL
  - ✓Qualification C48X high voltage ranges
  - ✓Qualify 0603 to 1210 medium voltage ranges
- New development : Evaluate and qualify high voltage SMD capacitors
  - ✓Single chip components
  - ✓Stacks





Work in progress

Thanks for your attention.

Any question?

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