Manufacturing of multilayer ceramic capacitors by laser machining

CNES-Exxelia contract n° 180649/00
Why laser machining?

- Exxelia’s core target has always been and is still high reliability passive components conception, development and supply, both standard and custom-design models.

- For MLCC’s, it means (among others) development of various designs, to fit customer requirements.

- Classical MLCC’s manufacturing technologies allow to build only parallelepipedic or circular capacitors.

- The aim here is to test a method to be able to build various shapes, needed in particular (but not only) for filtering (feed-through) applications.

- Study is in progress (with help of CNES), to build and test filtering MLCC’s, mono or multi capacitances, with miniaturized circular shapes or custom-design shapes.

⇒ laser machining
Examples of previous developments, mechanical machining

Single capacitance miniaturized model

Multicapacitance custom-design miniaturized model

Multi capacitance miniaturized model
Examples of previous developments, laser machining

Multicapacitance custom-design miniaturized model

4 adjusted capacitances

“Washing foot”

1206 size
Why UV laser?

Photons emitted in the UV spectra have an energy much higher than those emitted in IR.

Absorbed photons give a kinetic energy that breaks links of matter’s molecules; particles are ejected with very high speed = photochemical ablation.

LASER energy emitted in UV spectra is absorbed by metallic materials (copper, steel, aluminium…) as well as by insulating materials (polymers, ceramics, industrial diamond…)

M.U.L. use LASER sources with UV (355nm) emission to carry out custom-design micromachining.
Test vehicles for evaluation of laser machining

Double capacitance circular feedthrough capacitor

D = 1,4mm (-0,1/0)
d = 0,5mm (0/+0,05)
T = 1 mm max

Single capacitance circular feedthrough mini capacitor

Multi capacitance custom design shape feedthrough capacitor
Green ceramics laser machining: first trials on standard "’TBC’"

- Laminated green block after laser machining, MLCC’s still in place
- Laminated green block after laser machining, MLCC’s removed
- Green MLCC’s after laser machining
- Laser machined circular MLCC’s, fired, grinded
- Laser machined circular MLCC’s, terminated
- Laser machined circular MLCC’s, gold plated

⇒ Feasability validated
Multi capacitance custom design shape MLCC’s development

Green MLCC’s after laser machining

Laser machined circular MLCC’s, fired, grinded

Special tool for termination deposit on roll equipement

New technology for termination deposit

Syringe on 4 axes robot deposit
Multi capacitance custom design shape MLCC’s development

- Green MLCC’s after laser machining
- Terminated MLCC’s
- Gold plated parts, 2 x 50nF (0/ +100%) 200V
- Overlay test of printing screens – to be improved
- DPA : bad overlay ⇒ electrode shifting ⇒ shorts

Delivered to customer

Trials to be done on another manufacturing line, using optical centering

Test in progress
Laser machining benefit for MLCC’s custom design manufacturing

Close capacitance distribution (type 2 ceramic, 50nF each capacitance)

$\Phi_{ext}=1.3-1.4\text{mm}$

$\Phi_{int}=0.5-0.55\text{mm}$

$e = 1\text{mm max}$

Trials to be done on parallelepipedic parts (vs blade cutting) to validate or invalidate this improvement

More accurate

Better geometric definition
What do we have to improve?

- Up to 1mm thick, single-side machining
- Thicker than 1mm, double-side machining needed
  - ⚠️ matching after rollover

- Machining marker needed
  - ⇒ one more printing screen
Thanks a lot for your attention

ESCURE Pascale
R&D engineer • Capacitors GBU
Phone: +33 (0)1 60 31 70 16
pascale.escure@exxelia.com

Maybe you have some questions?

mul@micro-usinage-laser.com