Photonics Days Berlin Brandenburg 2023

Small, smaller, ceramics – how the old limits of microelectronics are being broken with miniaturized circuits on multilayer ceramic substrates

eCeramix GmbH
Dipl.-Ing. Nam Gutzeit
Founder and Managing Director
+49 3677 799 64000
info@eCeramix.de
www.eCeramix.de

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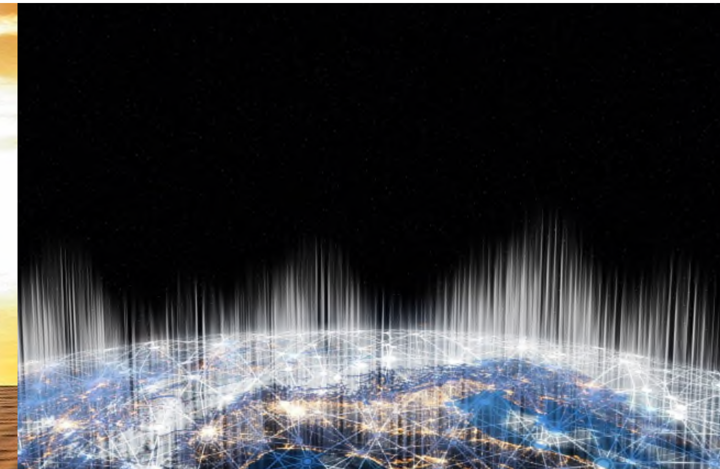
Elektronikindustrie

- Urbanisierung
- Demografischer Wandel
- Klimawandel
- Digitalisierung (Industrie 4.0,…)

…

- Vernetzung
- Sensoren
- Ressourceneinsatz
- Miniaturisierung

…



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eCeramix GmbH

The Core Area of eCeramix GmbH is the development and manufacturing of complex circuit designs and special electronic based on ceramic boards. We are specialized on the miniturization in Low temperature cofired ceramics (multilayer ceramic boards) and the combination with other materials

Nam Gutzeit	Michael Fischer	Alexander Schulz	Prof. Jens Müller
Founder and Managing Director	Founder	Founder	Founder
Development	Development	Development	Consulting
Miniaturization	Application	Circuit Design, RF Design	

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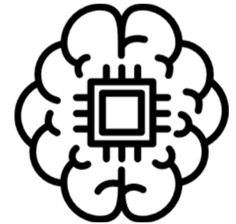
Opportunities

eCeramix GmbH offers …



… research and development by customer order

… technology and feasibility studies

… prototypes, small series and contract manufacturing

… technology transfer into your company structures

… technology consulting and training

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Your Benefit

ONE STOP SHOP

You benefit from …

… our long-time experience in research and development

… our access to newest mashines and equipment

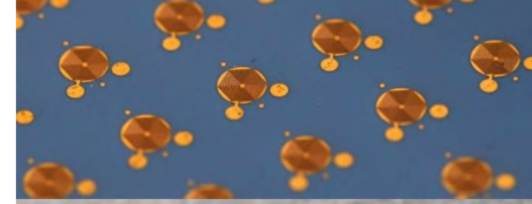
… Our direct cooperation to the TU Ilmenau

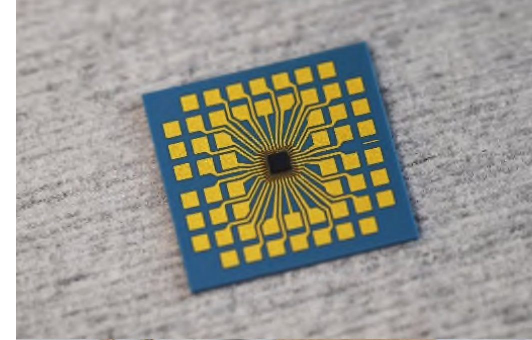
… the whole LTCC processing line

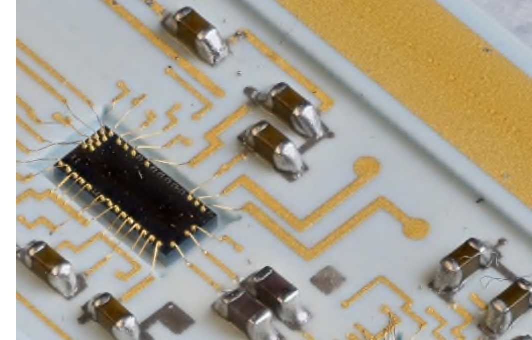
… newest technologies for structuring of thin and thick films

… several high precision assembly methods

… direct characterization and analytical methods







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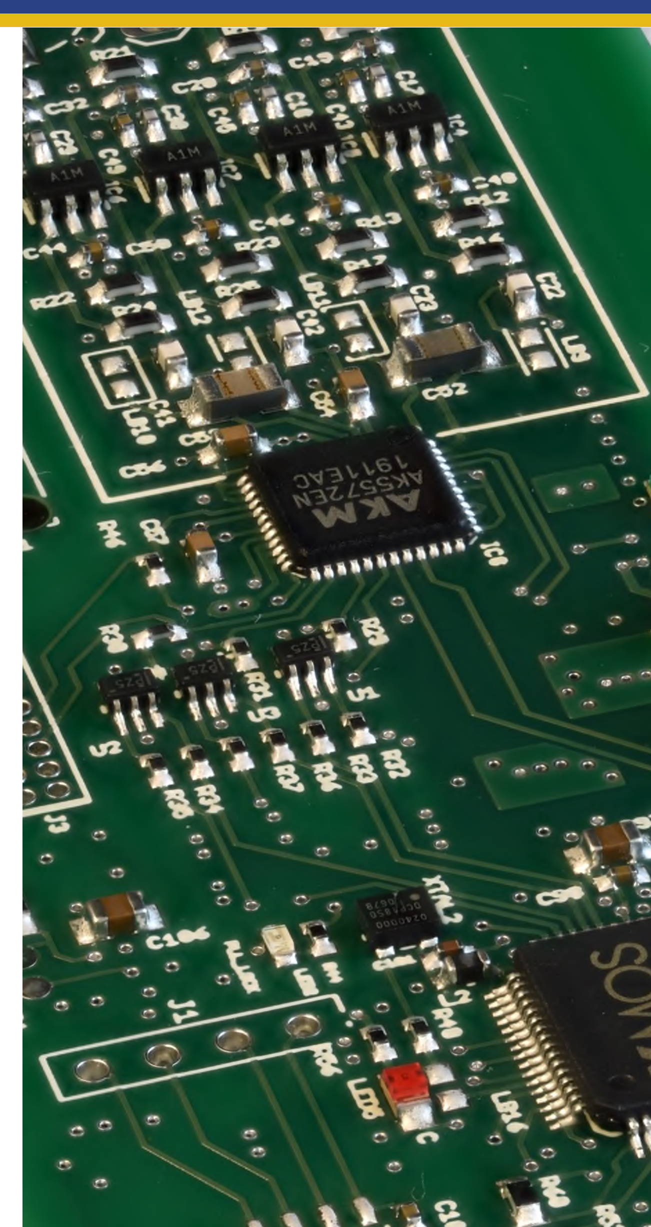
Assembly

- SMD
  - automatic assembly up to 0402
  - manual assembly up to 0201
  - reflow soldering (w./o. nitrogen), soldering under vacuum
- Chip assembly
  - automatic and manual assembly
  - different bonding technologies (e.g. conductive iso- and anisotropic, non-conductive, different temperature ranges)



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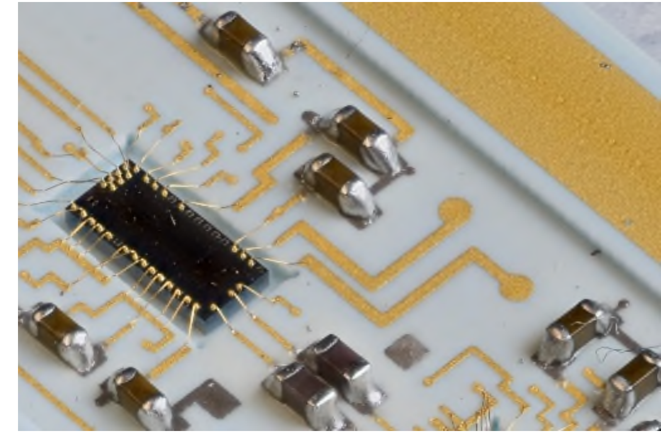
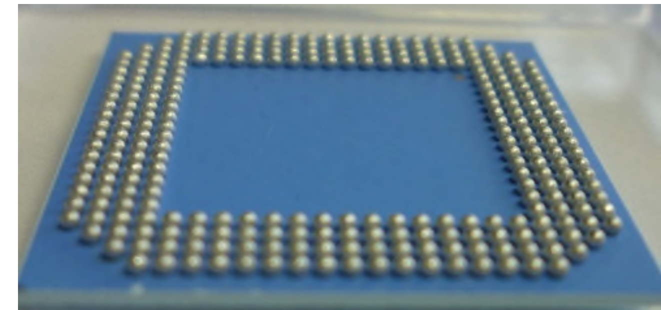
Assembly



- Wire bonding
  - ball wedge, wedge wedge and ribbon bonding
  - wire material: Au and Al wire (wedge-wedge only)
  - 17.5 µm and 25 µm incl. finepitch and ultra finepitch requirements
  - stud bumping with 17.5 µm and 25 µm Au wire
- Flip-chip bonding processes
  - Thermal compression bonding
  - ultrasonic bonding



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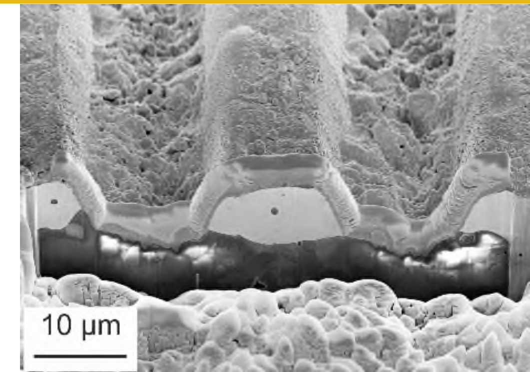
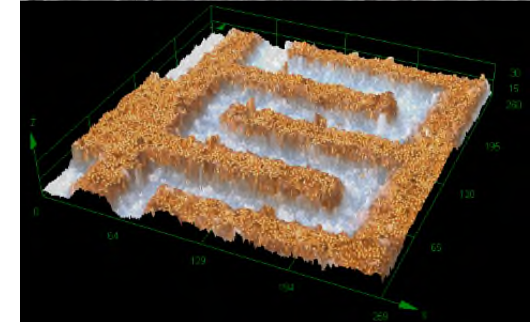
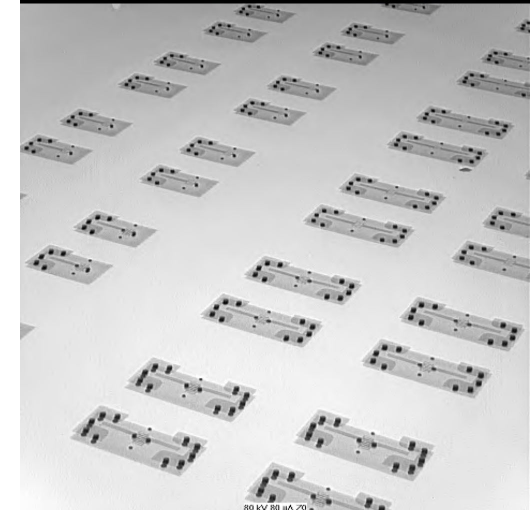
Characterization and Analysis

- optical microscopy
- scanning electron microscopy
- laser scanning microscopy
- X-ray transmission
- sonography
- optical and mechanical profilometry
- electrical characterization
- RF characterization up to 20 GHz
- thermal characterization
- pull and shear tests
- climate change tests







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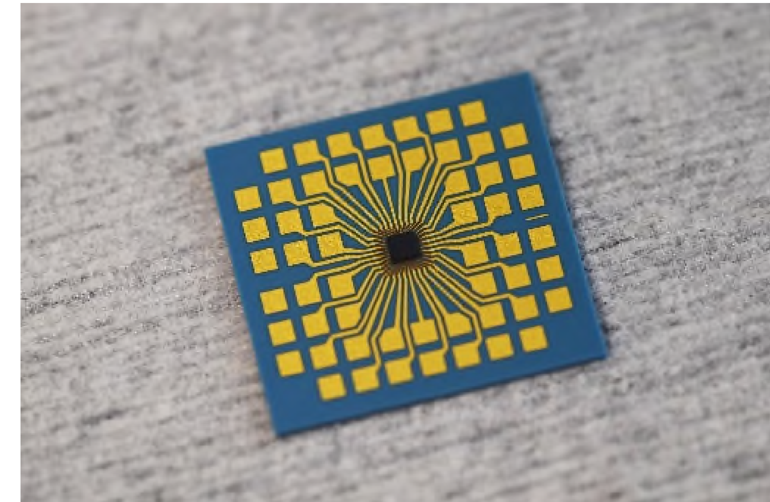
LTCC - **L**ow **T**emperature **C**ofired **C**eramics

- multilayer ceramic board material
- combining the benefits of HTCC und standard thick film technology
- complex 3D circuits
- functional carrier
- interposer (e.G. chip assembly)
- integration of passive elements
- integration of fludic structures and cavities
- RF structures



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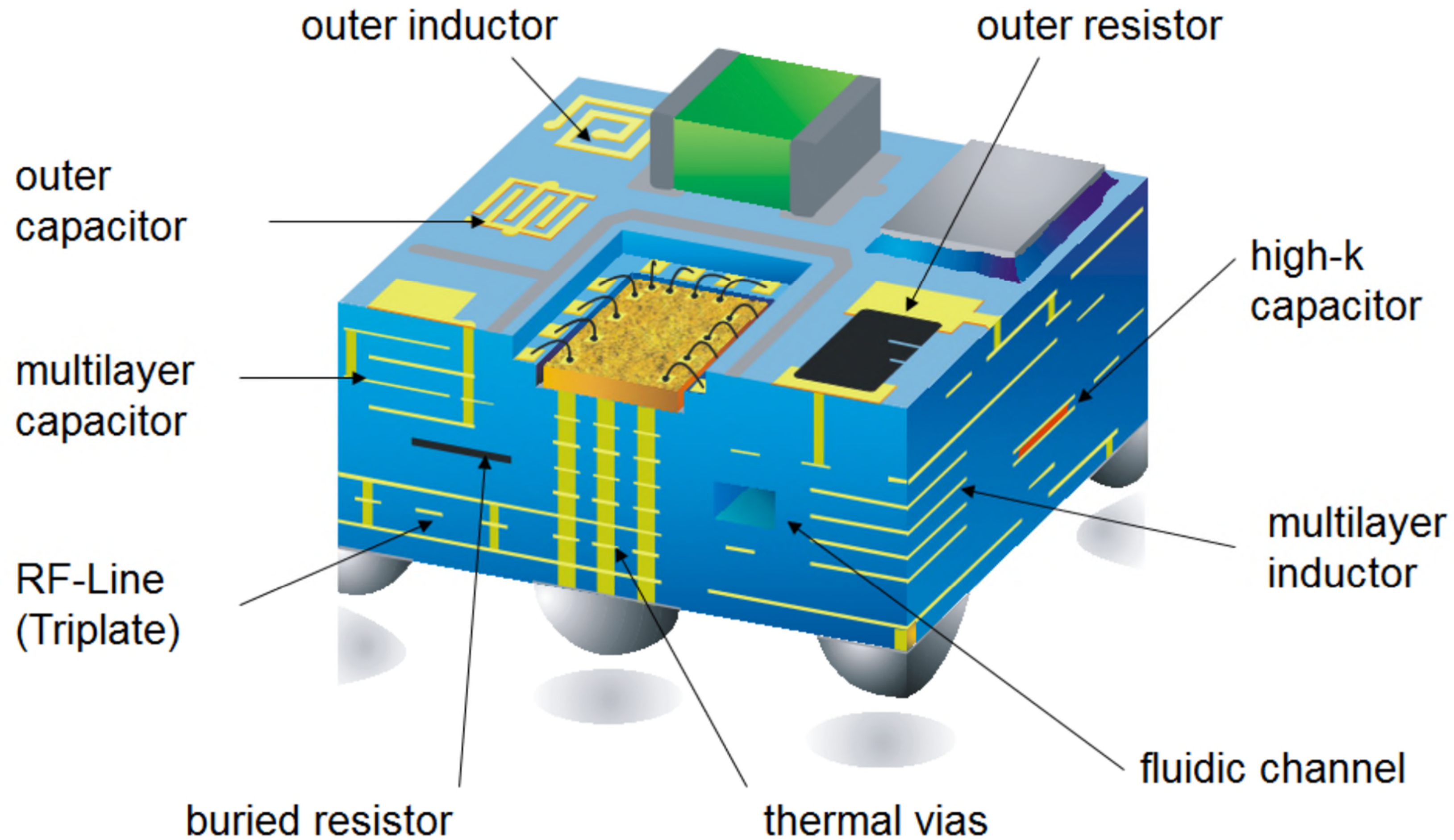
LTCC – Overview



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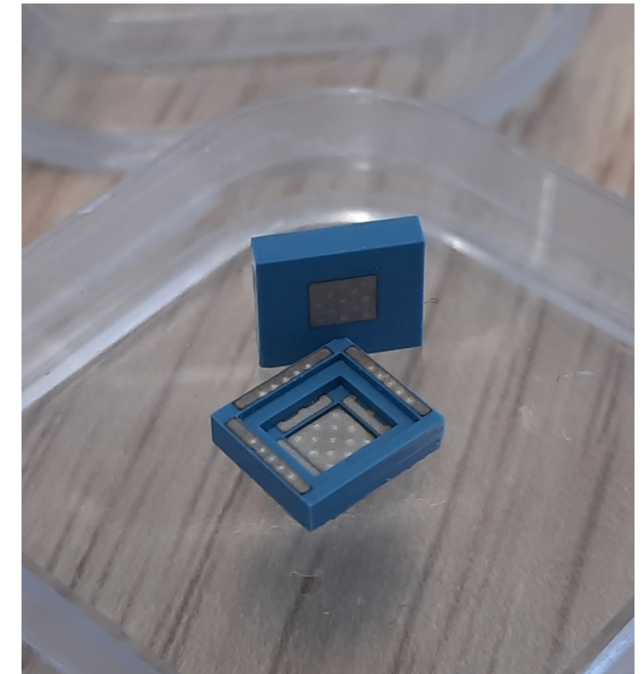
LTCC – Properties

- good mechanical stability
- low thermal expansion

Material	Thermal conductivity [W/mK]	CTE
Aluminium	225	23
Copper	360	17
Silver	417	19
Gold	314	14
Diamond	2300	1,2
MMC	550	5,8
Carbo-Nanotubes	6000	…
Aluminiumnitride	170	4,7
Aluminiumoxide	20	7
LTCC	**4**	**5,8**
Silicon	150	2,6
FR4	0,25	15

Thermal conductivity of LTCC with thermal vias

10..60 W/mK



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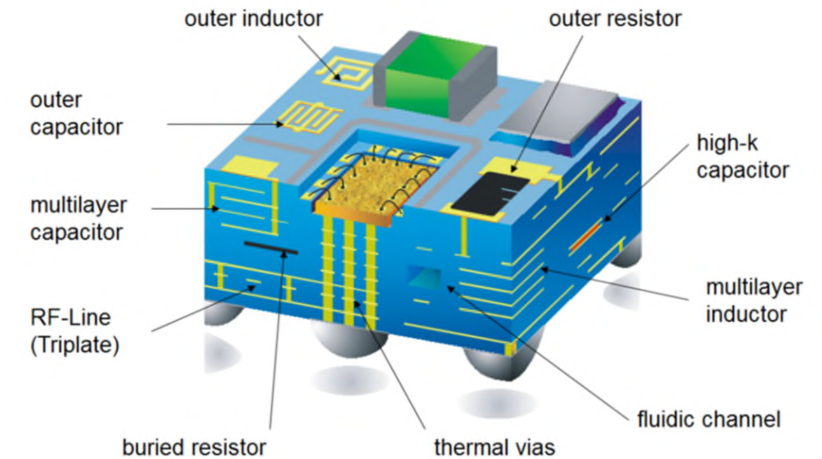
LTCC – Properties

- good mechanical stability
- low TCE
- hermetically tight
- high temperature stability
- chemically inert / low outgassing
- high break through voltage
- low thickness tolerance of the single layers
- comparable assembly processes like PCB
- compatible with high temperature assembly processes



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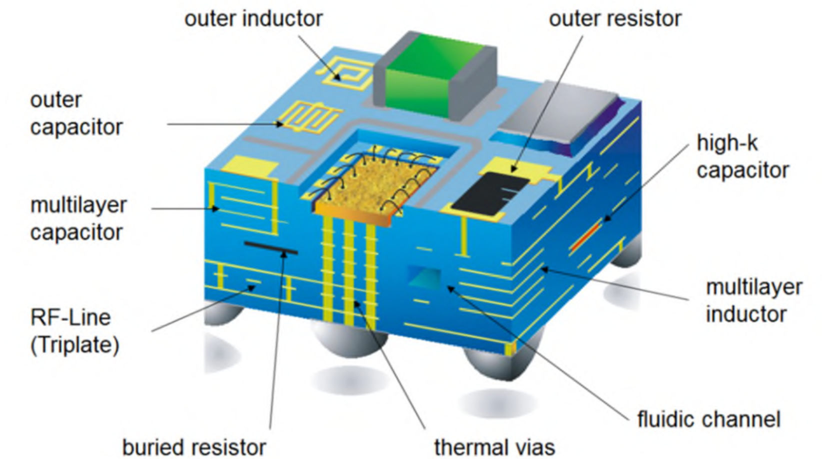
LTCC – Properties

- good RF properties
- combination with different materials
- compatible with thick and thin film techniques
- galvanical process possible
- high wiring density
- TCE matching for semiconductors possible
- deformable in green state
- Integration of thermal vias increases thermal conductivity



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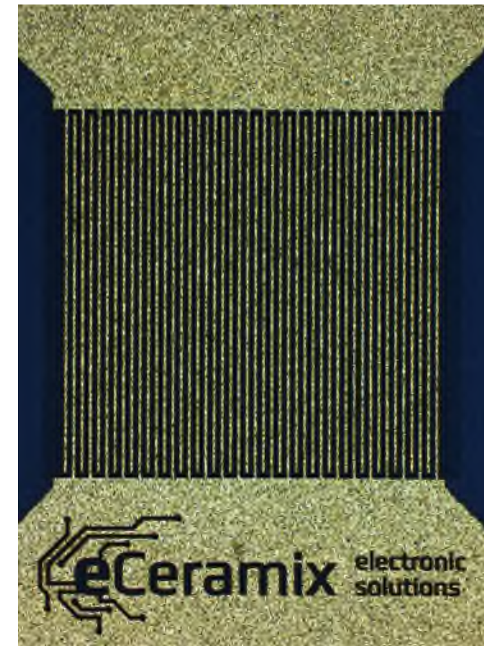
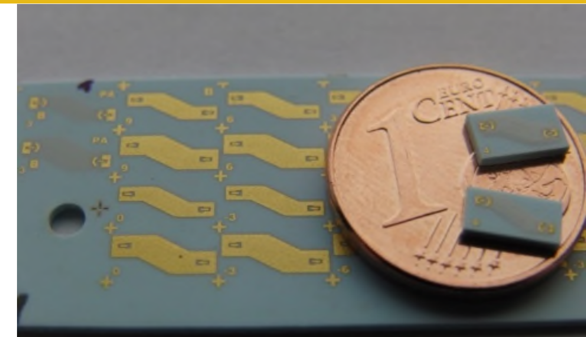
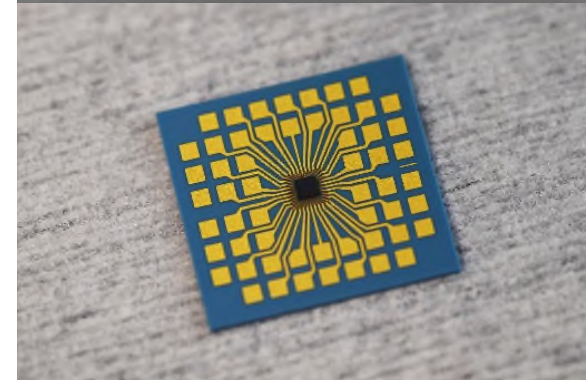
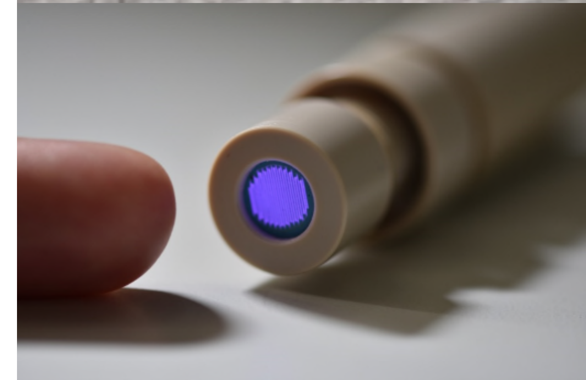
Application fields of LTCC

- electronics for harsh environment (radiation, high temperatures, chemical or acid contact)
- RF
- Sensor technologies
- Photonics
- Aerospace
- Life-Science
- medical devices
- …









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LTCC Technology – Overview technology chain

tape

preparation

via preparation
cavity preparation

via filling

screen printing

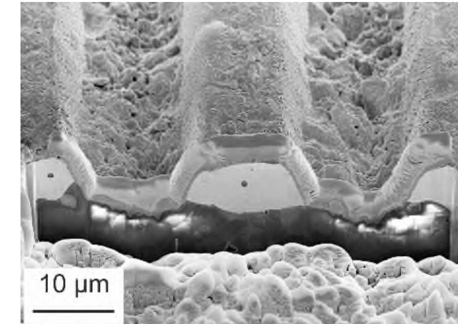
stacking

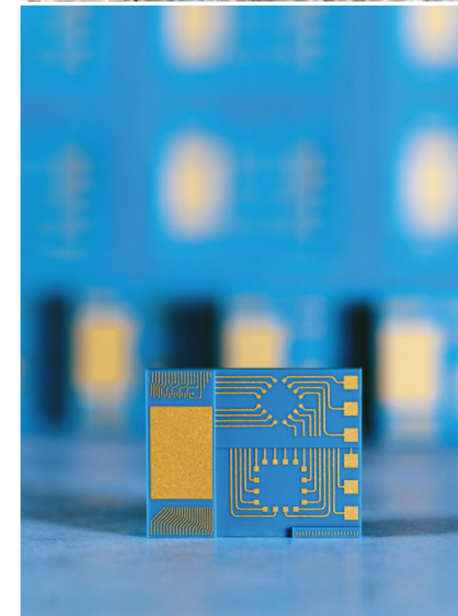
lamination

co-/post-firing

separation

assembly





→usage of laser ablation

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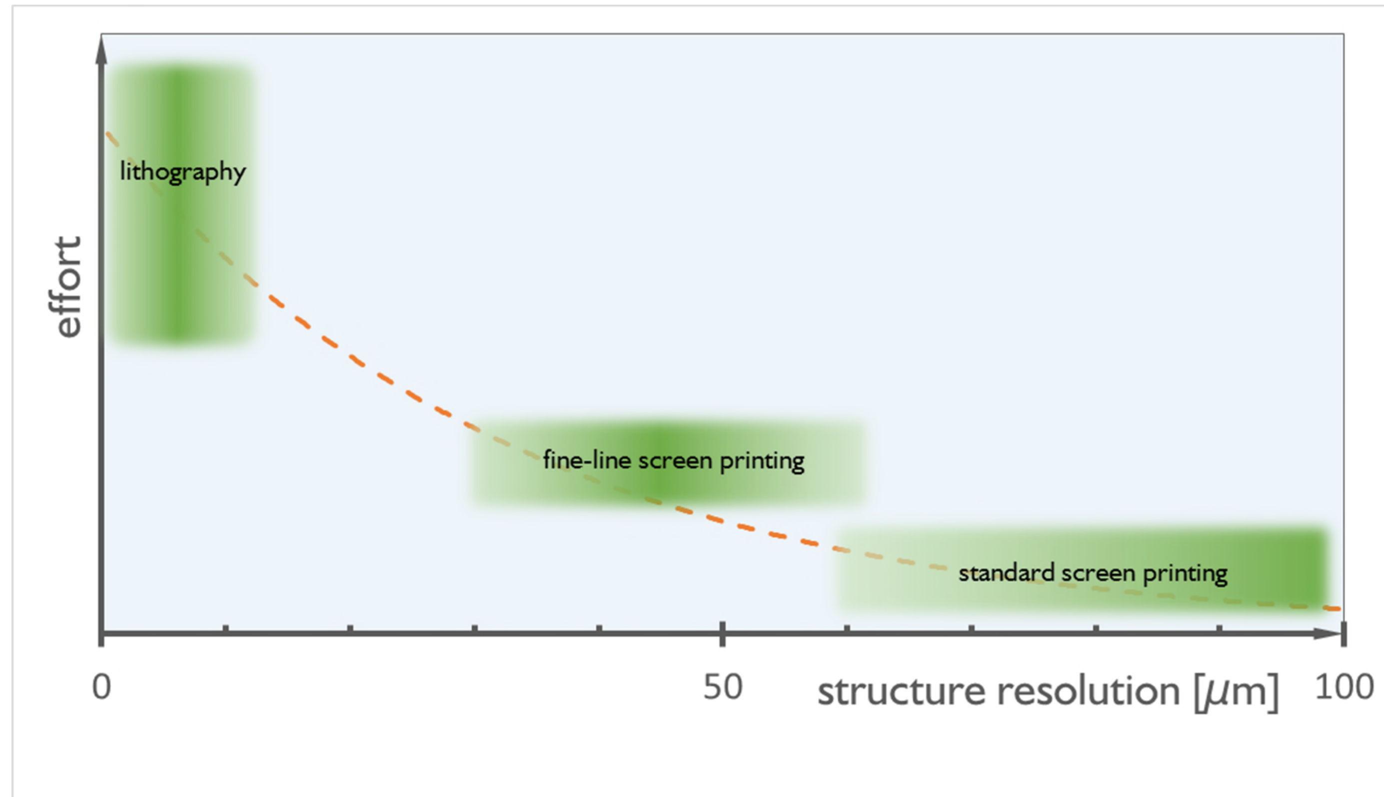
LTCC Technology – borders of miniaturization



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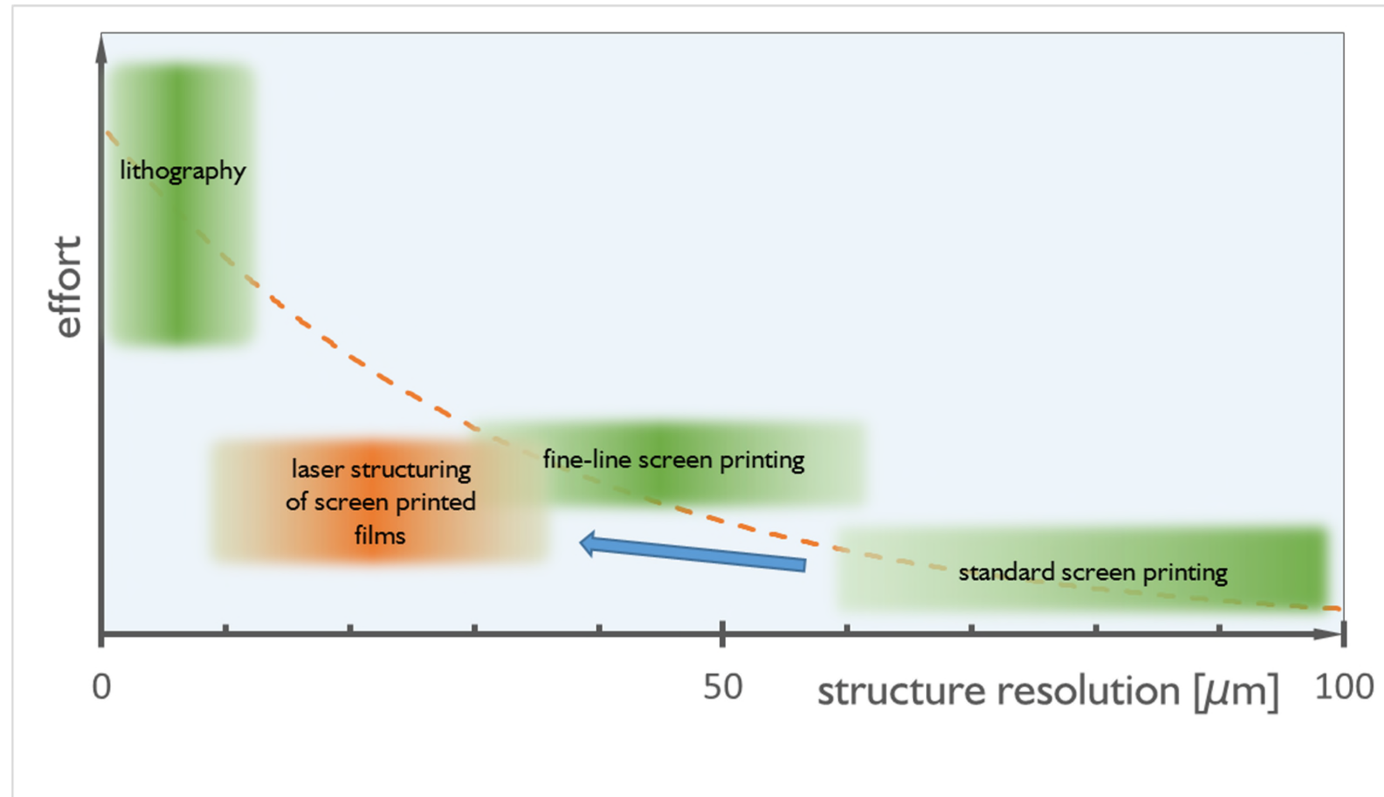
LTCC Technology – borders of miniaturization



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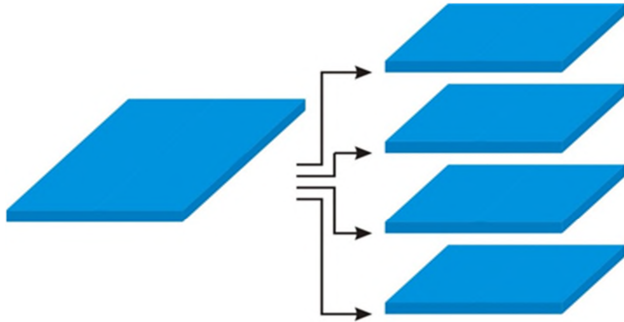
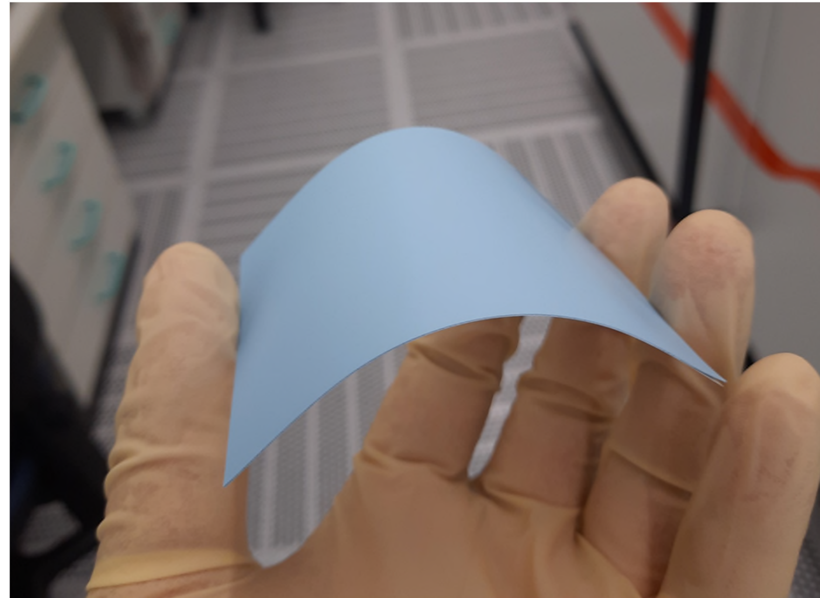
LTCC Technology

tape preparation





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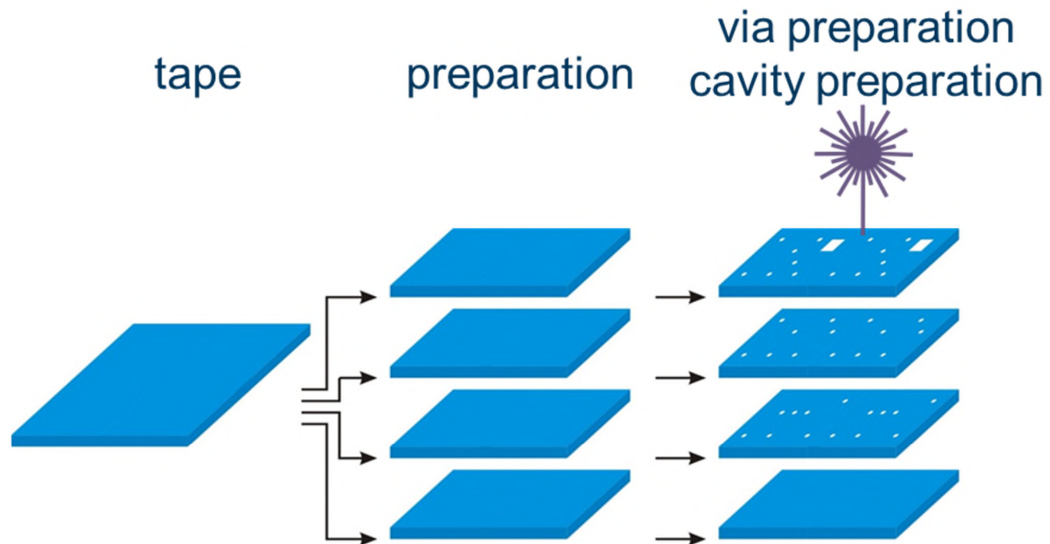
LTCC Technology – Via Punching



→usage of laser ablation

Vias down to Ø 75 µm (min. 50 µm)

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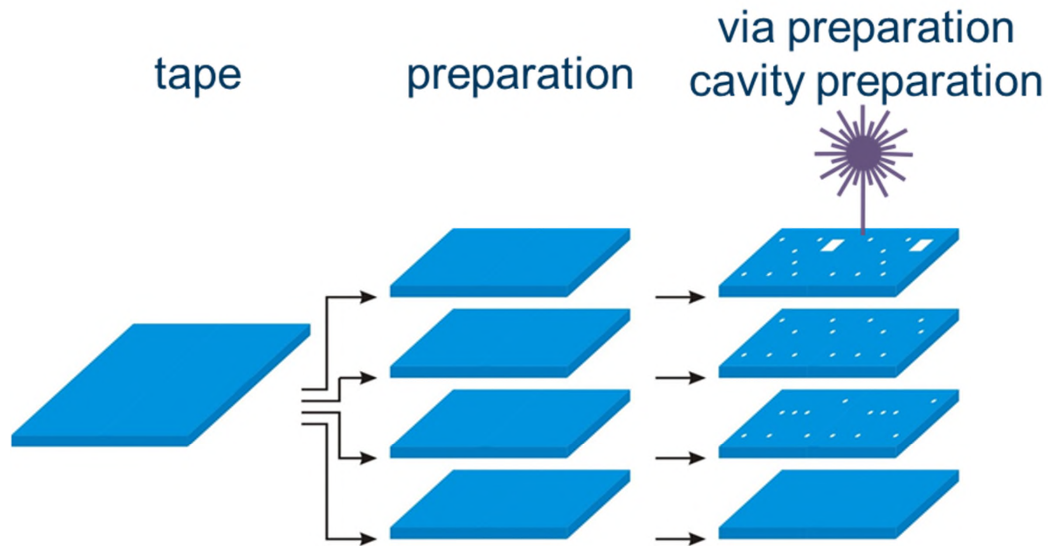
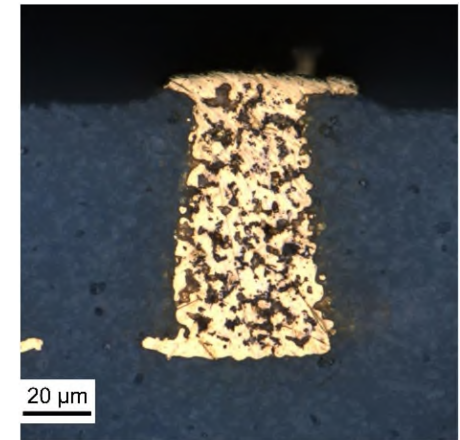
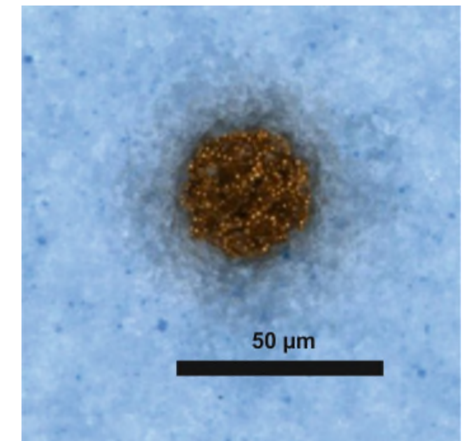
LTCC Technology – Laser Drilling of Vias







→usage of laser ablation

Micro-Vias down to Ø 30 µm

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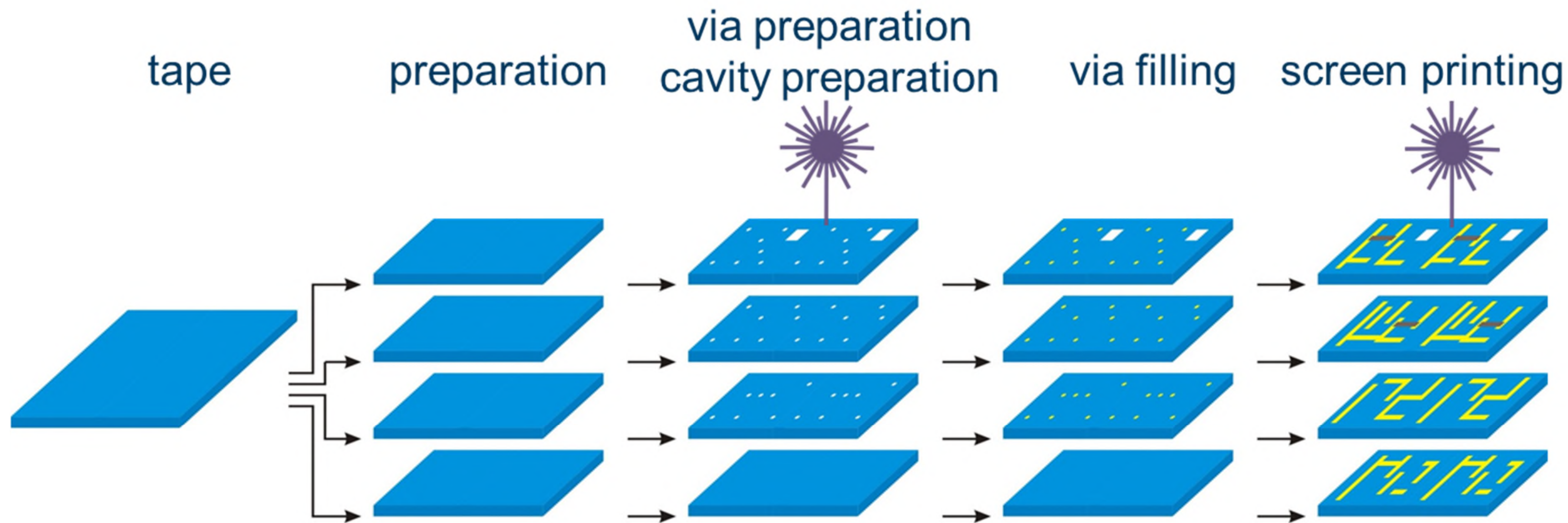
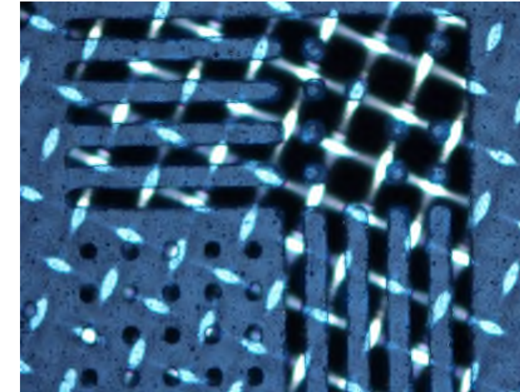
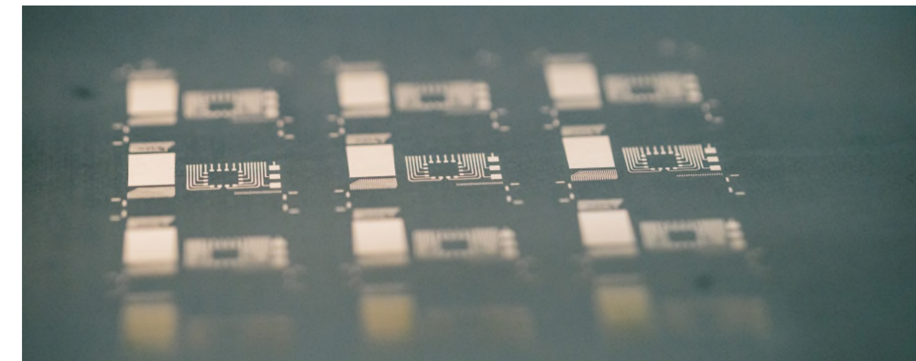
LTCC Technology – Laser ablation in green state







→usage of laser ablation

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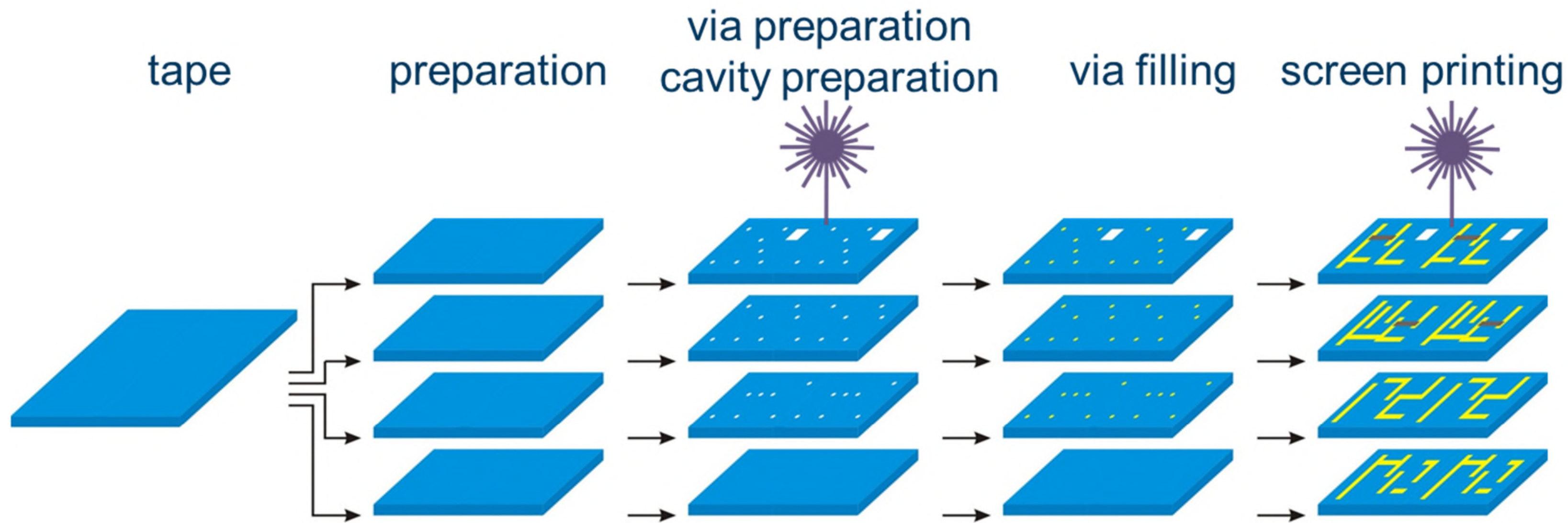
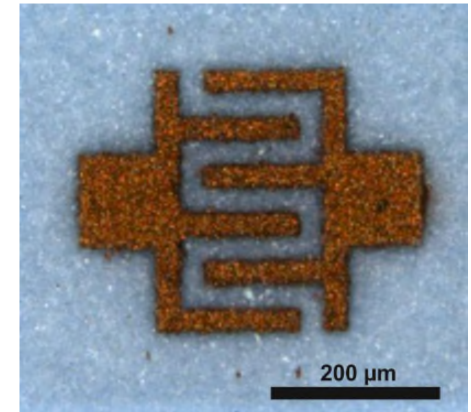
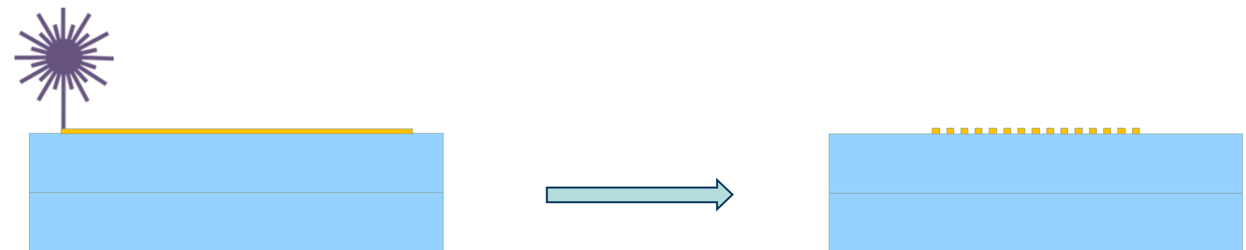
LTCC Technology – Laser ablation in green state







→usage of laser ablation

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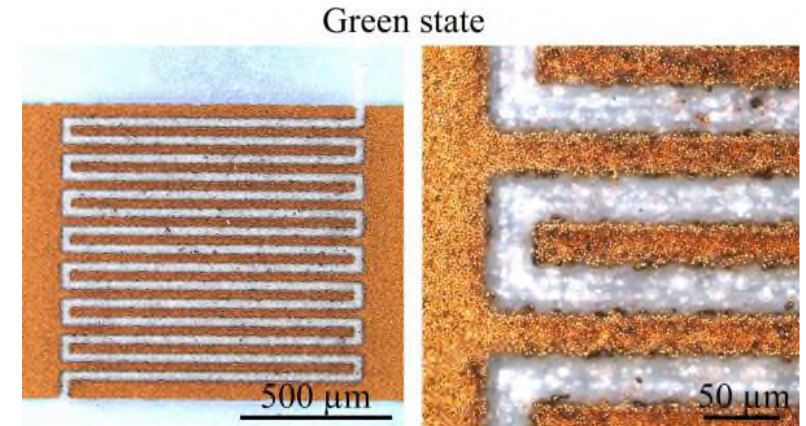
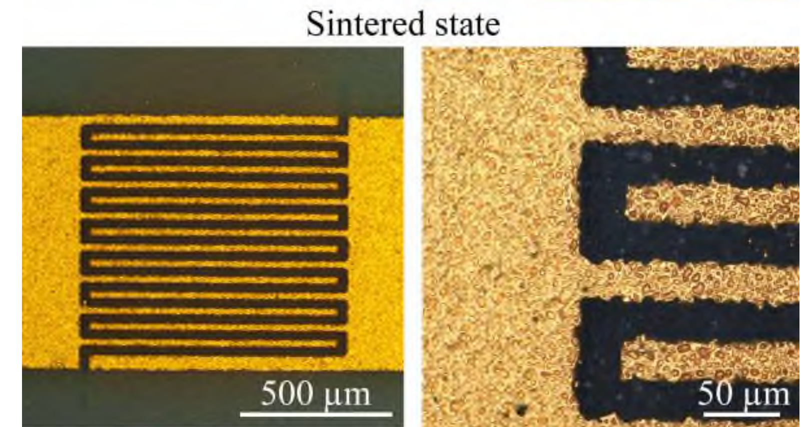
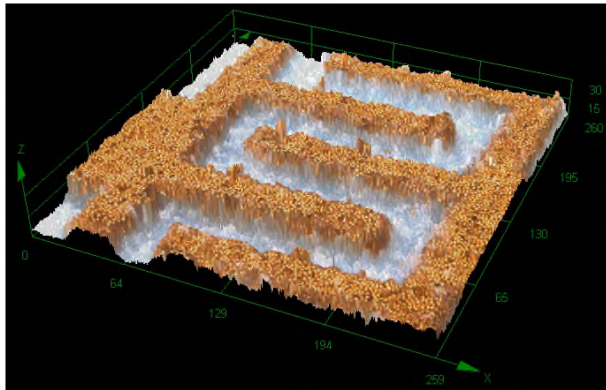
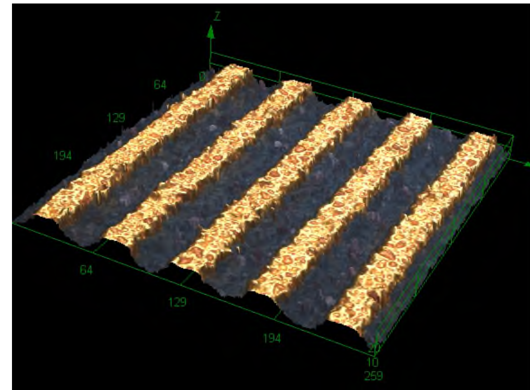
LTCC Technology – Laser ablation in green state

- laser ablation of screen printed dried films
- burried structuresd with small structure size
- down to 25 µm Lines and Spaces









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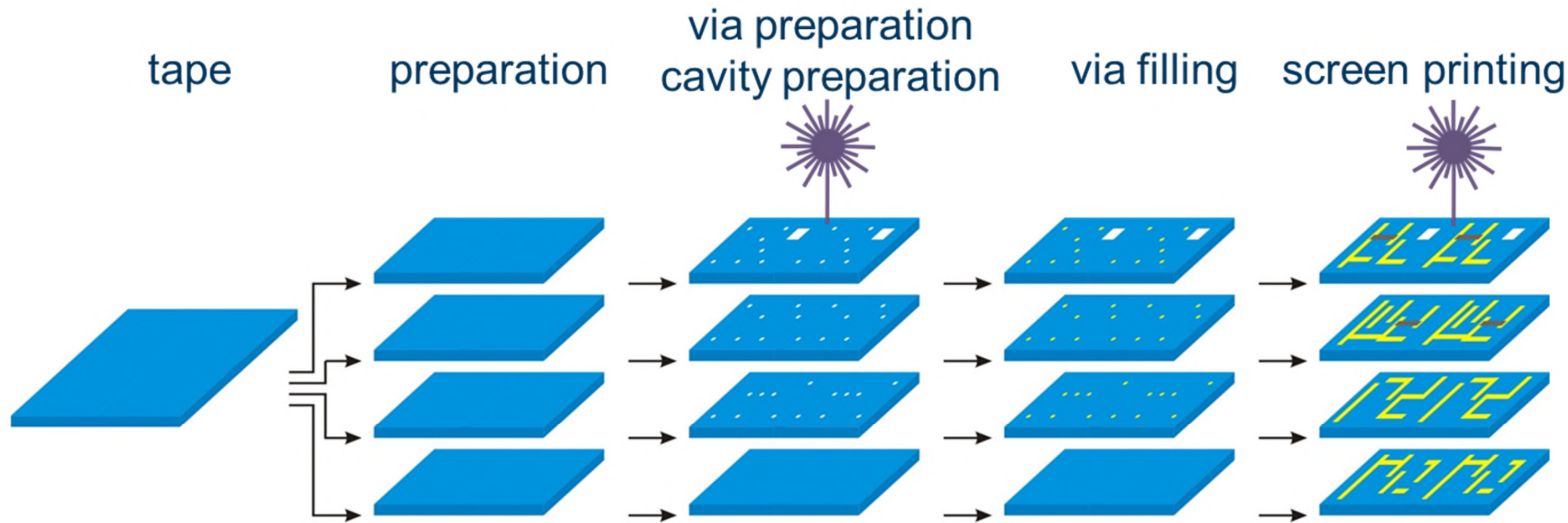
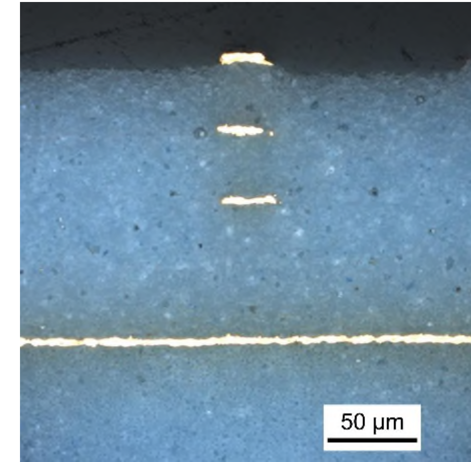
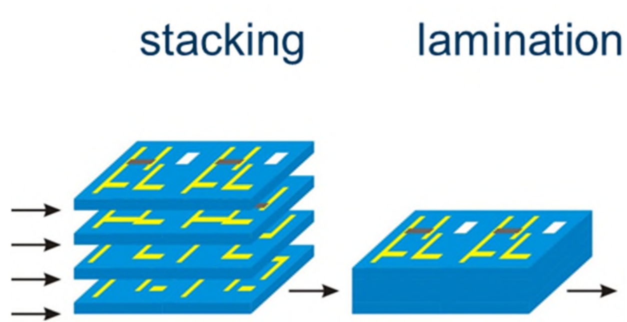
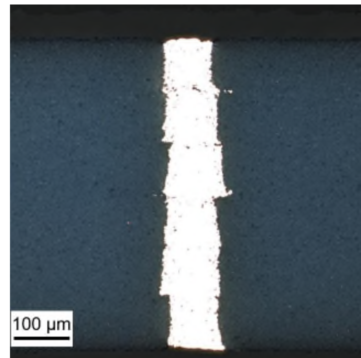
LTCC Technologie

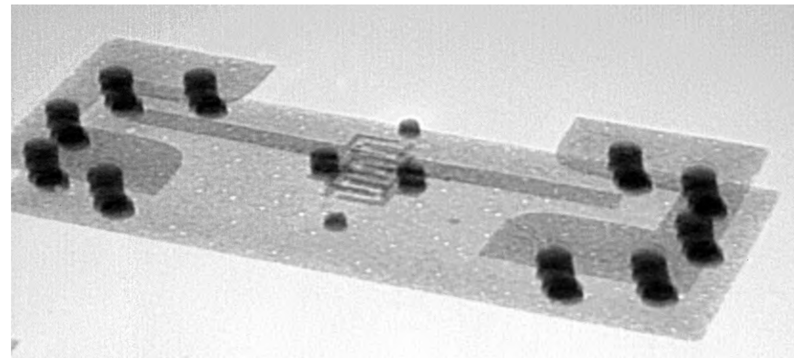
- standard tolerances: 15 µm
- high precision tolerances down to 2,5 µm

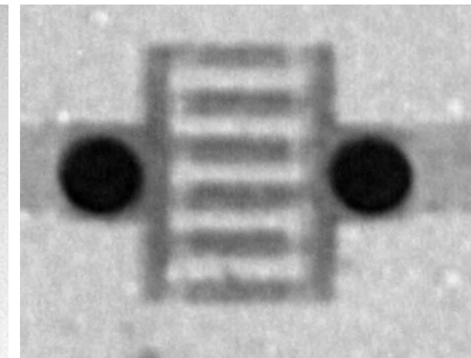












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LTCC Technology – Postfired Laser Structuring

tape

preparation

via preparation
cavity preparation

via filling

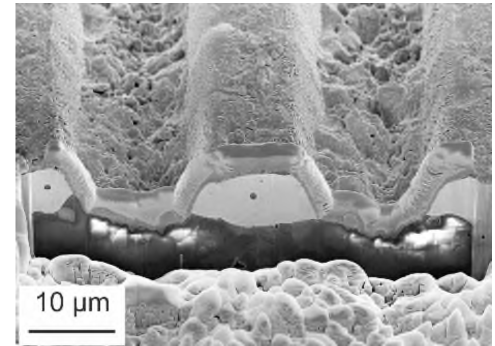
screen printing

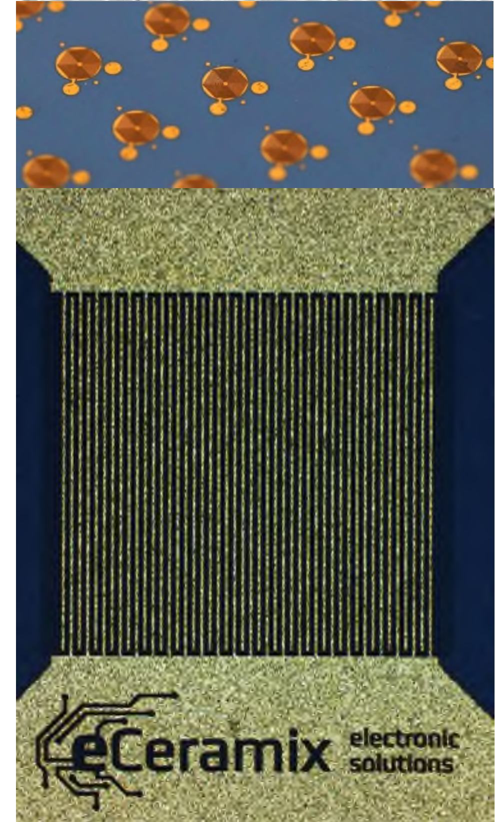
stacking

lamination

co-/post-firing

→usage of laser ablation





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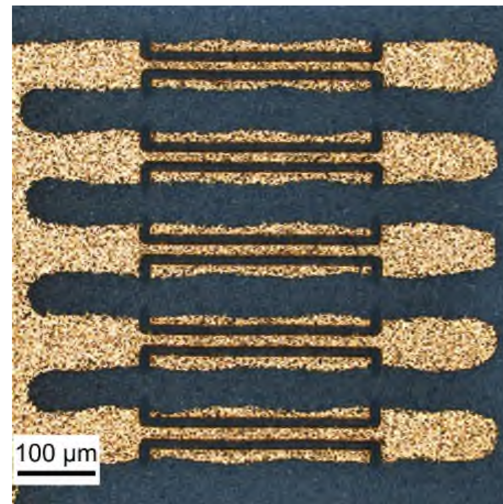
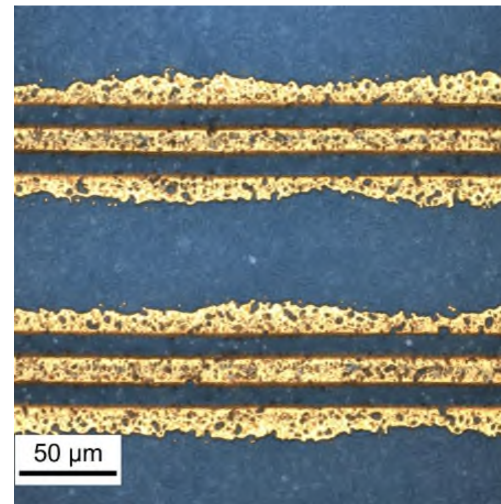
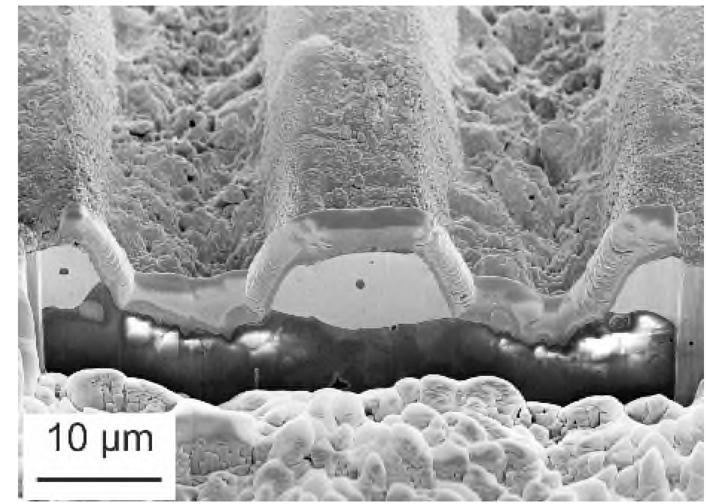
LTCC Technology – Postfired Laser Structuring

- Laser ablation of screen printed film after sintering
- burried structures possible with Tape-on-Substrate process
- down to 10 µm Lines und 13 µm Spaces
- very small tolerances down to ± 0,3 µm







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LTCC Technology

tape

preparation

via preparation
cavity preparation

via filling

screen printing

stacking

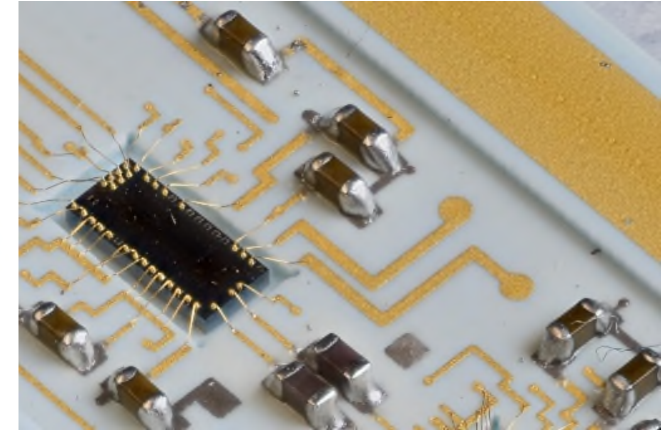
lamination

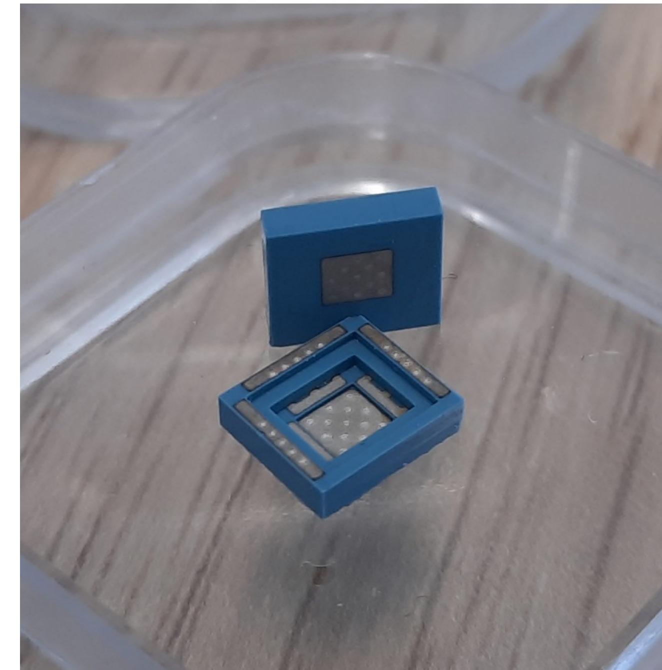
co-/post-firing

separation

assembly

→usage of laser ablation





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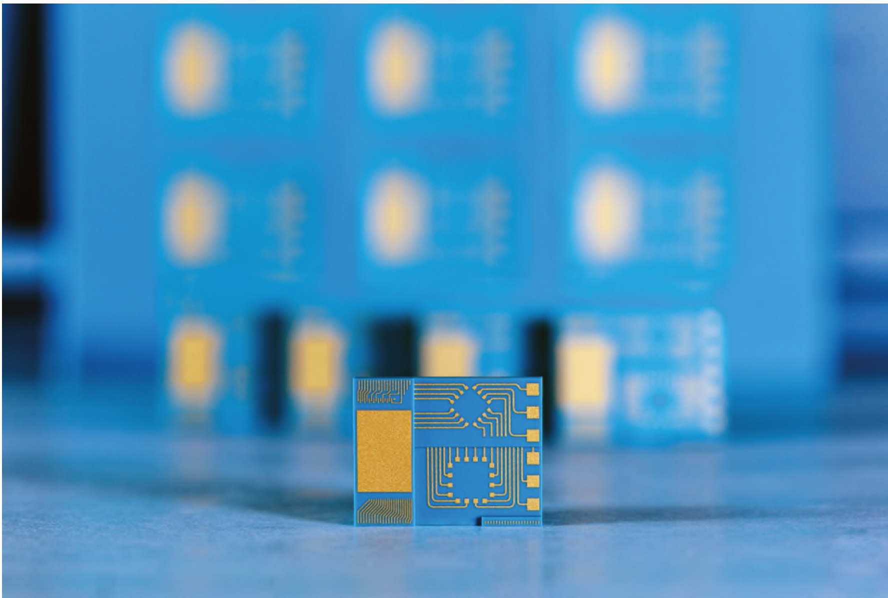
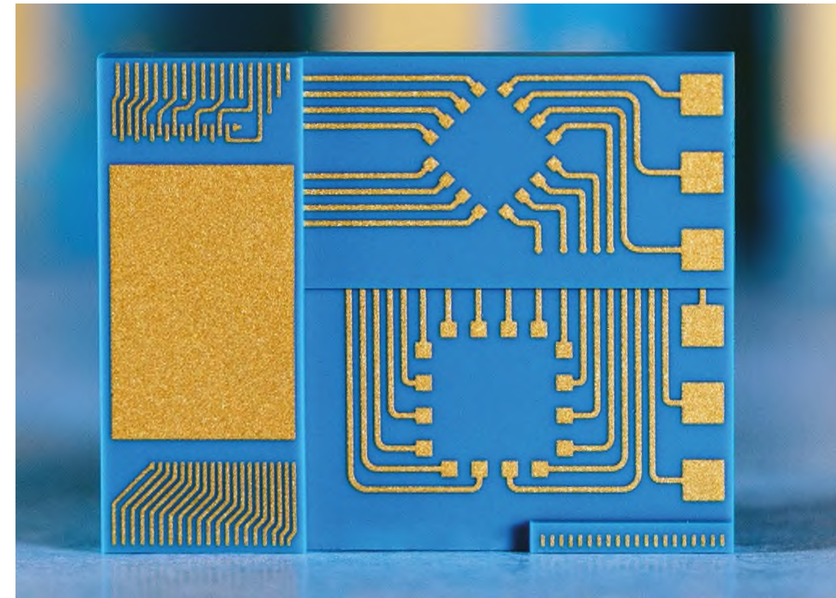
Application – Optical micro bench





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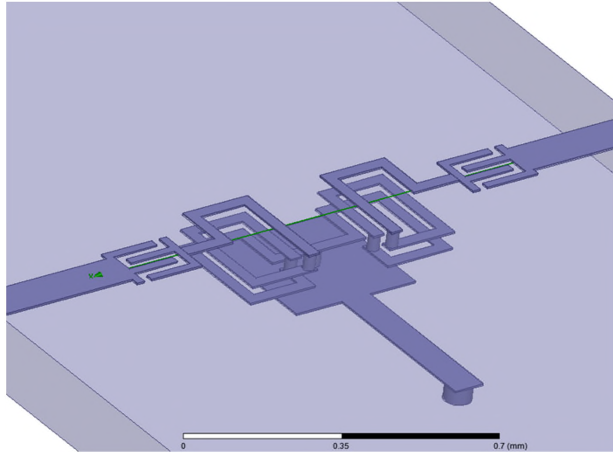
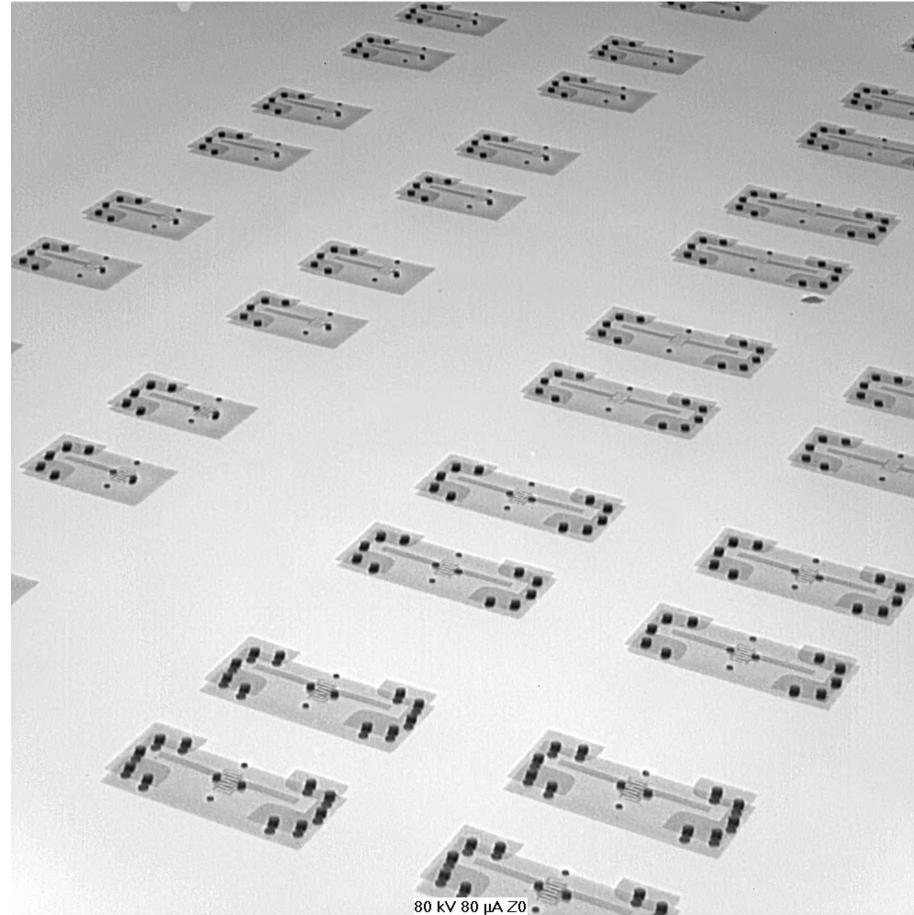
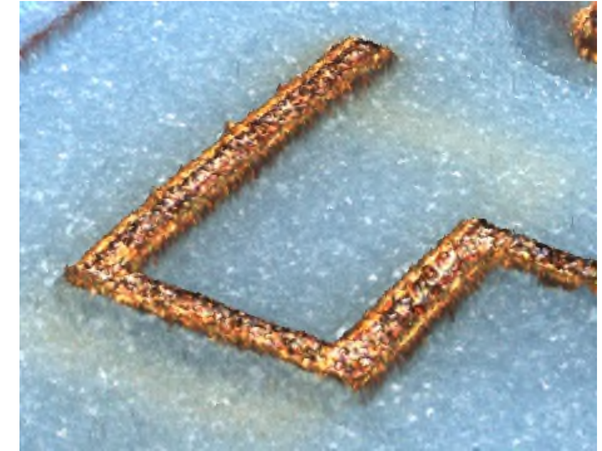
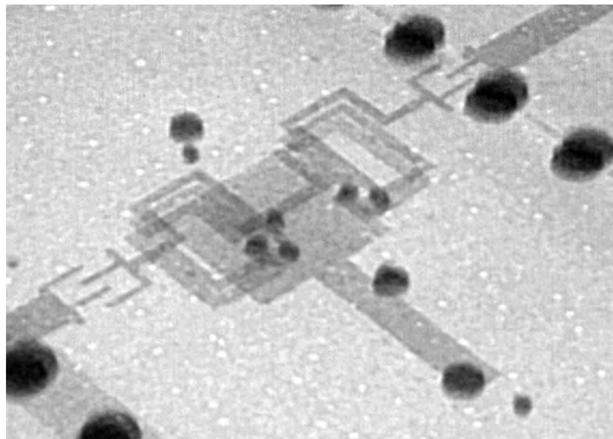
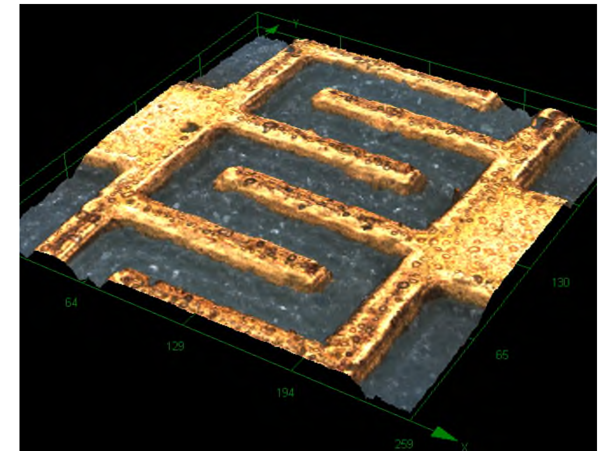
Application – Filter for 5G











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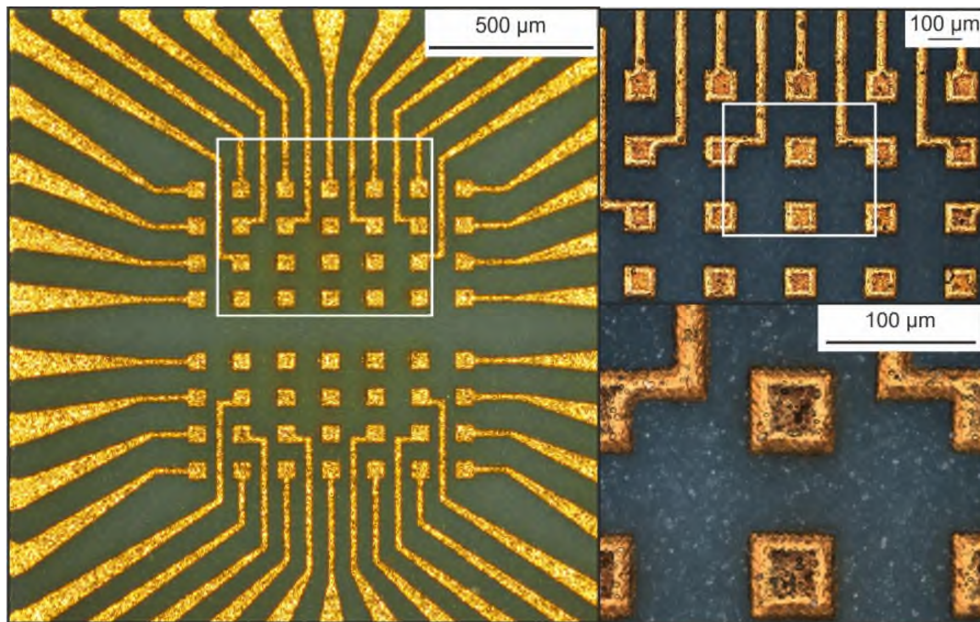
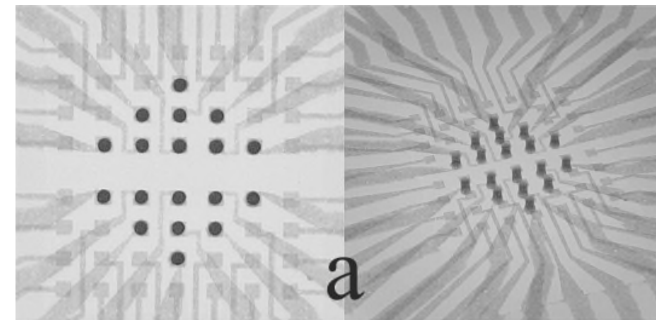
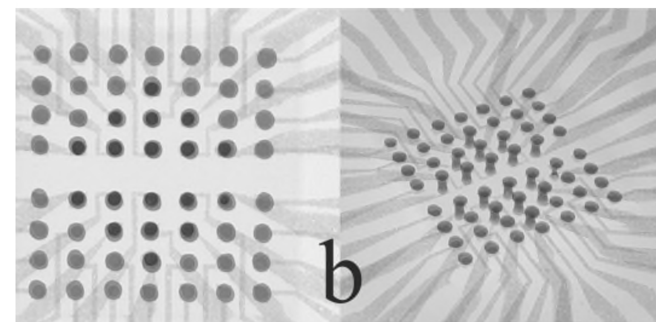
Apllication – Semiconductor assembly

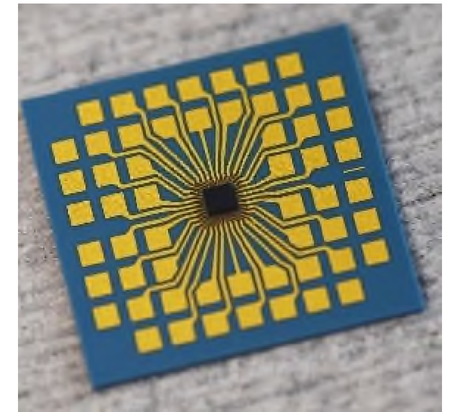
- laser ablated multilayer structures in LTCC
- Flip Chip assembly

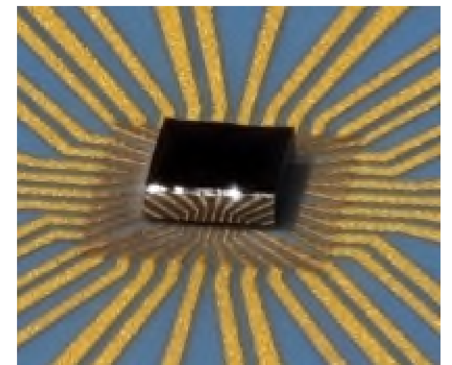






X-ray image of LTCC substrate a) without b) with assembled silicon test chip





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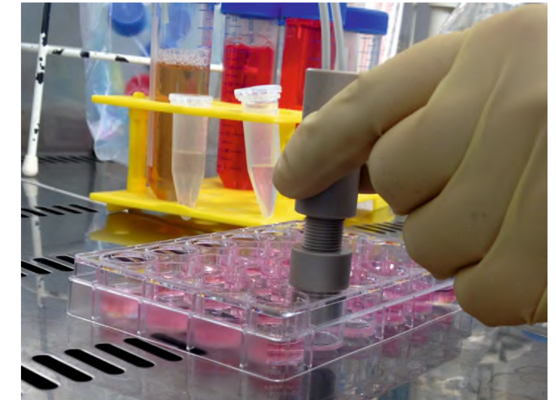
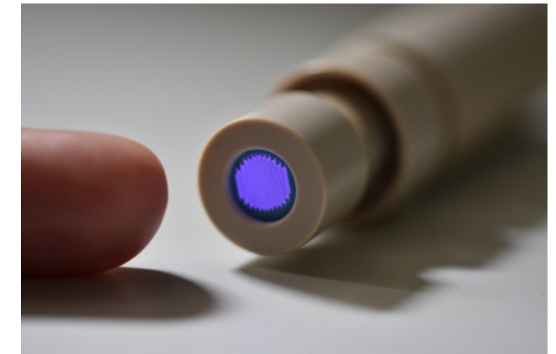
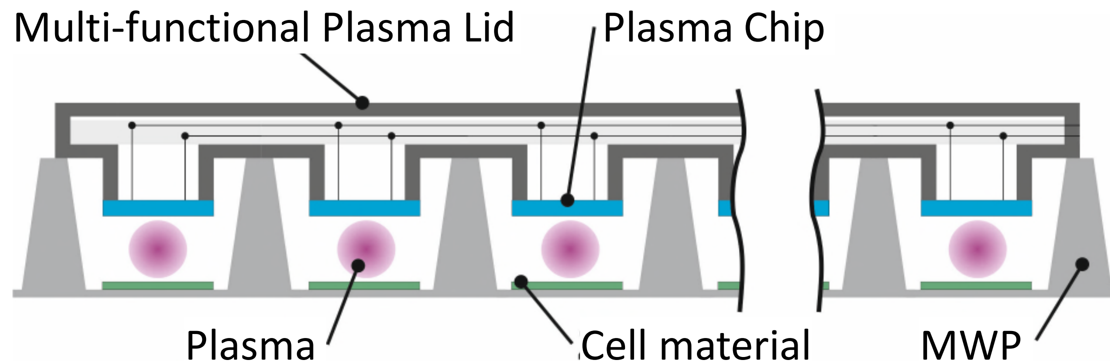
Plasma lid for disinfection of cell cultures

- Plasma lid for multi well plates
- mild physical disinfection
- patented







Final Trip Class 2020

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eCeramix GmbH

Dipl.-Ing. Nam Gutzeit

Ehrenbergstraße 11

98693 Ilmenau

Tel.: 03677 799 64000

E-Mail: info@eCeramix.de

Web: www.eCeramix.de