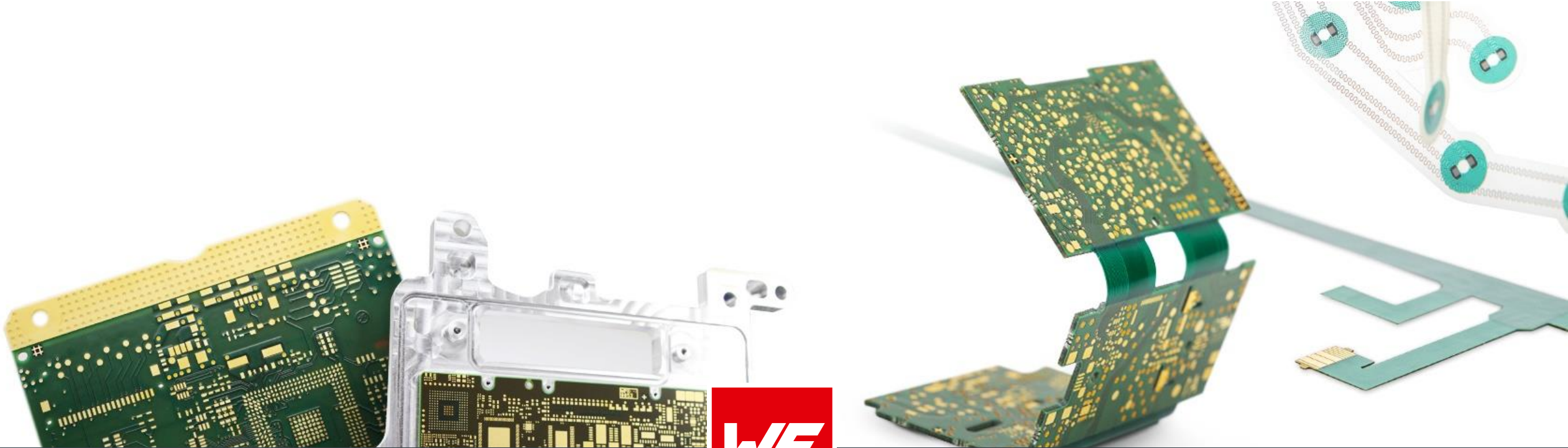




MINI, MICRO, MICROVIA: HDI PCB SAMPLE WE.MICROBGA!

Andreas Dreher, Field Application Engineer

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

YOUR SPEAKER

Andreas Dreher

Technical Project Management

- HDI-Design
- Signal Integrität & High Speed

Since 2003 at Würth Elektronik CBT

How to reach me :

Phone +49 7622 397-133

Mail andreas.dreher@we-online.com



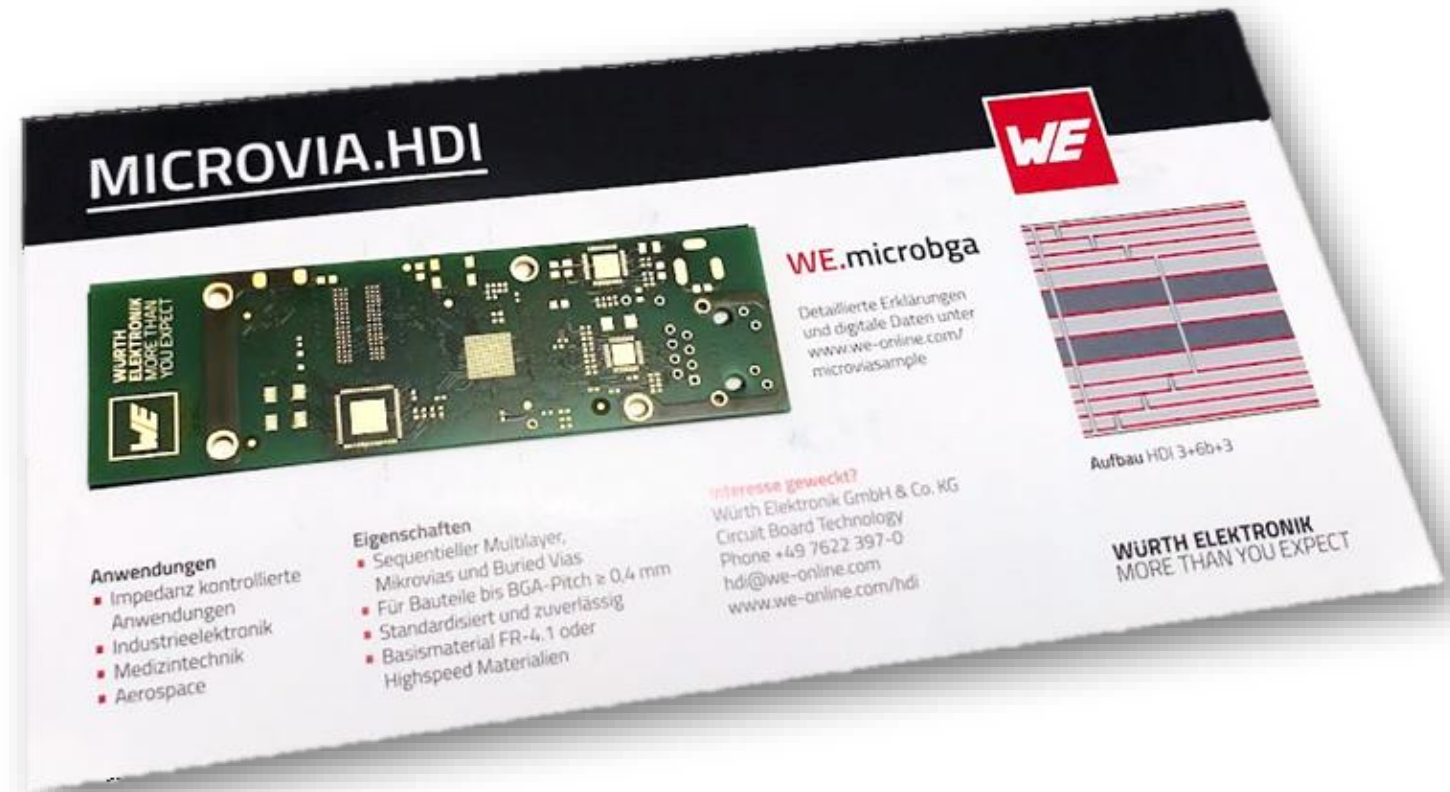
Andreas Dreher

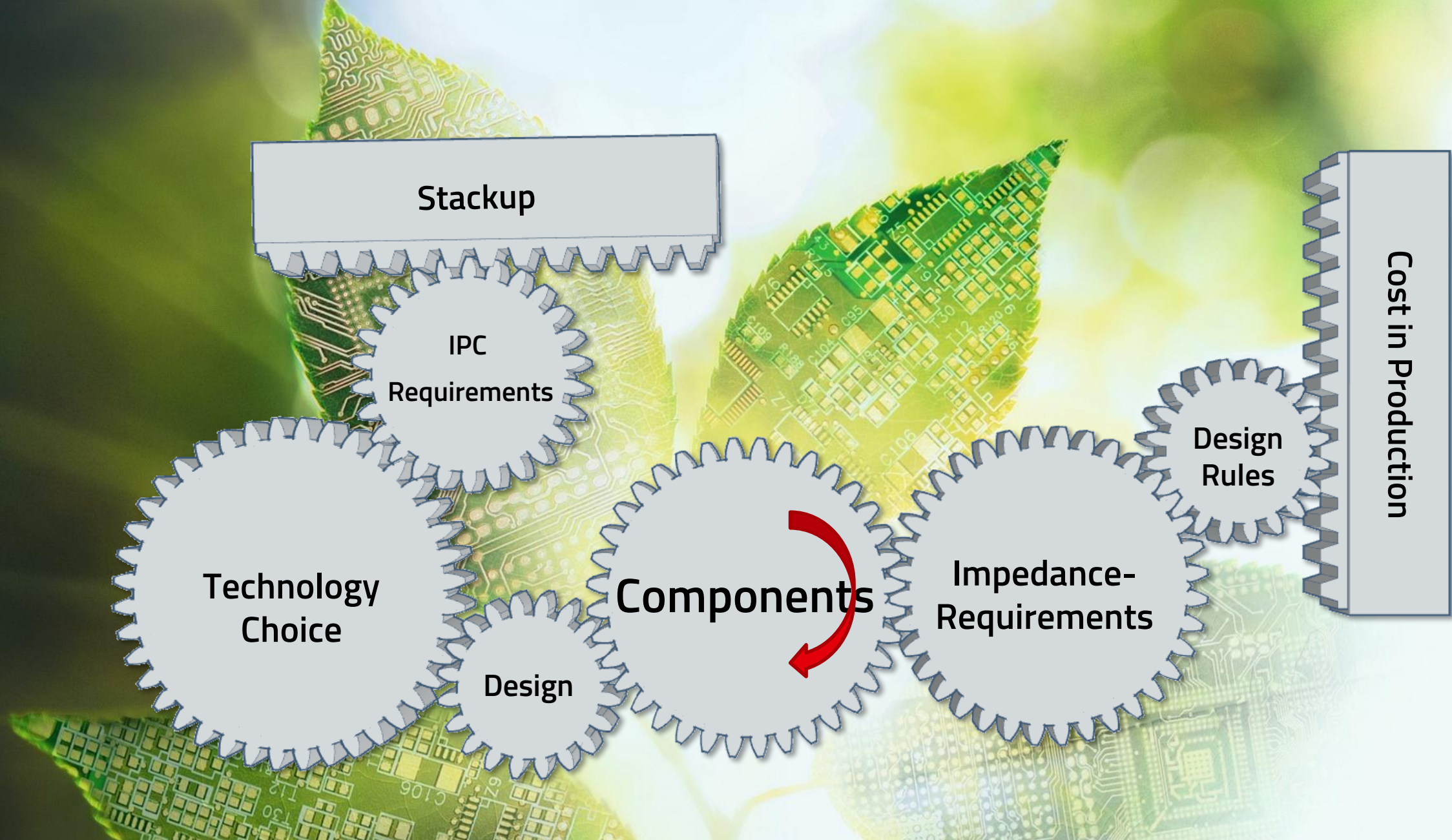
Technical Project Management



AGENDA

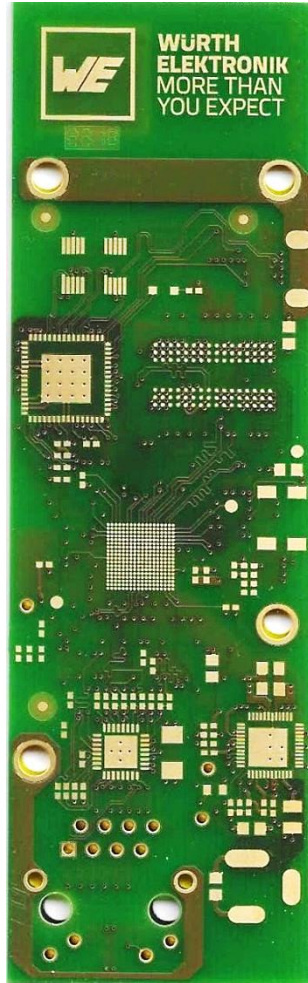
- Introduction to the Sample
- Routing BGA
- Background in the Production
- Impedance Calculation





INTRODUCTION TO THE SAMPLE

WE.microbga



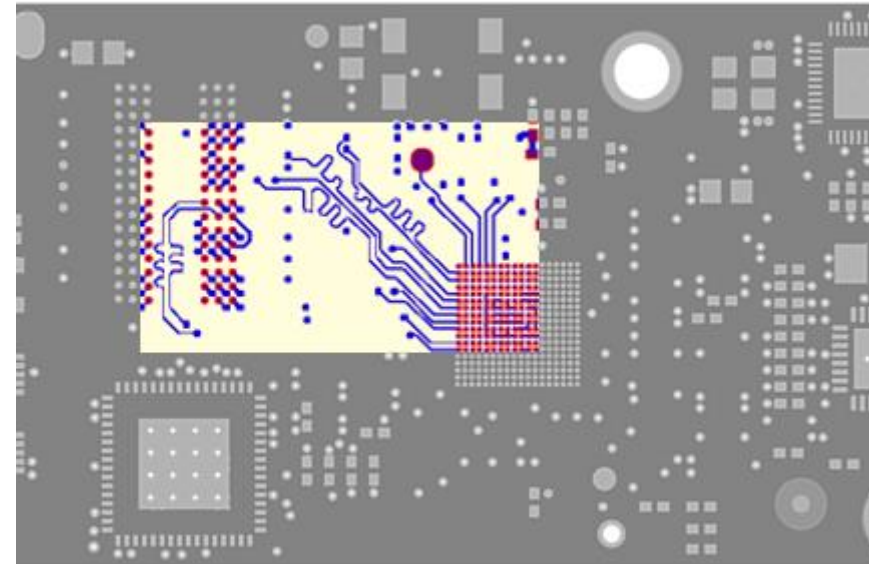
Power Line

Memory Chip

QFP Components

BGA
Pitch 0,40 mm

Serial Interface
with THT Via

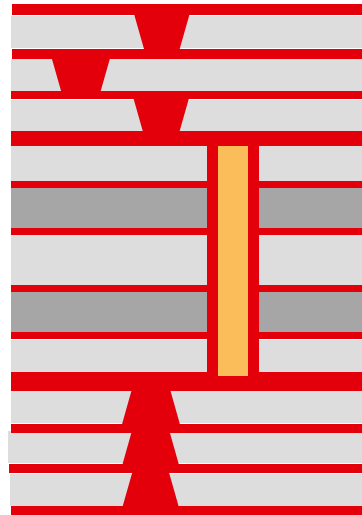
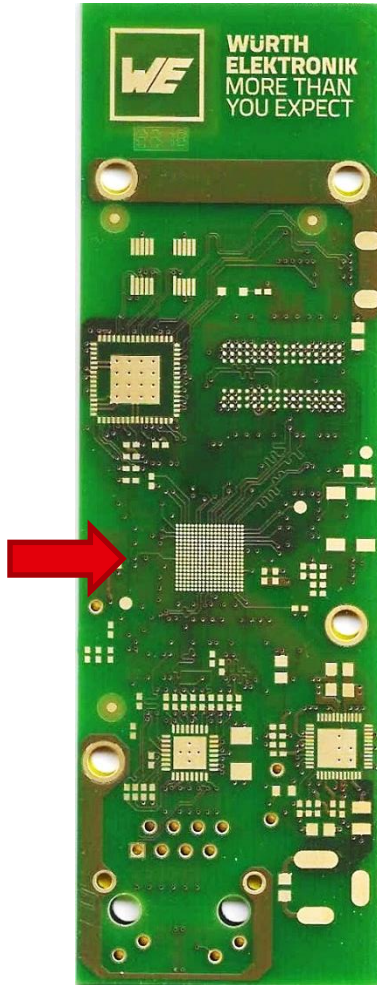


Specified impedances with project-specific stackup,
length compensation for runtime matching

ROUTING IN BGA

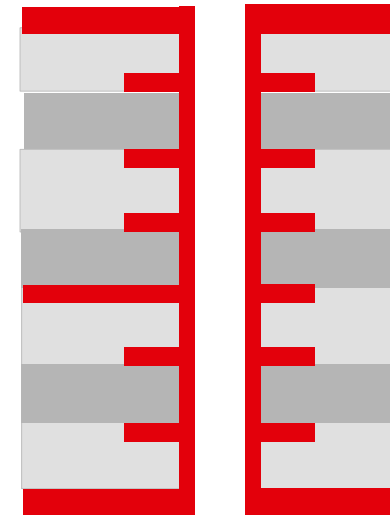
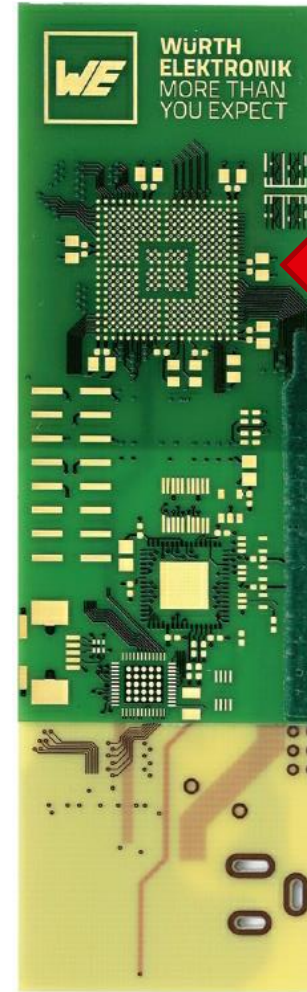
WE.microbga

BGA
Pitch 0,40 mm



WE.fan

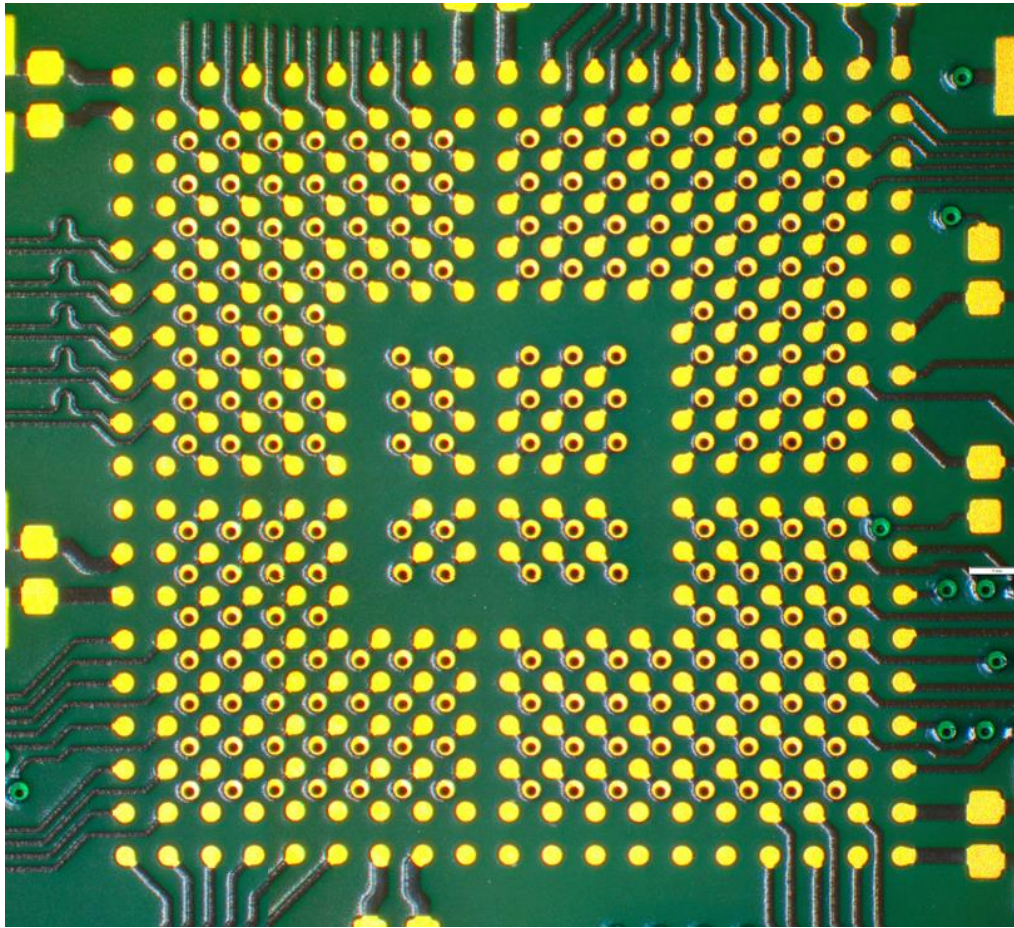
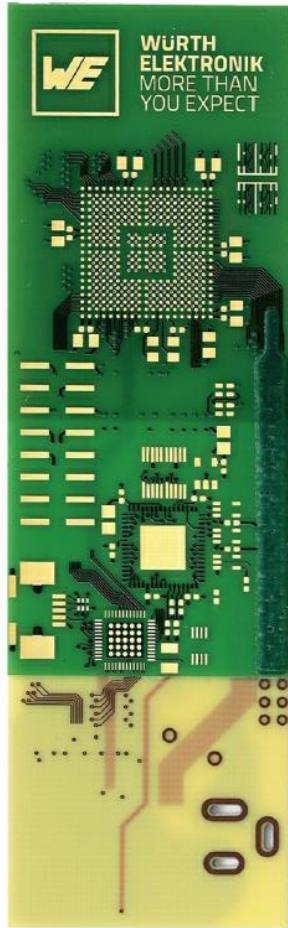
BGA
Pitch 0,80 mm



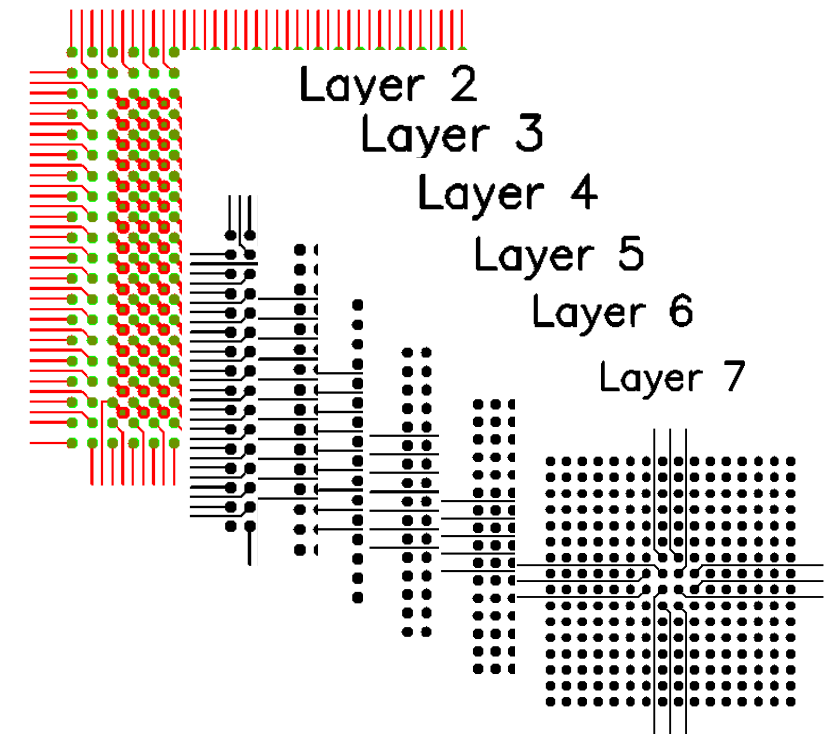
ROUTING IN BGA

WE.fan

BGA 0,80 mm



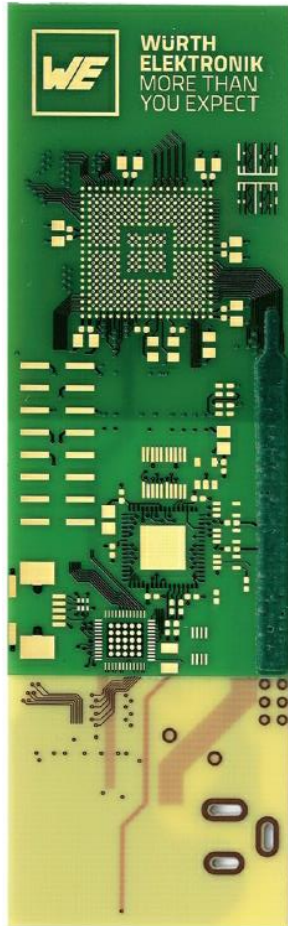
- 20 x 20 rows PTH – plated trough hole



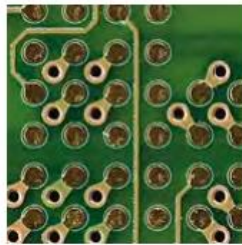
ROUTING IN BGA

WE.fan

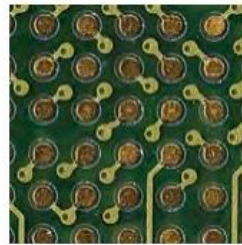
BGA 0,80 mm



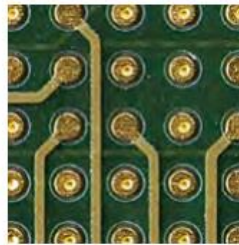
BGA 0.80 mm pitch



Var. 1: Dogbone with through-hole vias



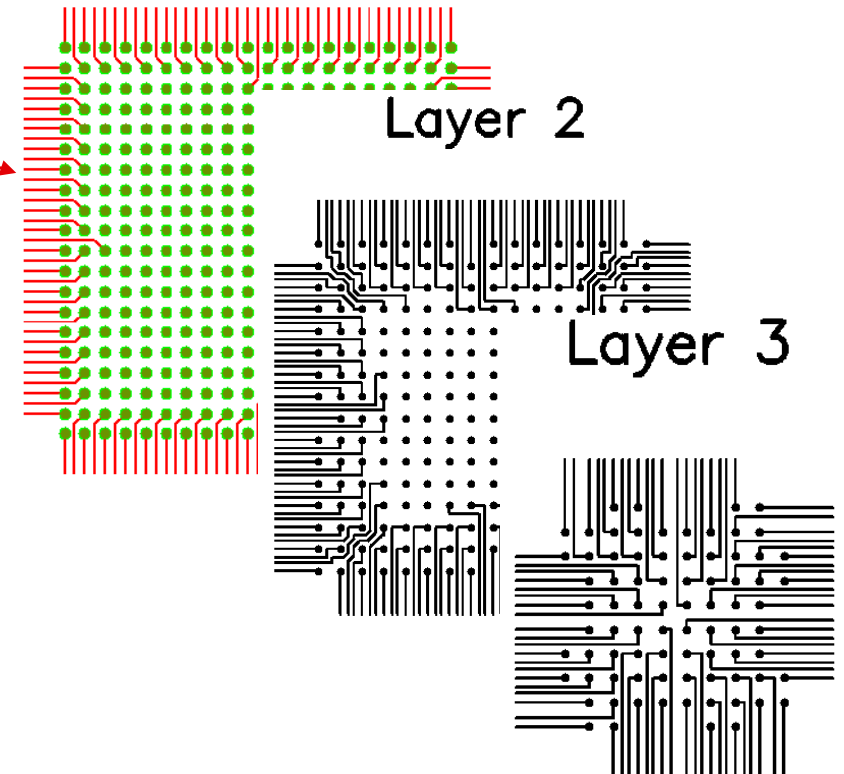
Var. 2: Dogbone with microvias



Var. 3: Microvia in pad

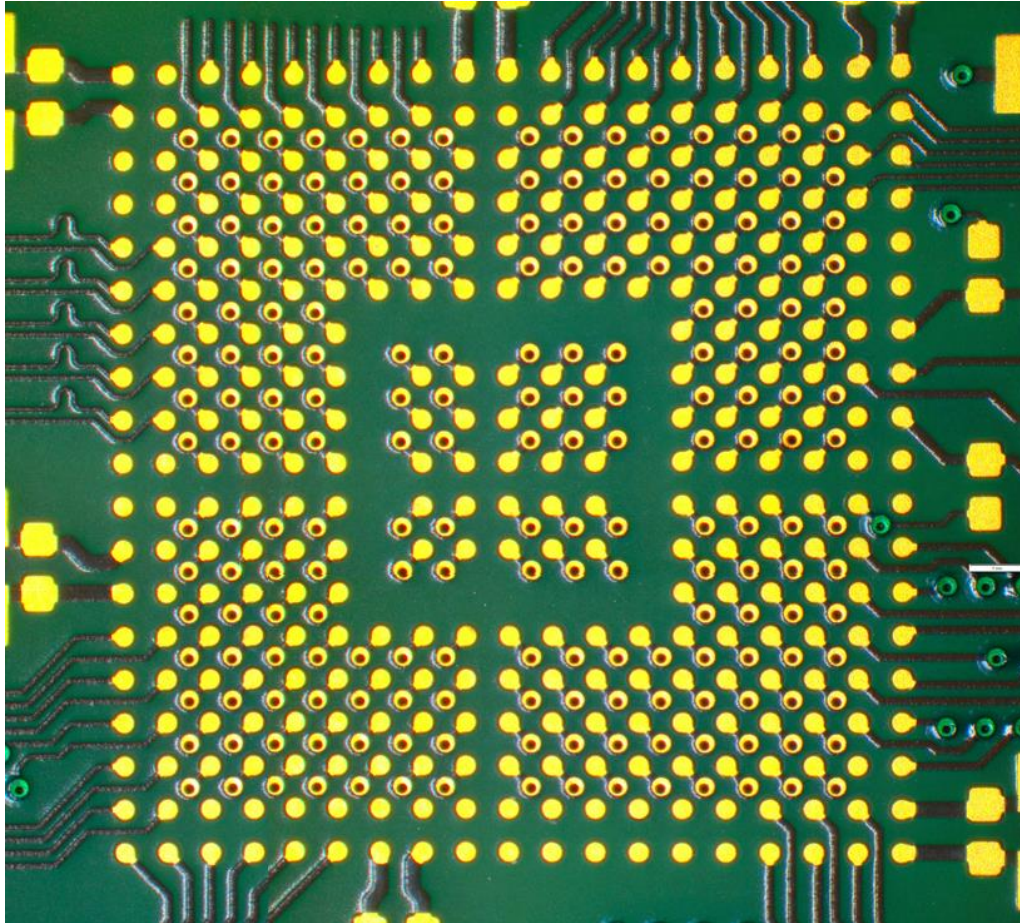
	Var. 1	Var. 2	Var. 3
BGA solder pad	max. 400 μm	—	max. 500 μm
Solder mask clearance	50 μm	$\geq 50 \mu\text{m}$	50 μm
Via pad size BGA area	500 μm	—	—
Microvia pad outer layers	—	300 / 350 μm	300 / 350 μm
Microvia pad inner layers	—	300 / 350 μm	300 / 350 μm
Track width / spacing outer layers	$\geq 100 \mu\text{m}$	$\geq 100 \mu\text{m}$	$\geq 100 \mu\text{m}$
Track width / spacing inner layers	$\geq 100 \mu\text{m}$	$\geq 100 \mu\text{m}$	$\geq 100 \mu\text{m}$

- 20 x 20 rows Micro Via

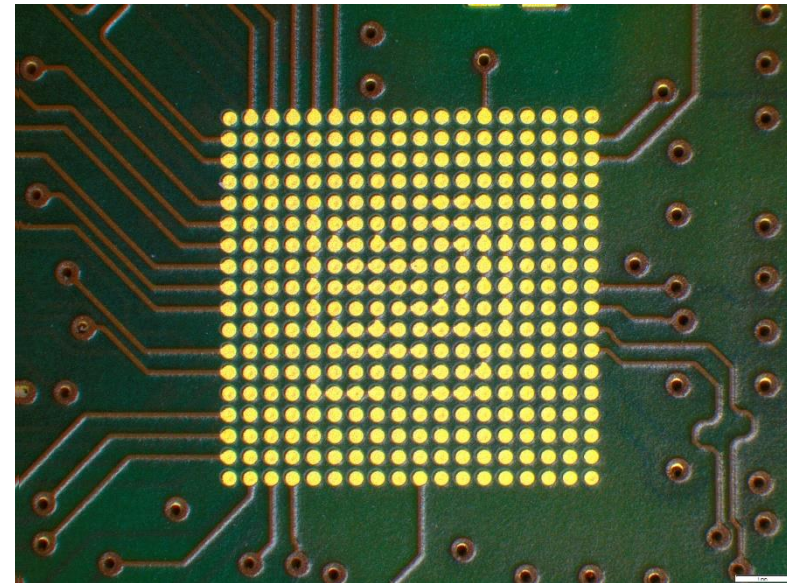


COMPARISON IN SIZE

BGA 0,80 mm 20x20 Pads



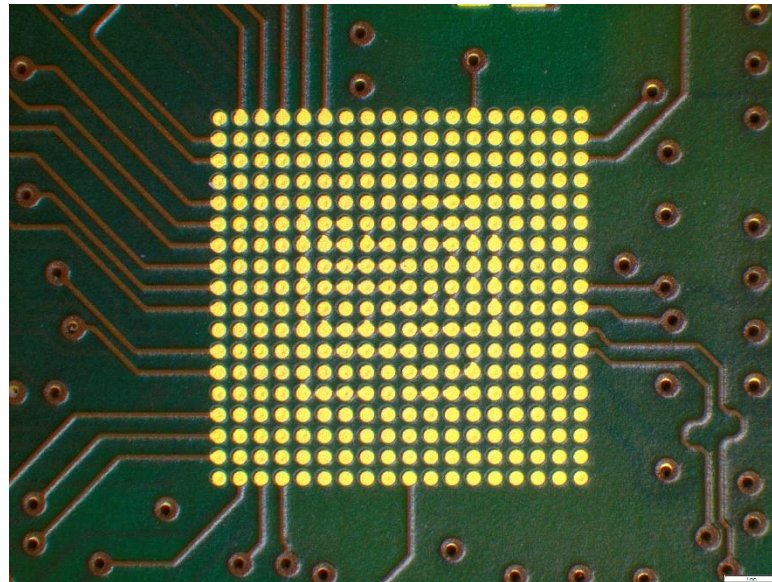
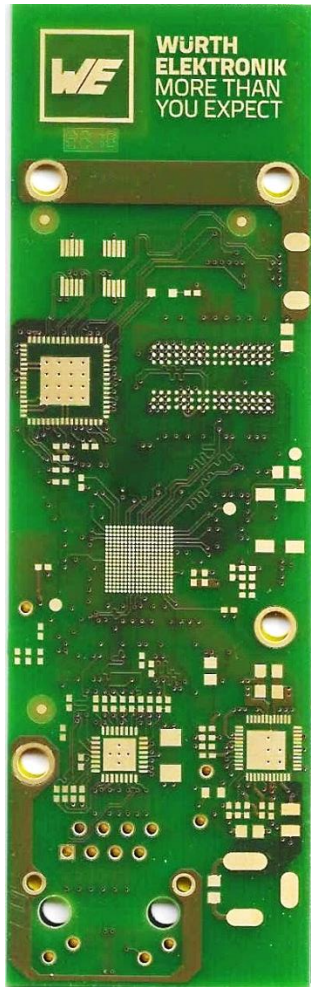
BGA 0,40 mm 20x20 Pads



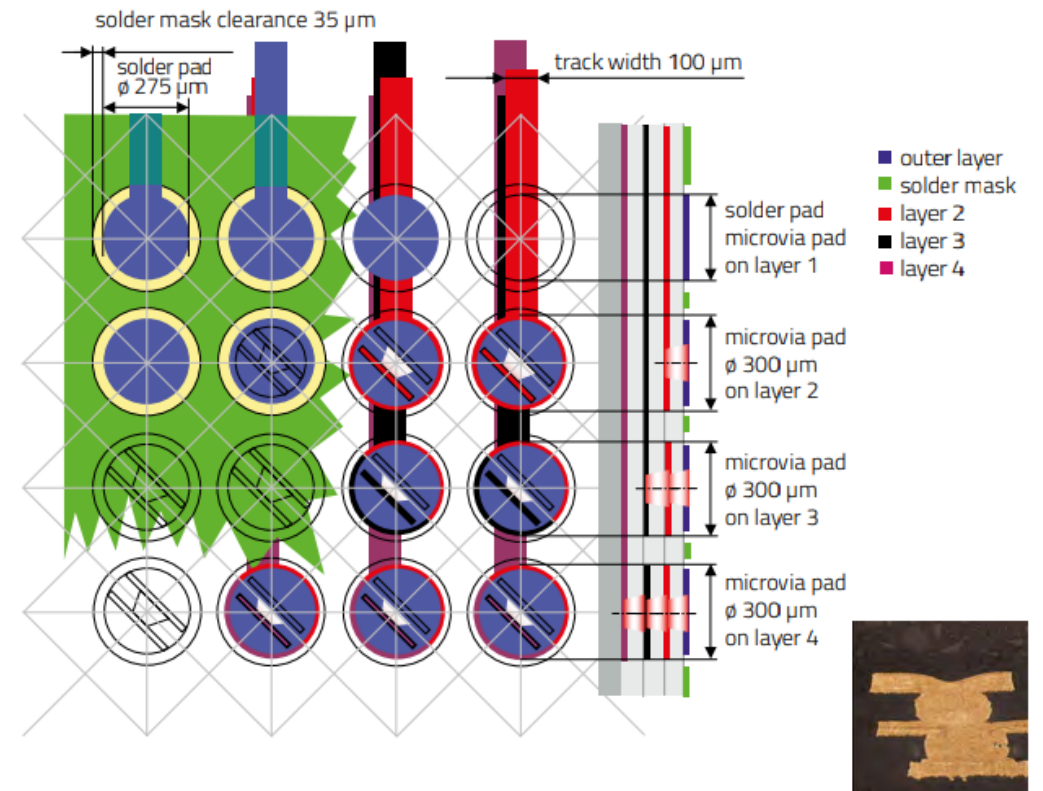
Use the benefits of Micro Via Design not only in BGA -
use it everywhere!

ROUTING BGA

WE.microbga Pitch 0,40 mm

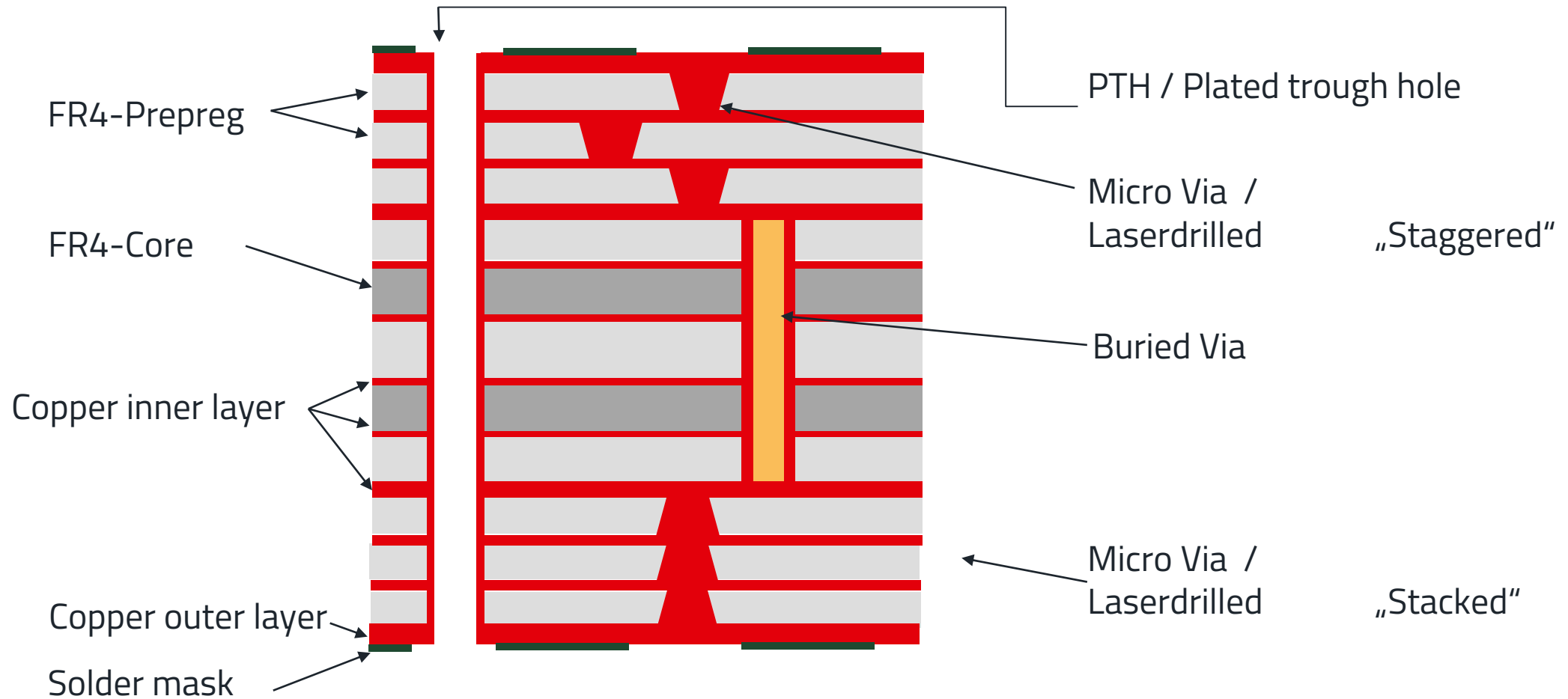


BGA 0.40 mm pitch



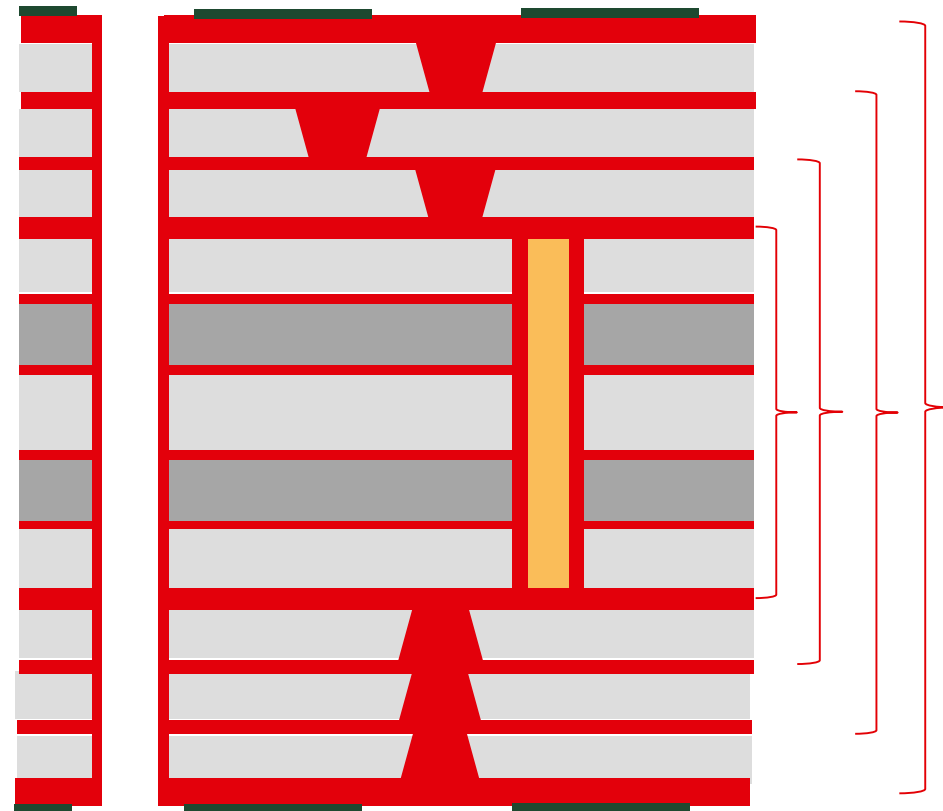
OVERVIEW STACKUP

HDI12 3-6b-3



CONSTRUCTION OF A HDI PCB

HDI12 3-6b-3



6x Galvanic Processes

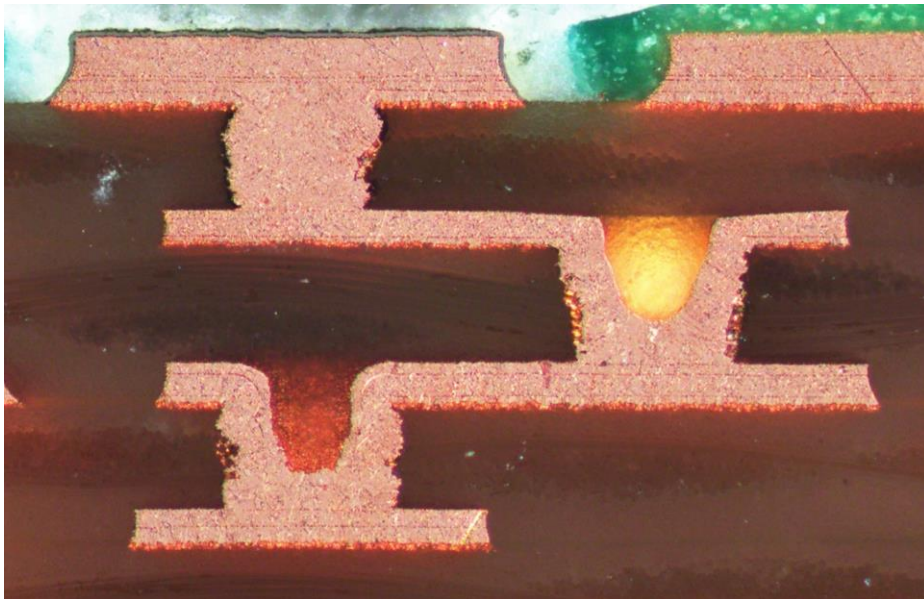
5x Photo Processes

4x Press cycles

DESIGN MICRO VIA

Technology Choice

„Staggered“ Micro Via

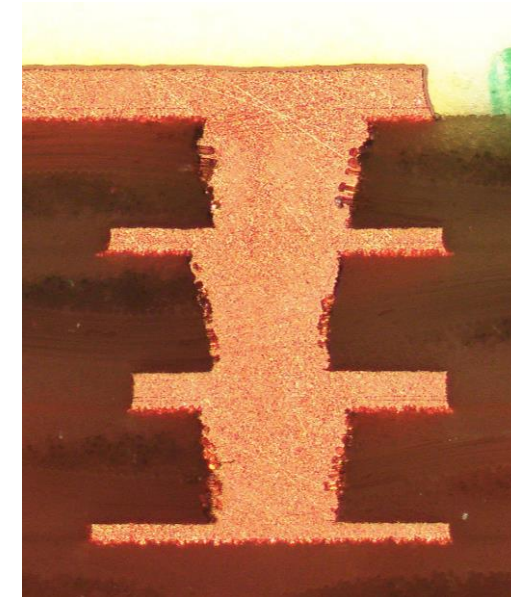


Copper filled

Filling Resin filled

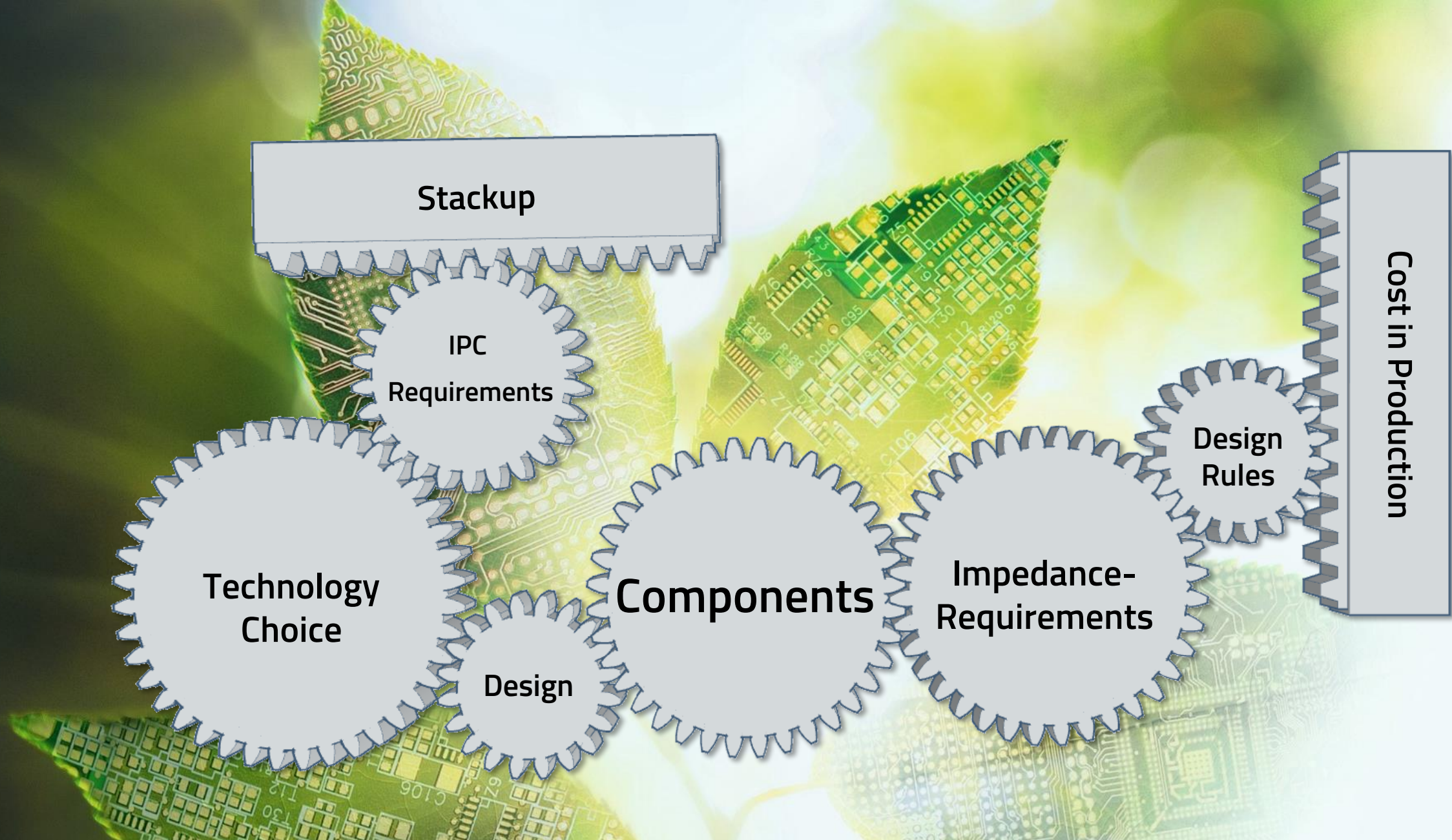
Prepreg Resin filled

„Stacked“ Micro Via

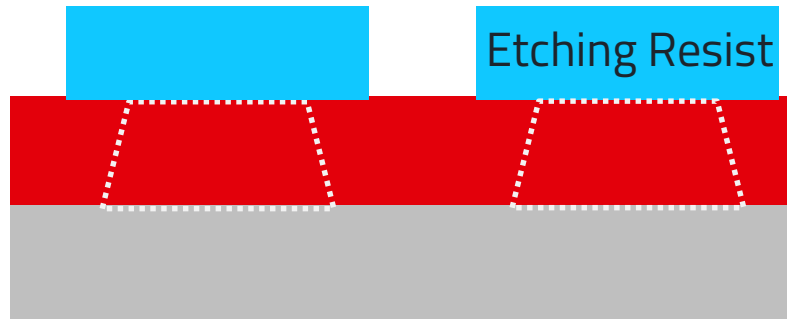


Early discussion between Project Partners results in Potential multiplication

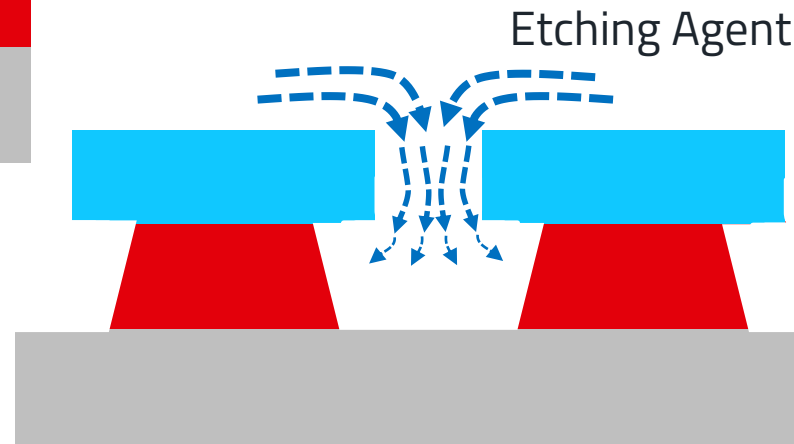
„the whole thing is more than the sum of its parts“ Aristoteles



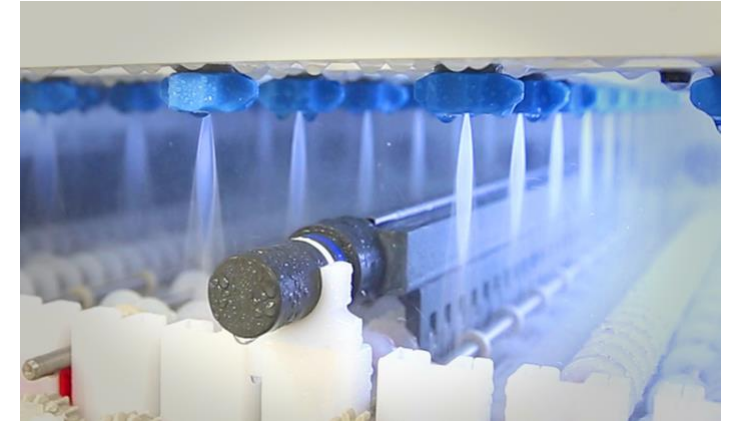
BASICS: PRODUCTION OF A PCB – INNER LAYERS



Lamination of Resist & Develop

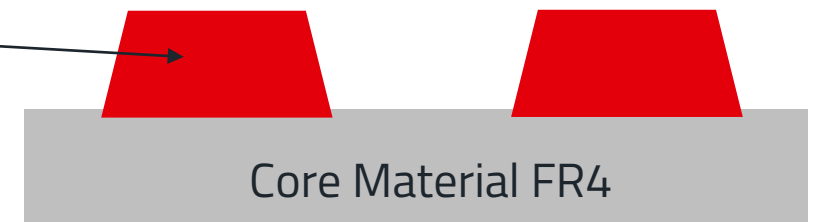


Etching



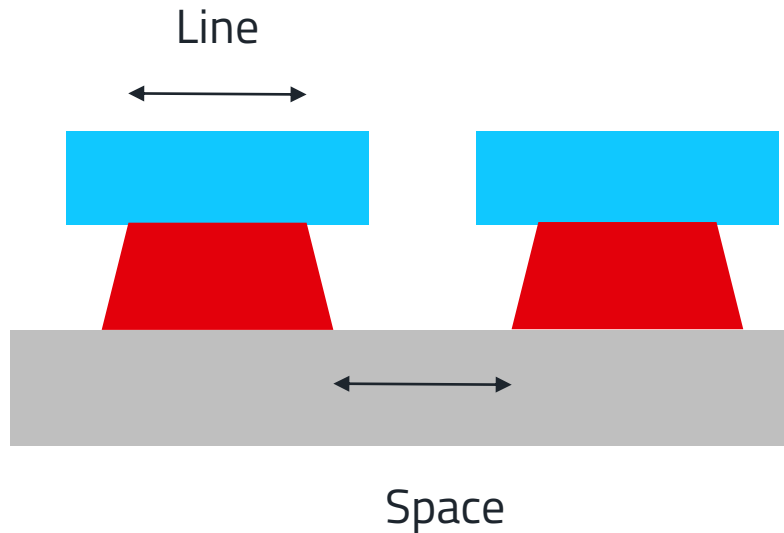
Quelle schmid-group.com

Track



Stripping

CORRELATION BETWEEN COPPER THICKNESS AND LINE WIDTH



Outer layers – conductor spacing						
Starting foil thickness	Minimum copper thickness ¹		Nominal final thickness	Minimum conductor spacing Standard	Minimum conductor spacing Advanced	Minimum possible line width
	IPC-class 1, 2	IPC-class 3				
8,5 µm [1/4 oz.] ²	26,2 µm	31,2 µm		100 µm	75 µm	60 µm ³
12 µm [3/8 oz.] ²	29,3 µm	34,3 µm		100 µm	80 µm	60 µm ³
17,1 µm [1/2 oz.]	33,4 µm	38,4 µm	35 µm	120 µm	100 µm	60 µm ³
34,3 µm [1 oz.]	47,9 µm	52,9 µm	70 µm	180 µm	160 µm	120 µm
68,6 µm [2 oz.]	78,7 µm	83,7 µm	105 µm	275 µm	225 µm	125 µm
102,9 µm [3 oz.]	108,6 µm	113,6 µm		390 µm	320 µm	150 µm
1) IPC-6012E-EN Table 3-15: External Conductor Thickness after Plating						
2) Extra cost: No standard copper foil						
3) Outer layers: only possible with uniform circuit layout						
Inner layers - conductor spacing						
Starting foil thickness	Minimum copper thickness ⁴			Minimum conductor spacing Standard	Minimum conductor spacing Advanced	Minimum possible line width
	IPC-class 1, 2, 3					
17,1 µm [1/2 oz.]	11,4 µm			100 µm	75 µm	60 µm ³
34,3 µm [1 oz.]	24,9 µm			120 µm	100 µm	60 µm ³
68,6 µm [2 oz.]	55,7 µm			180 µm	150 µm	125 µm
102,9 µm [3 oz.]	86,6 µm			250 µm	225 µm	175 µm
4) IPC-6012E-EN Table 3-14: Internal Layer Foil Thickness after Processing						

LINE/SPACE DEPENDENCY - PRACTICAL EXAMPLE



In narrow spaces: small conductor spacing

Rest of the layout: generous spacing

New data formats: Use attributes

Asymmetric layout definition

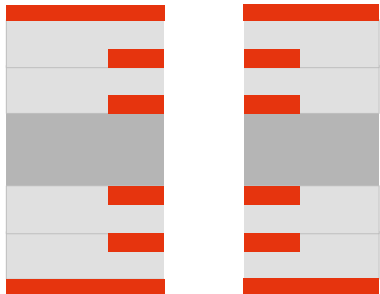
Line/Space

Not 100 μm / 100 μm

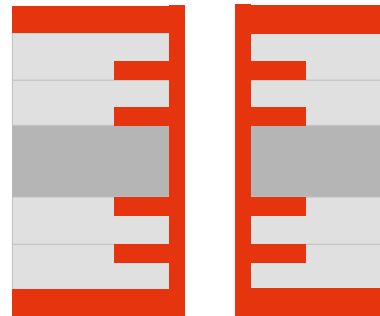
but 80 μm / 120 μm

FILLED VIA - PRODUCTION PROCESS

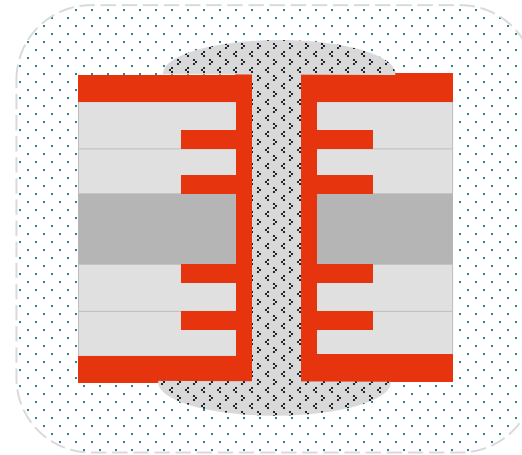
Drilling



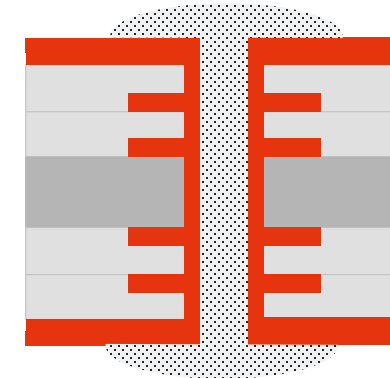
Metallization



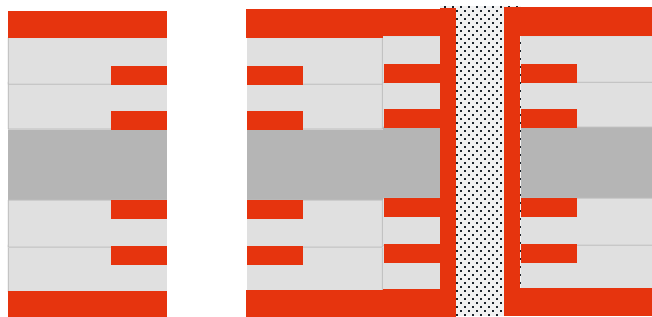
Vakuum Filling



Curing

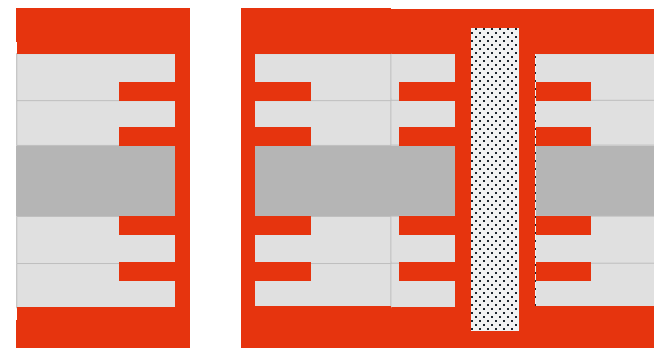


Sanding



Type V Filled Via

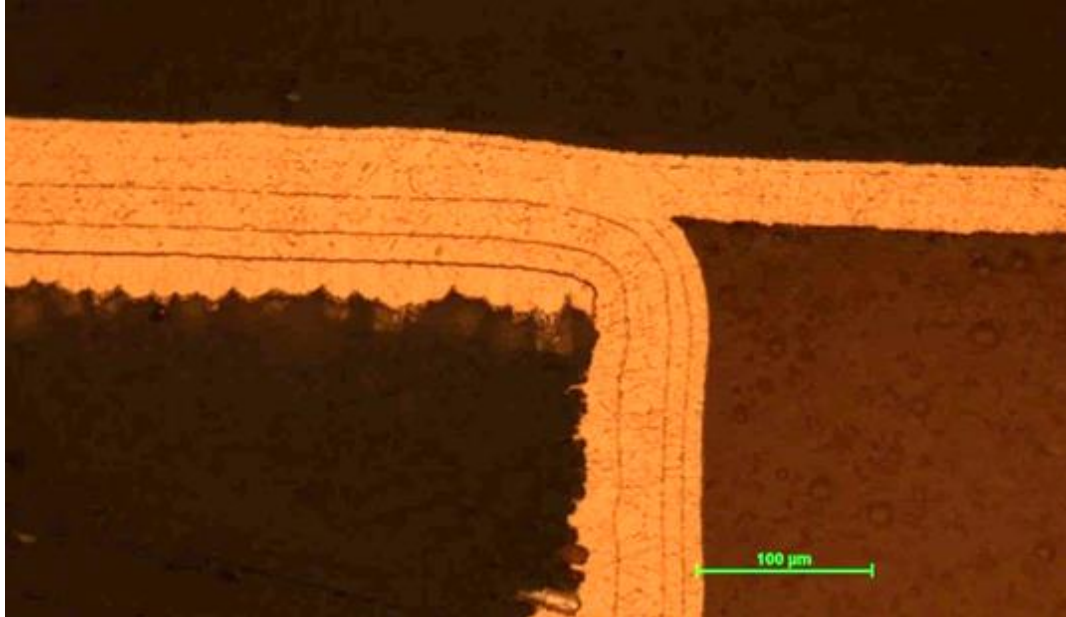
Cap metalization



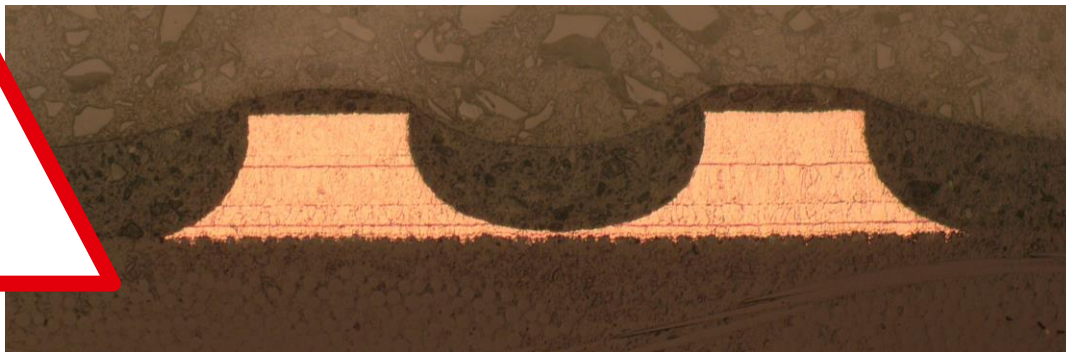
Type VII Filled Via

FILLED VIA – TECHNOLOGY COMBINATION

Limitations with fine line structures



Due to repeated electroplating, the copper rises on the surface. This means that compromises in the structure sizes are sometimes necessary.

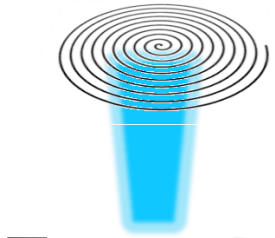


Typical design parameters depending on the Cu thickness

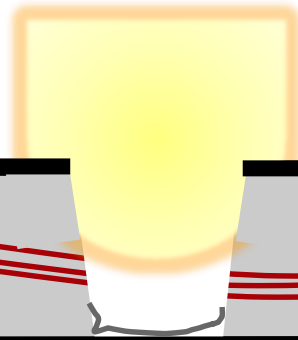
Copper-Thickness	Line width	Space
~ 30 µm	75 µm	100 µm
~ 40 µm	100 µm	120 µm
~ 50 µm	120 µm	180 µm

CREATING A MICRO VIA

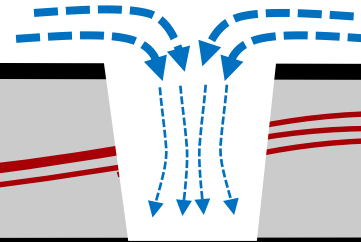
1. Step
removing Copper



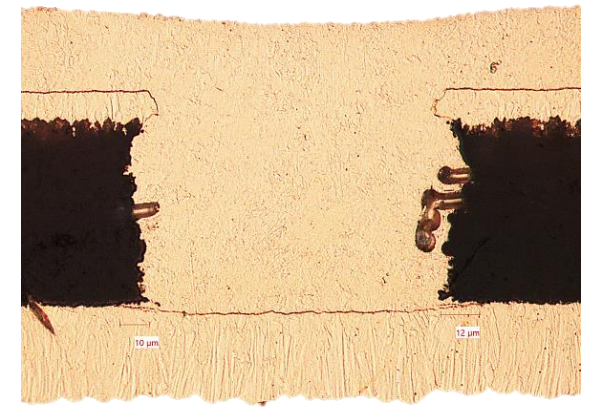
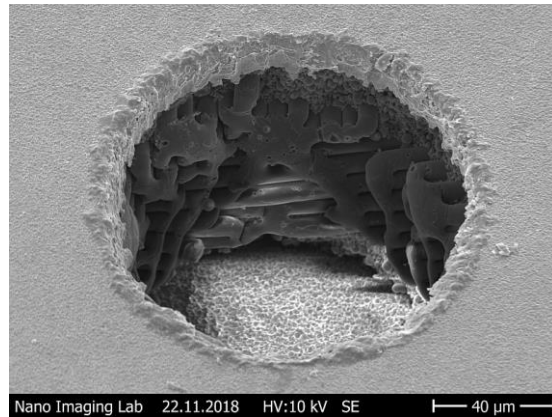
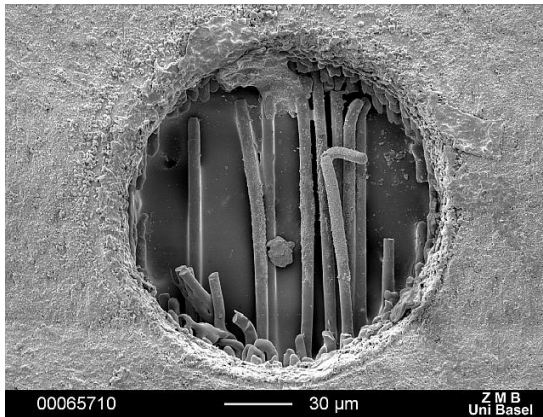
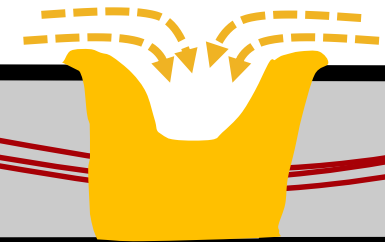
2. Step
Removing Resin



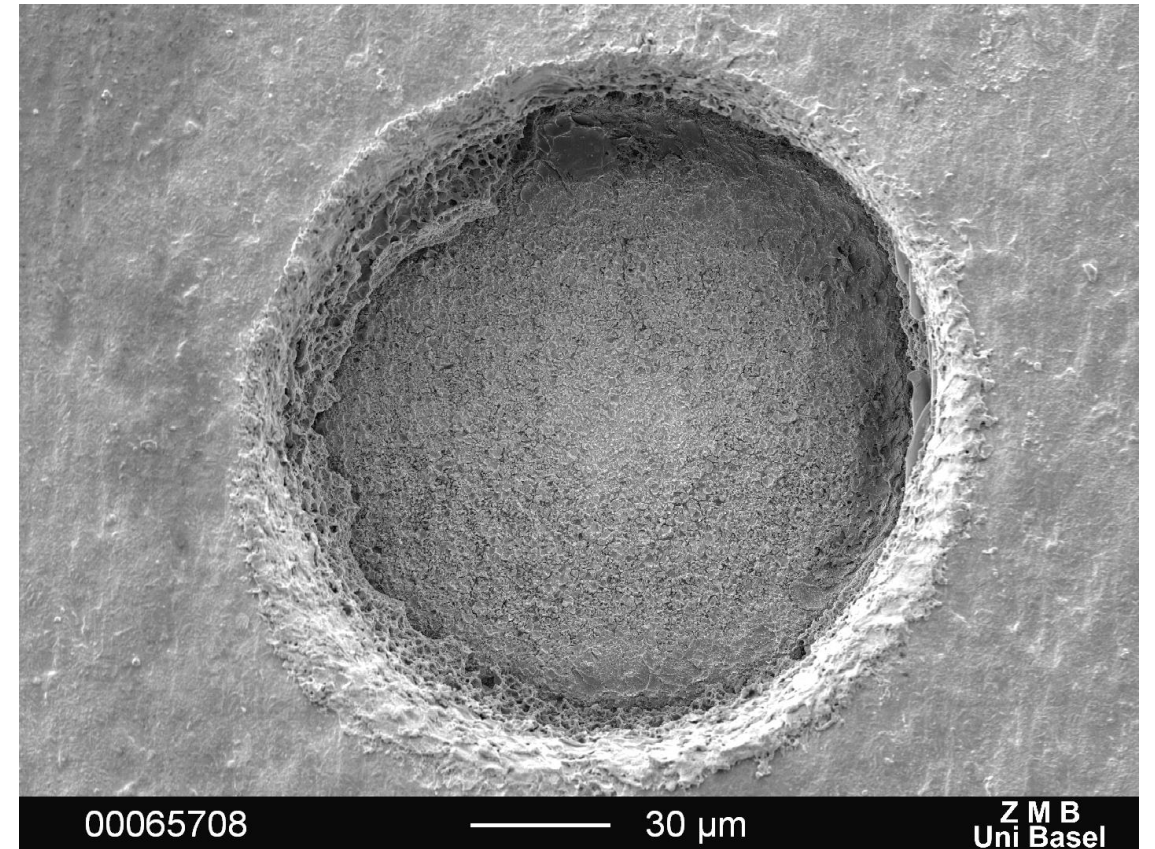
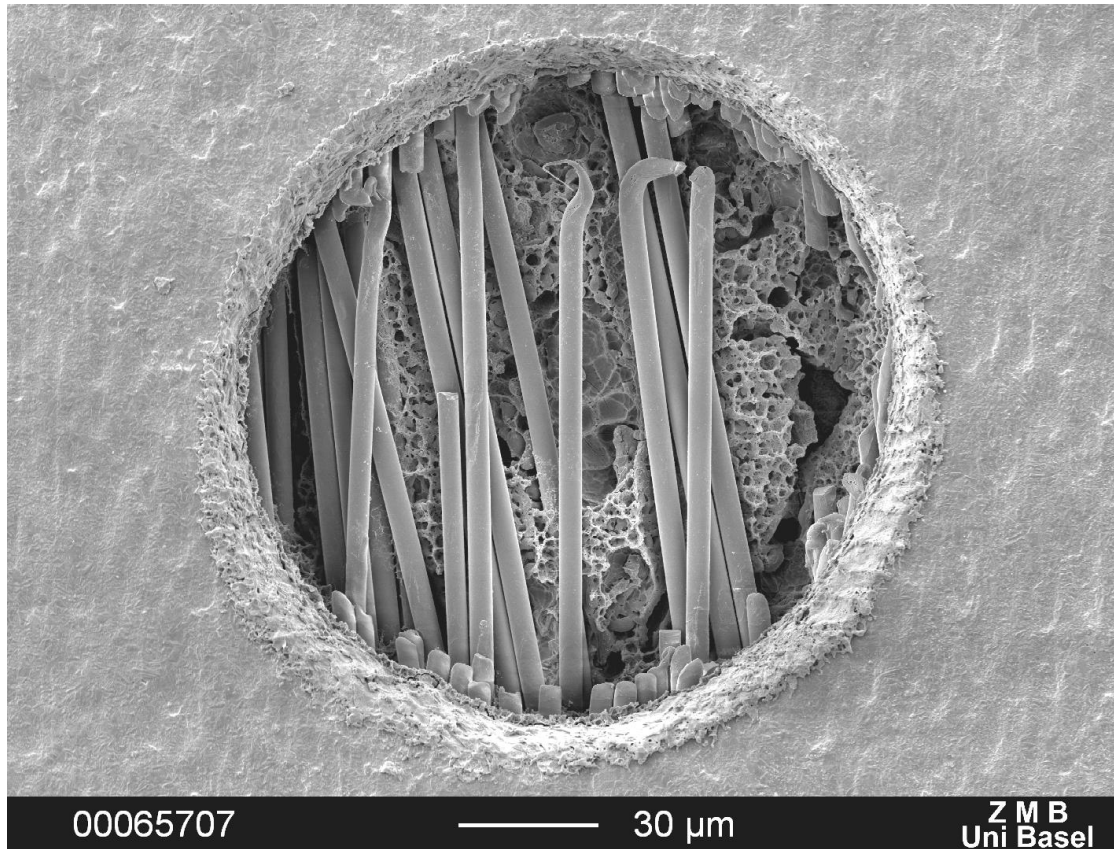
3. Step
Desmear



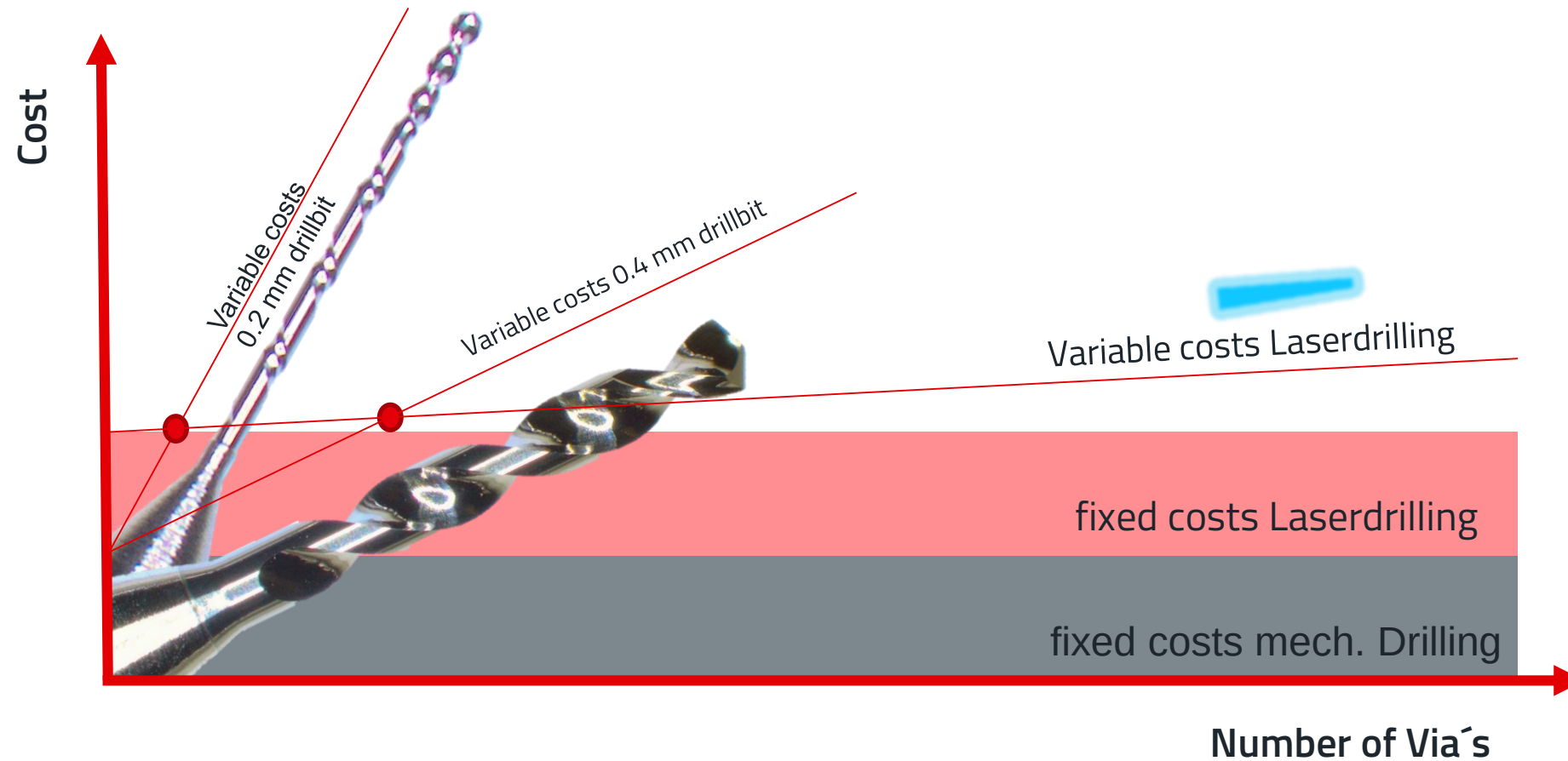
4. Step
galvanic plating



CREATING A MICRO VIA



VARIABLE AND FIXED COSTS IN THE PROCESS



PRODUCTION MACHINES

Laserdrilling

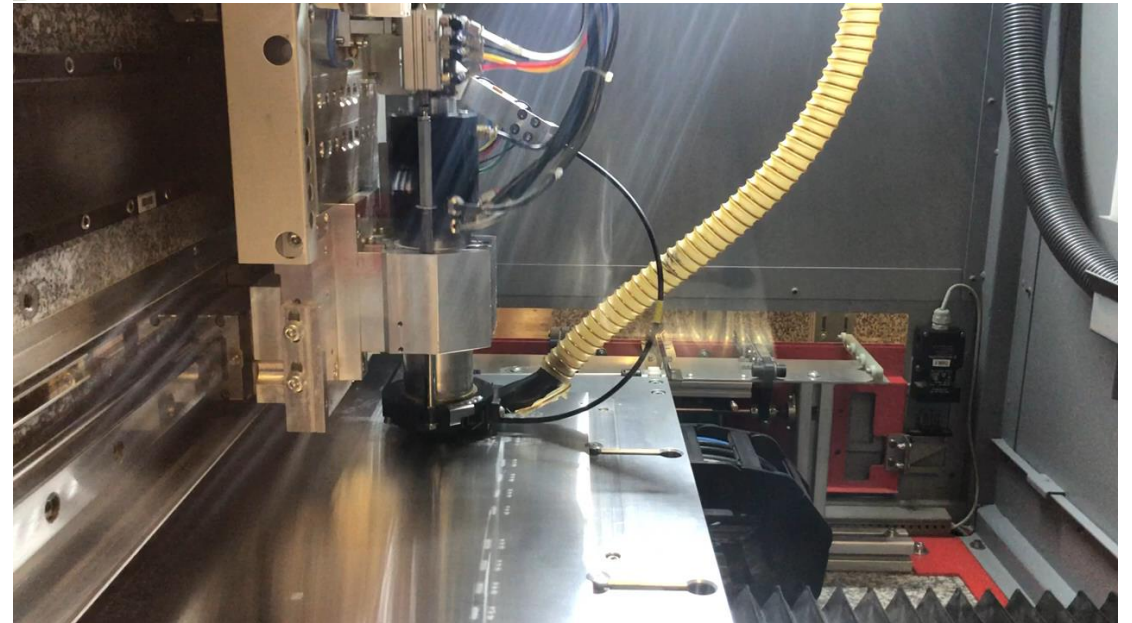


Source: Disney Store



~ 300 holes per Second

mech. Drilling

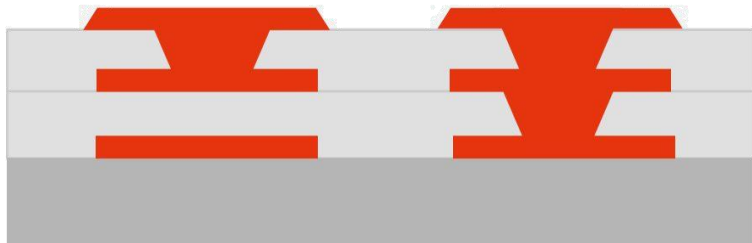


~ 2 holes per Second

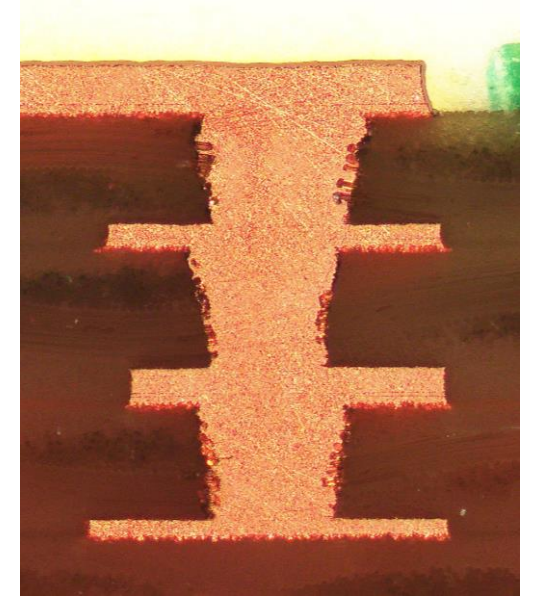
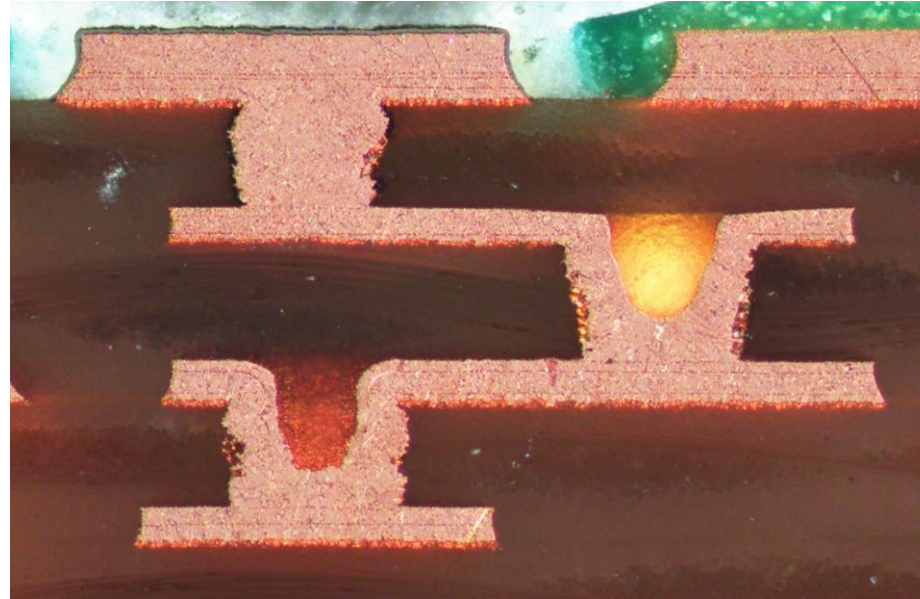
MICRO VIA FILLING



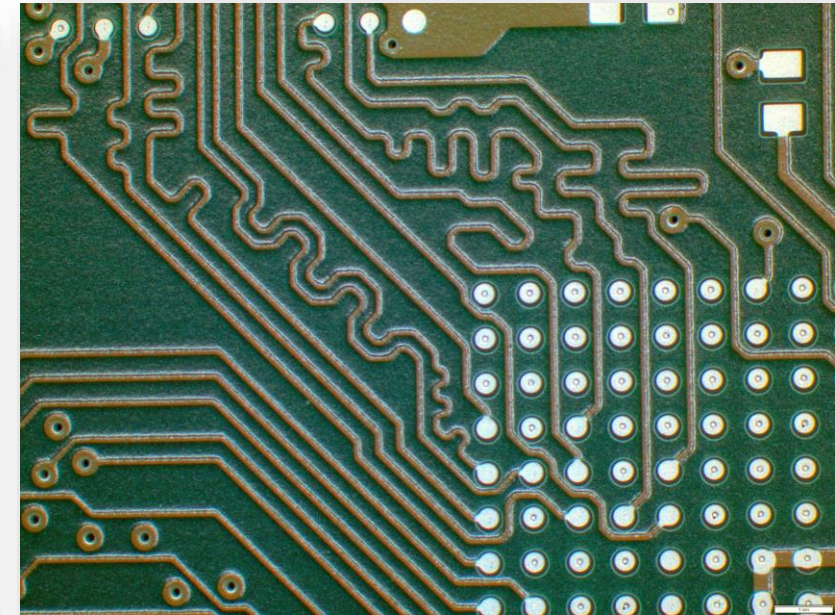
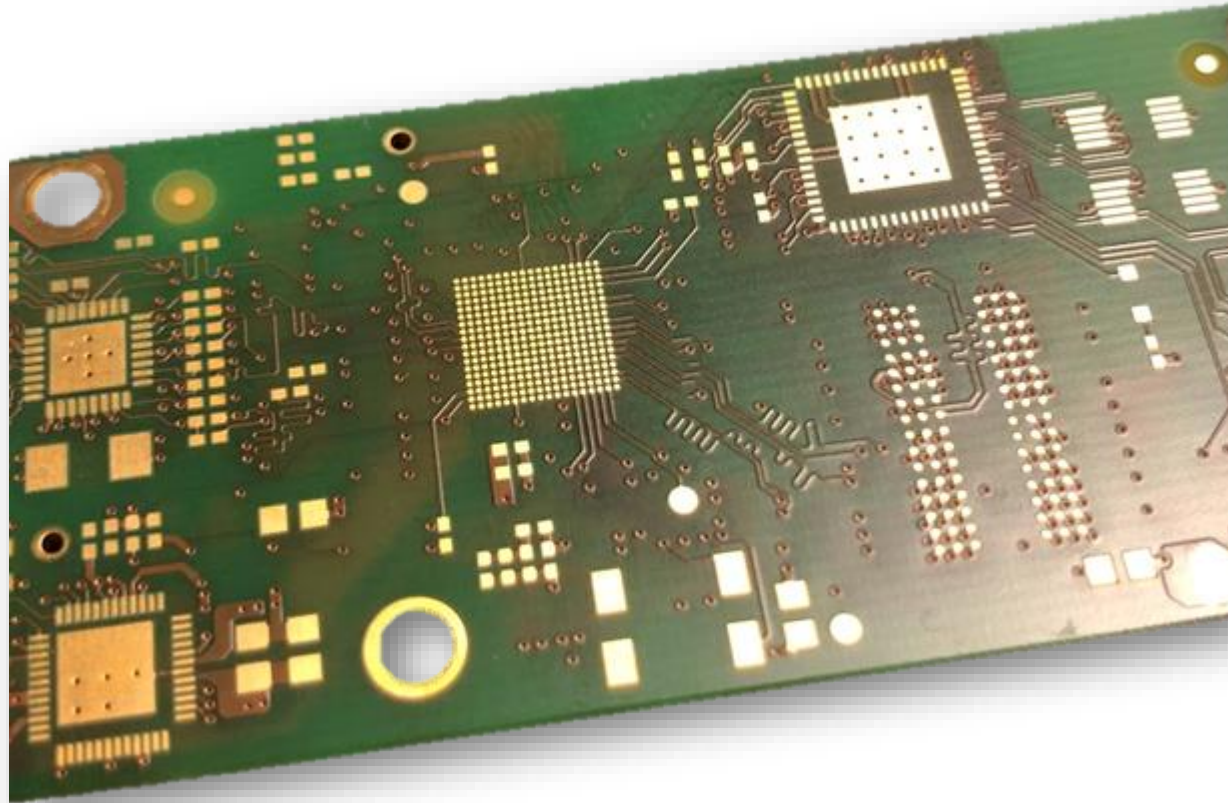
Filled Micro Via



Copper Filled Micro Via

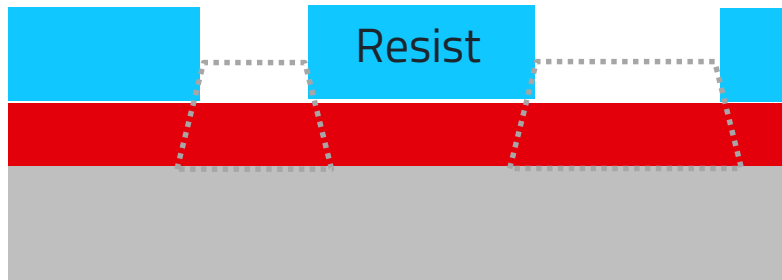


CONDUCTOR TRACKS & FINE STRUCTURES – OUTER LAYERS

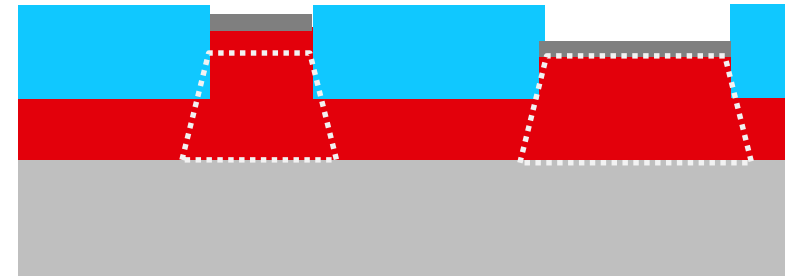


BASICS: MANUFACTURING A CONDUCTOR TRACK – OUTER LAYERS

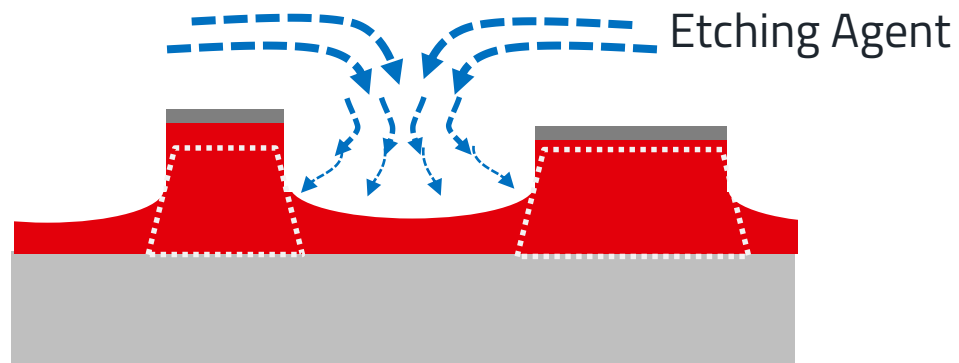
Lamination



Galvanic: selective copper plating



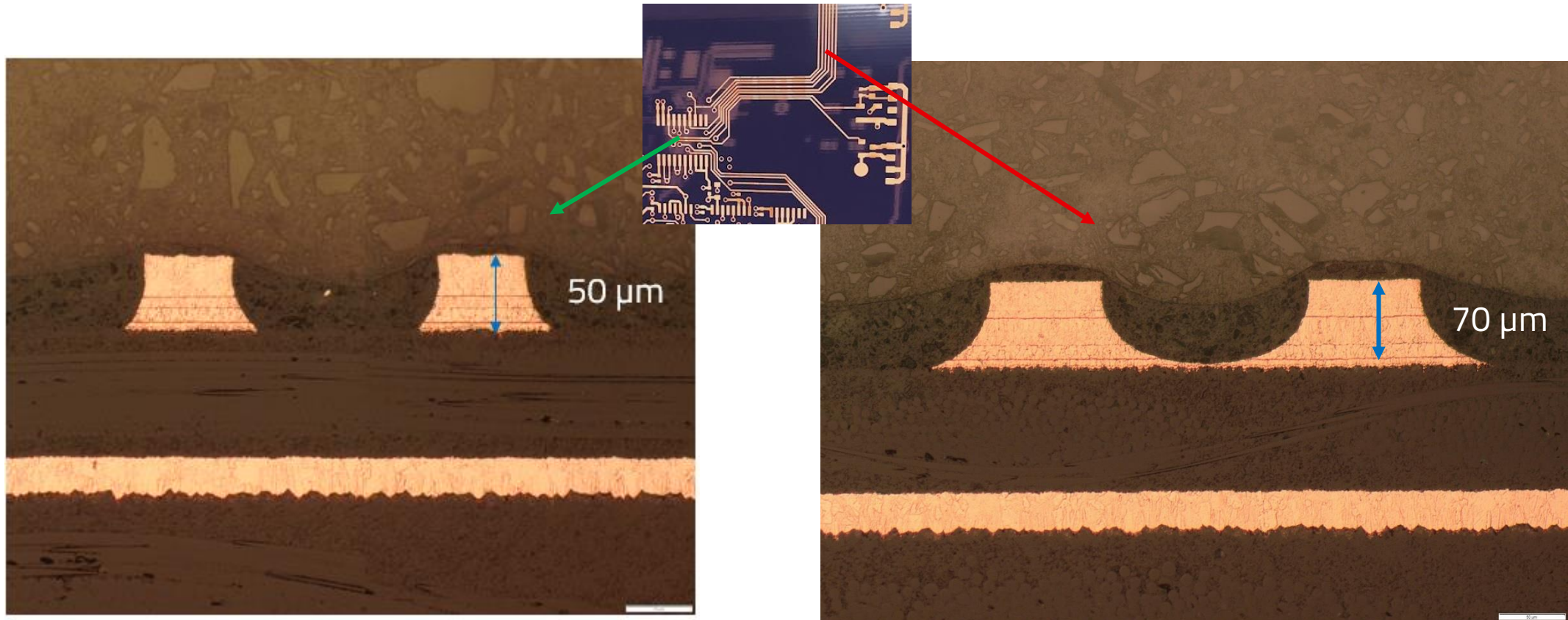
Stripping – Etching – removing Tin



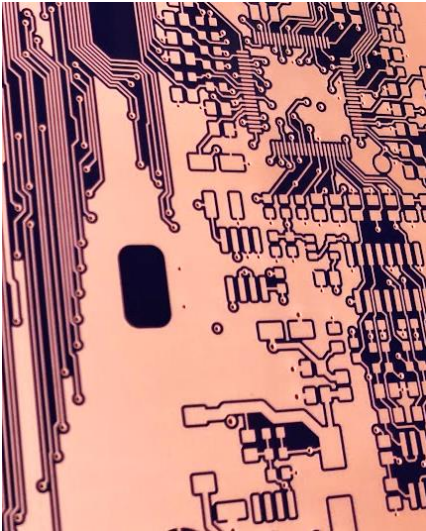
Final structures



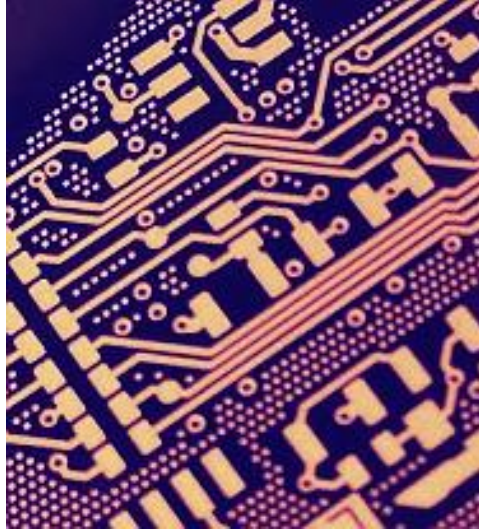
COPPER DISTRIBUTION – EFFECTS



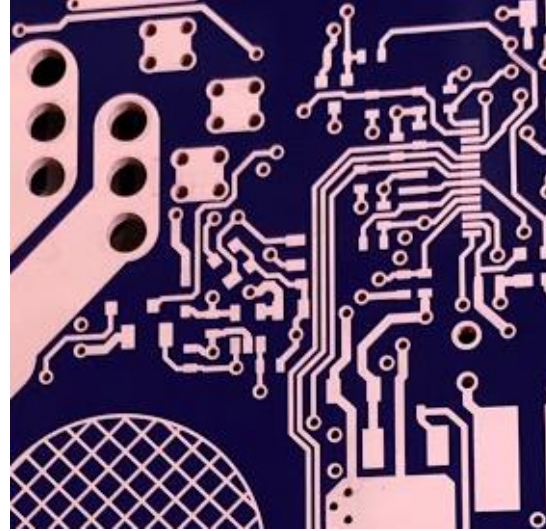
COPPER DISTRIBUTION IN THE LAYOUT



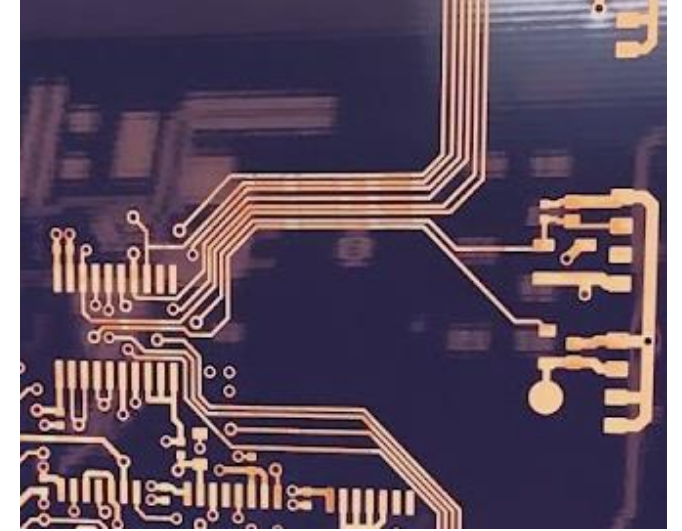
Flooded copper

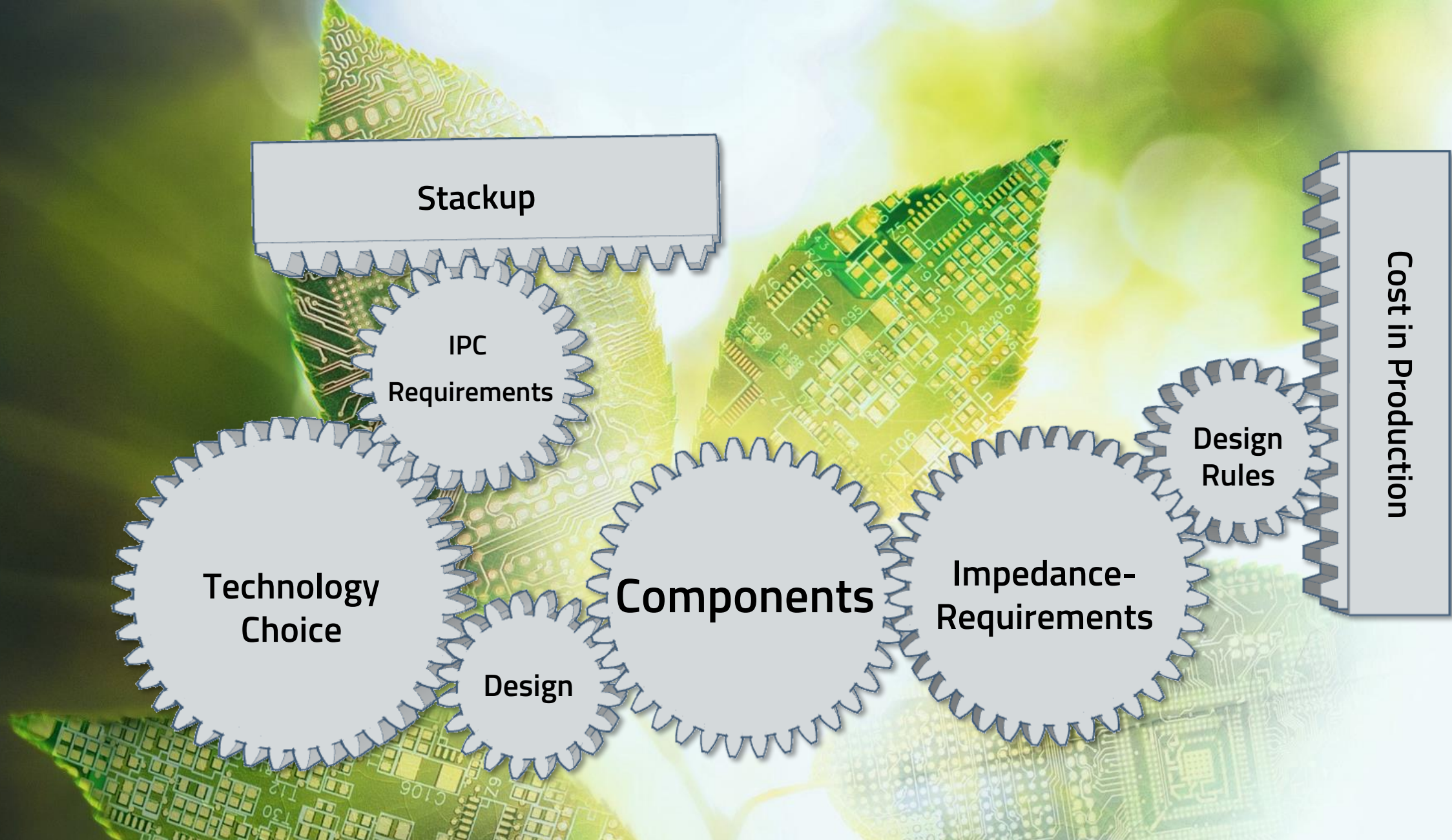


Distribution homogeneous

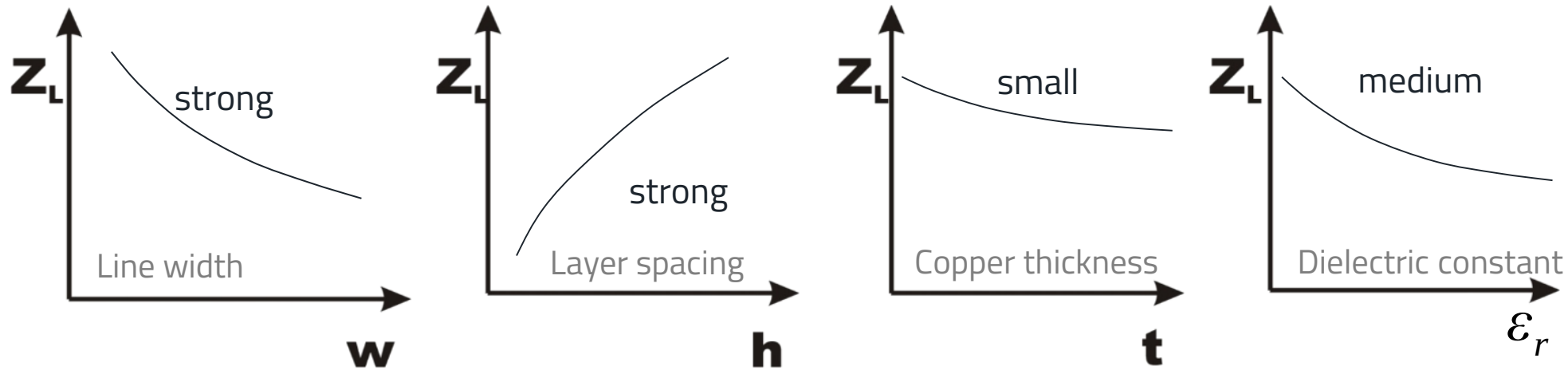


Critical structures freestanding





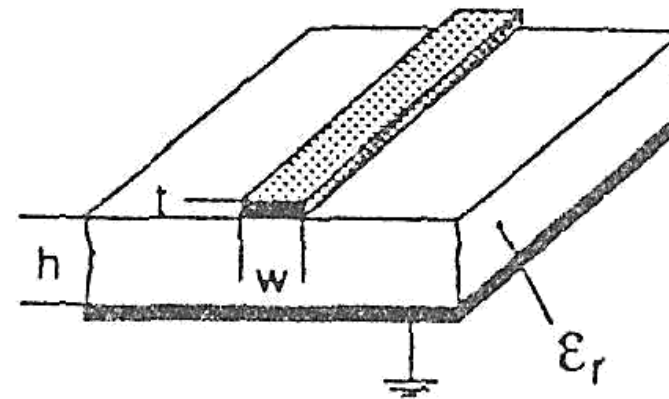
IMPEDANZ - INFLUENCING FACTORS



$w+h$ = Desinger + PCB Plant

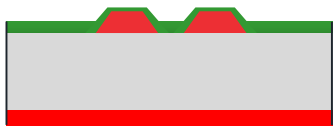
t = galvanic Process, starting copper

ϵ_r = material

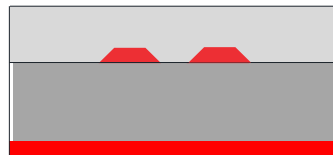


IMPEDANCE MODELL

Layers
Configuration:



Surface
Microstrip



Embedded
Microstrip

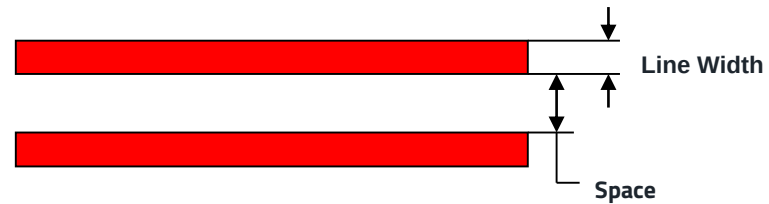


Stripline

Conductor track
Configuration:



Single



Differentiell



Coplanar

IMPEDANCE - OPTIONS IN MANUFACTURING

Impedance calculation

LAGENAUFBAU HDI				14 - Lagen			
WE-Artikel Nr.:		HDI14_4+6(8b)+4					
KUNDE:		CBT SH		WÜRTH ELEKTRONIK			
LAGENBEZEICHNUNG	AUFBAU	BASIS-Material	CU	PREPREG ANZAHL/TYP	[ϵ_r]	ENDDICKE (Nominal)	KUNDEN-FORDERUNG
KUNDE	WE					[μm]	[μm]
1		Folie	12 μm	1)		40	> 33
2	REF	Folie	12 μm	1 x 1080		68	> 24
3	S1	Folie	9 μm	1 x 2113	4.30	85	> 24
4	REF	Folie	12 μm	1 x 2113	4.30	92	> 24
5	S2		17.5 μm	1 x 1080	4.00	68	> 24
6	REF		0.150 mm		4.10	150	
7	P		17.5 μm			15	
				1 x 1080		70	60
			17.5 μm			15	
			0.150 mm			150	ca. 150

Material: lowCTEz Tg.150° hf (EM-370)

Impedanzen:

S1 Zo 45 Ohm @ 75 μm LB-Breite

S1 Zdiff 79 Ohm @ 75 / 85 / 75 μm

S1 Zdiff 90 Ohm @ 75 / 350 / 75 μm

S2 Zo 49 Ohm @ 75 μm LB-Breite

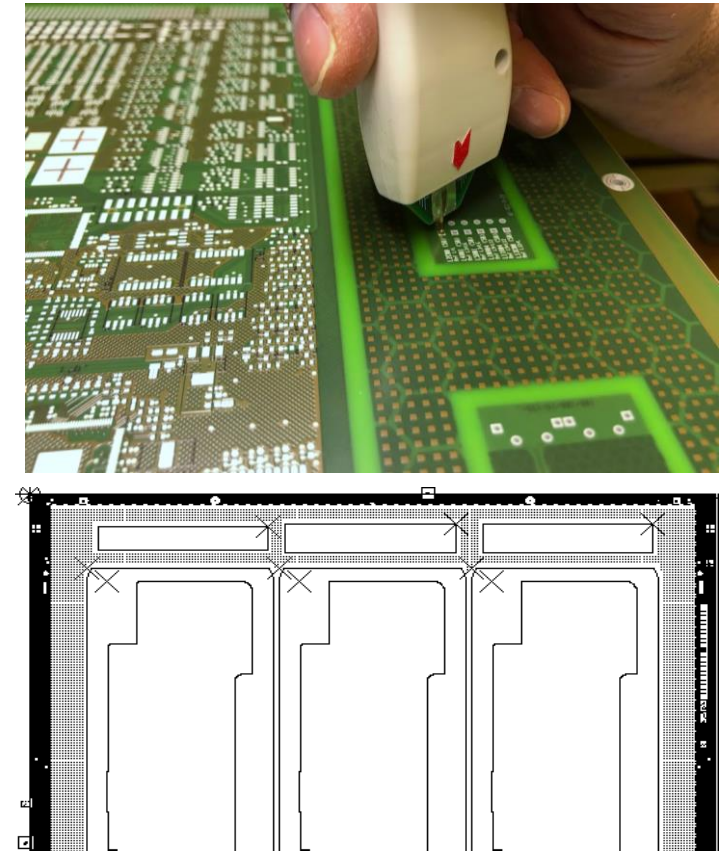
S2 Zdiff 78 Ohm @ 100 / 100 / 100 μm

S2 Zdiff 90 Ohm @ 80 / 132 / 80 μm

Impedance manufactured

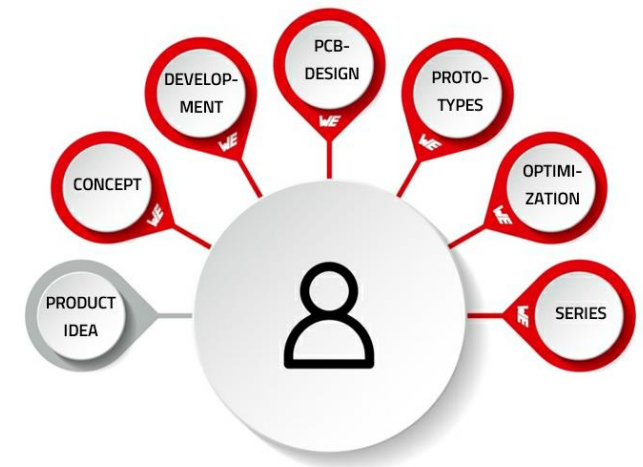
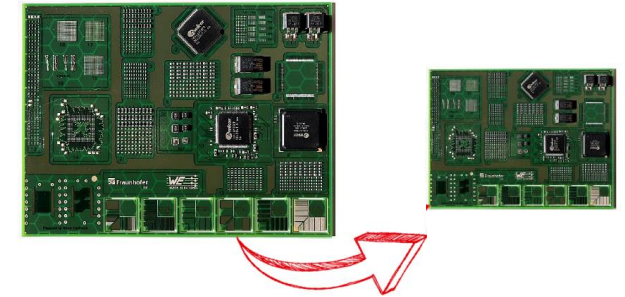


Impedance tested



SUMMARY

- Use the benefits of Micro Via Design not only in BGA - use it everywhere!
- In tight spaces: small conductor spacing - Rest of the layout: generous spacing
Use asymmetrical line/space parameters
- Individual layer structure creation enables impedance requirements to be met
- Early discussion between the partners enables potential multiplication!



THANK YOU FOR YOUR ATTENTION!

Questions?



Order your sample now

www.we-online.com/microviasample

Contact:

Würth Elektronik GmbH & Co. KG
Circuit Board Technology
+49 7622 397-133
andreas.dreher@we-online.com