WÜRTH ELEKTRONIK

DIGITAL PCB STANDARDS – MATERIAL DATABASE

AGENDA

1. My objectives for today's webinar
2. The Würth Elektronik materials database for AltiumDesigner20
3. Demonstration of Material Library import process in AD20
4. The description makes the difference
5. Minimum copper layer thicknesses of the finished PCB according to IPC
6. Summary and outlook

Andreas Schilpp
Technical Marketing

MY OBJECTIVES FOR TODAY'S WEBINAR

1. **Each participant knows**
    1. how the WE CircuitBoardTechnology material database for AD20 is structured and what data content is included
    2. how to load and use an Altium Material Library
    3. where the WE CircuitBoardTechnology material database can be requested.
2. **Each participant will be given a recipe for determining the minimum copper layer thicknesses permitted by IPC according to the information in the WE CircuitBoardTechnology material database or in the WE standard layerstacks.**

DIGITAL PCB STANDARDS – MATERIAL DATABASE

Introduction

Within Altium Designer20 there is the capability to create layer stackups for PCB designs suitable for production. This is possible utilizing the Layerstack Manager in combination with the Material Library within a PCB job.

Request the files with the link in the red box!

Request files here

Terms and Conditions

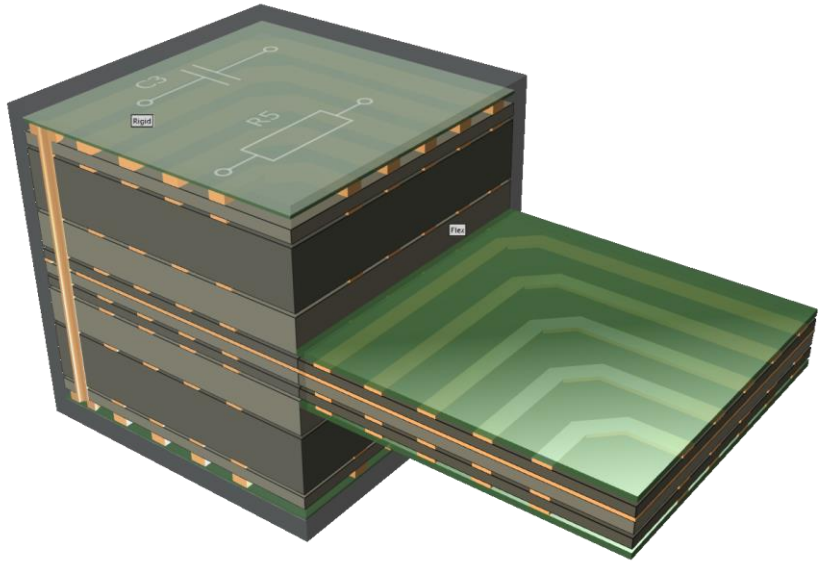
DIGITAL PCB STANDARDS – MATERIAL DATABASE

Introduction

- This Material Library is the basis of our standard layer stackups, see also our webinar from 2.2.2021

Download BASIC stackups here

Download HDI stackups here

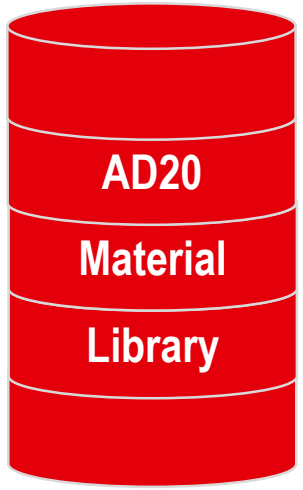


Download RIGID.flex stackups here

DIGITAL PCB STANDARDS – MATERIAL DATABASE

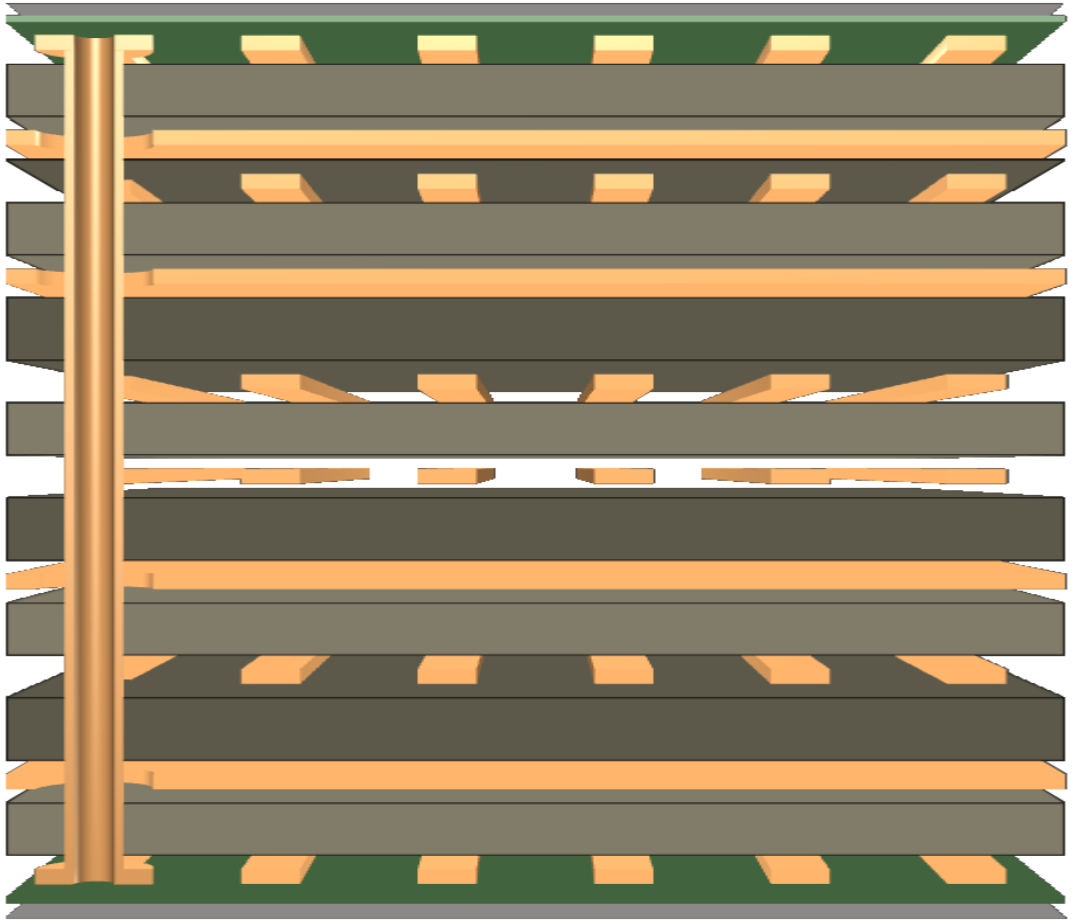
Benefit

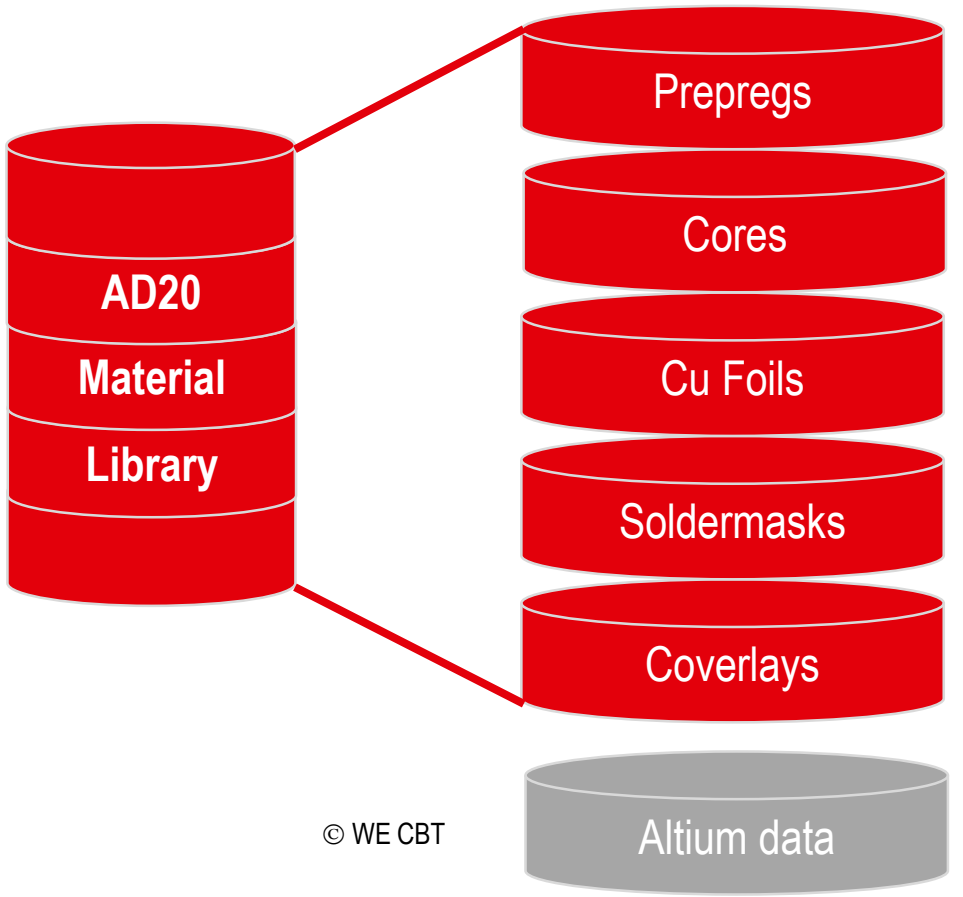
- **Enables more control to the PCB designer as a plug-in solution**
  - Provides material options you may need
  - Shows the impact of what you are doing repectively changing
  - Helps to decide if adjustments have to be made in the stackup or in the trace routing to meet impedance requirements
  - See real dimensional properties in Altium 3D view, i.e. core thickness
- **Secures accurate material selection and dk / df values**
  - Manufacturability of final stackup is more likely
  - Altium Draftsman uses material data of the library also for documentation
  - 3D field solver integrated in AltiumDesigner (Simberian) is able to correctly calculate impedance values based on accurate material data
- **The WE Material Library is a perfect match for WE capabilities**



DIGITAL PCB STANDARDS – MATERIAL DATABASE

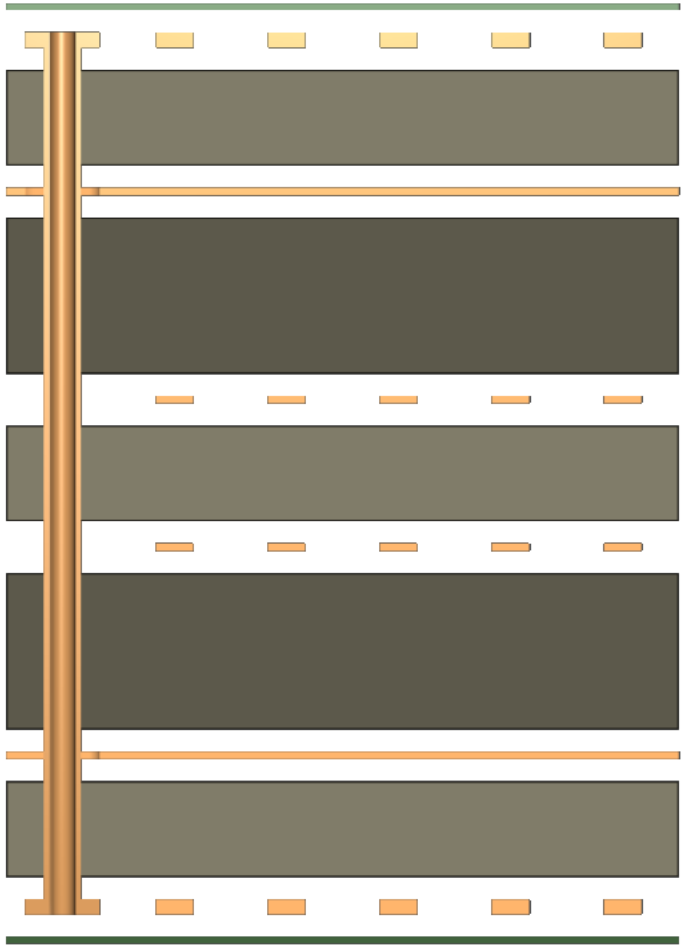
Stucture and content

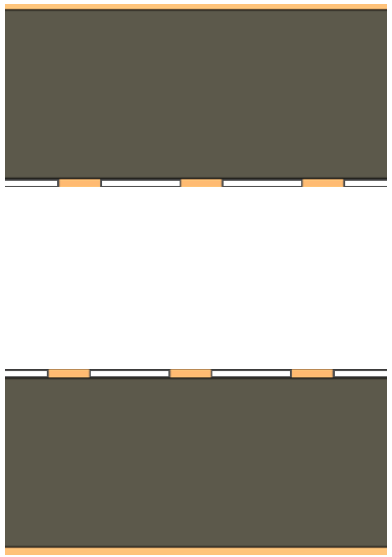


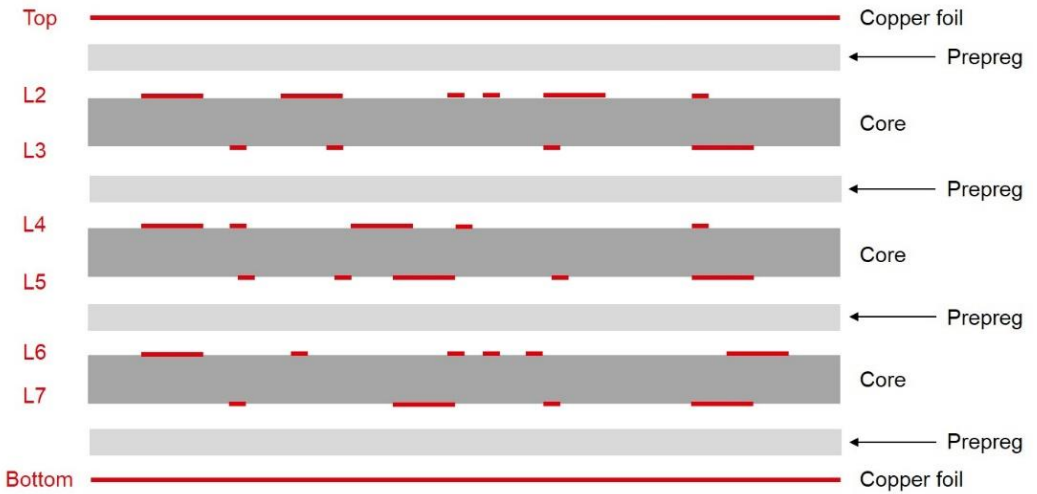


DIGITAL PCB STANDARDS – MATERIAL DATABASE

Comparison EDA stackup versus real life

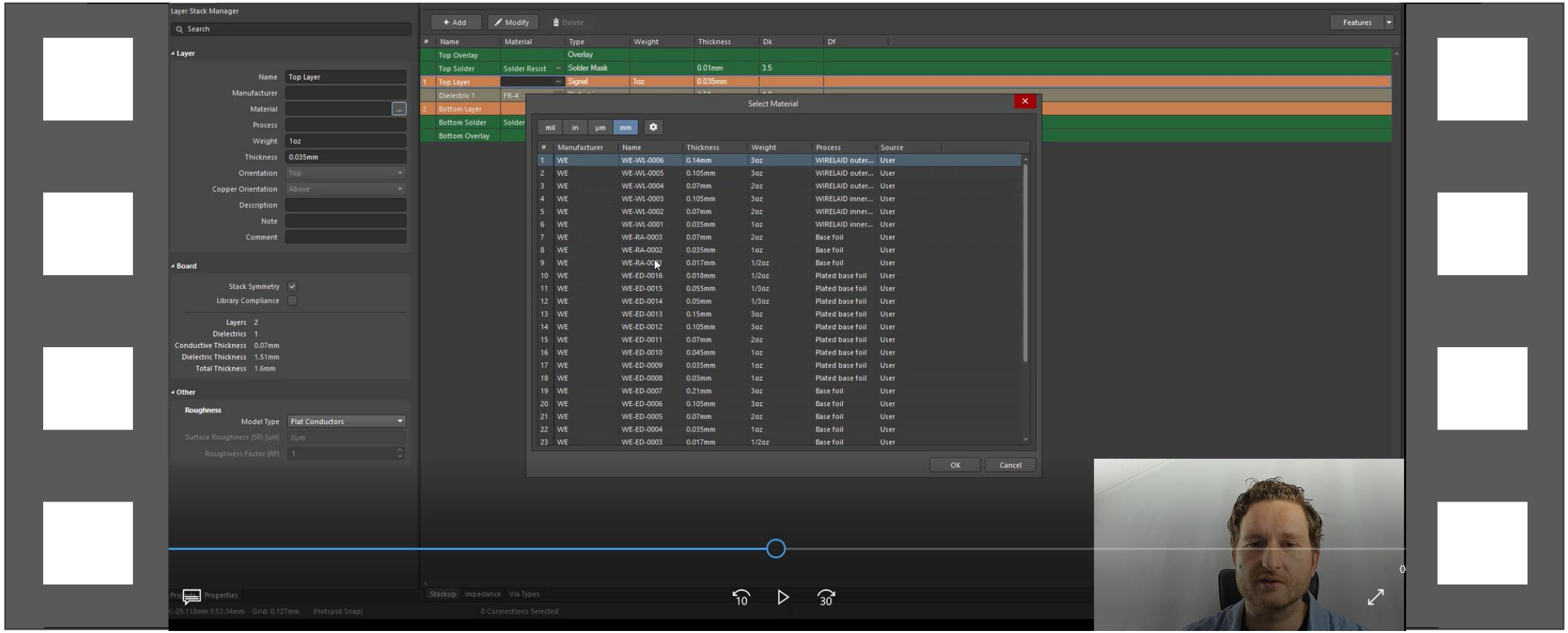






DEMONSTRATION

Video: Material Library import into AD20 – step by step



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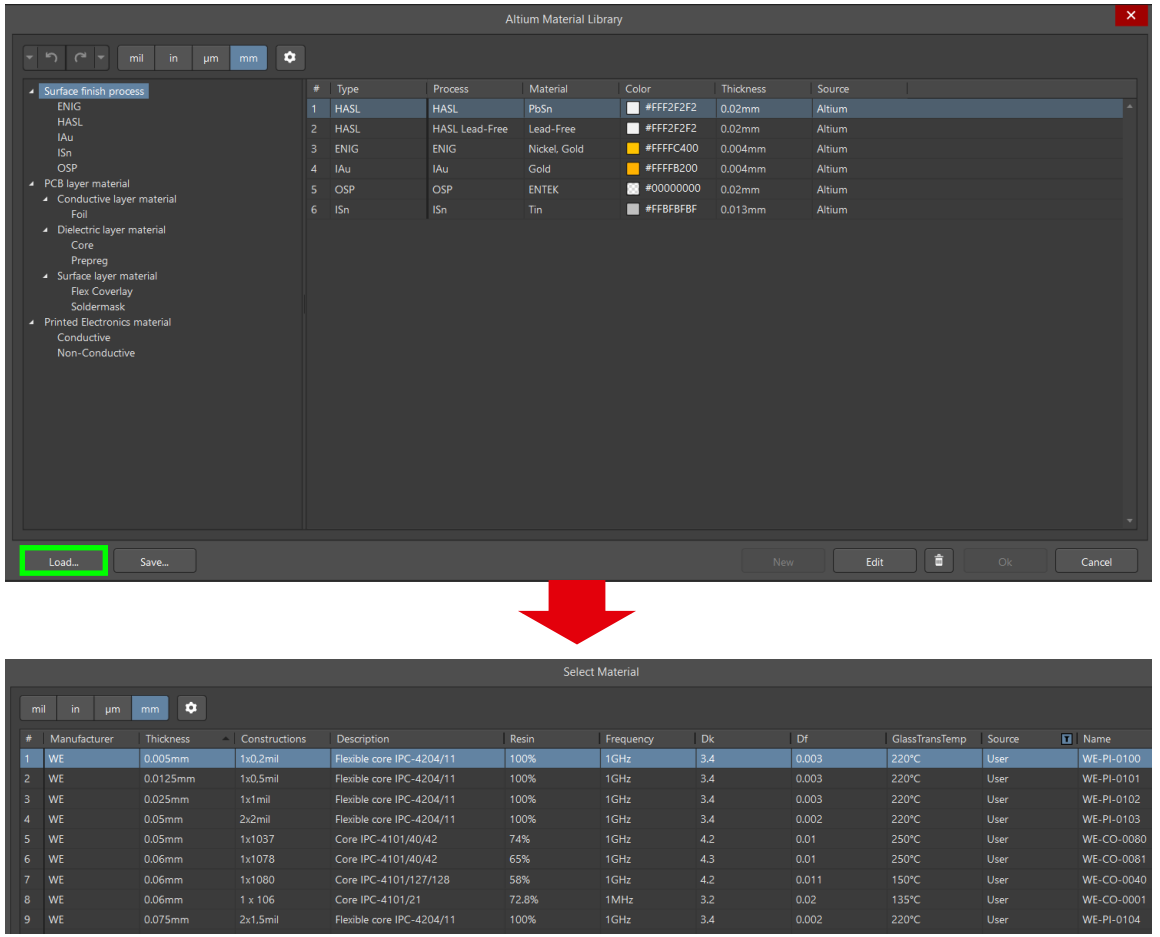
Quick Installation Guide in AD20

- Start AD20, Open or Create a New PCB – PCB Editor
- Access the PCB Layer Stack Manager:
  Design > Layer Stack Manager
- Open the Altium Material Library: Tools Material Library
- To install the WE Material Library,
  click the Load… button
- Choose XML-File
  „WE-AD20-Material-Library_V2.12.xml“ and OPEN –
  loading is performed.
- Activate columns „Description“ and „Note“ in the
  Setting Menu!
- DONE!



DIGITAL PCB STANDARDS – MATERIAL DATABASE

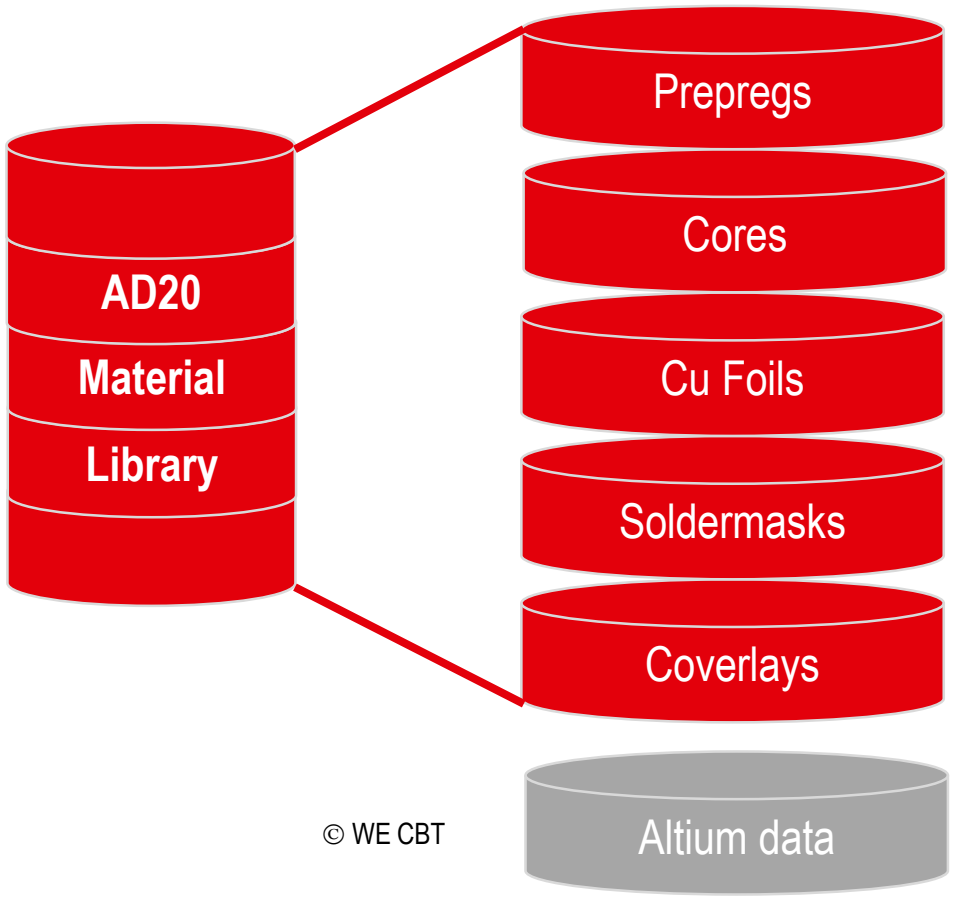
Deleting user content

- **CLEAN-LIB.xml comes with the Würth Elektronik Circuit Board Technology material library.**

  The file "CLEAN-LIB.xml" can be used to delete user entries of the material database, i.e. Würth Elektronik Circuit Board Technology material library.

  The Altium entries cannot currently be deleted.

- **Just follow the Quick Installation Guide an Load the CLEAN-LIB.xml file.**



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DIGITAL PCB STANDARDS – MATERIAL DATABASE

The description makes the difference

- **Example: RIGID.flex layerstack 3Ri-4F-3Ri**

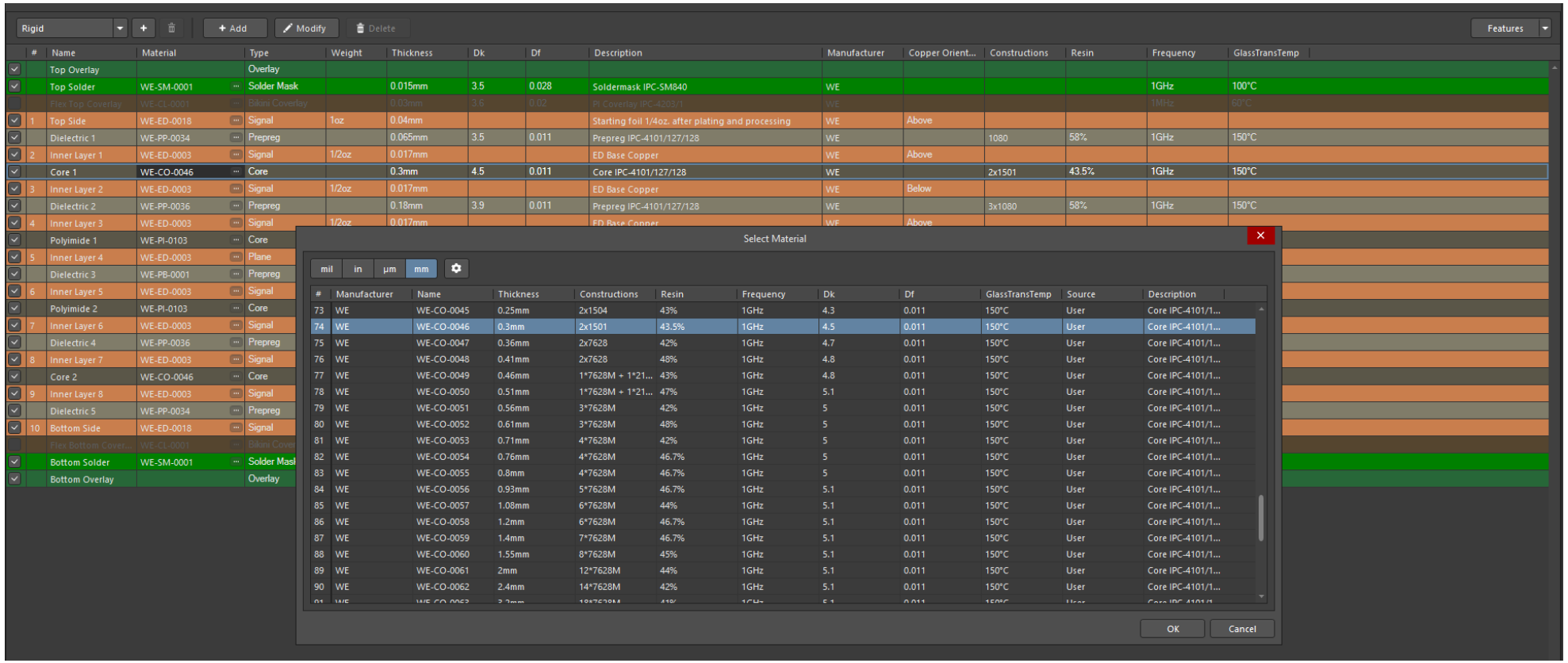
#	Name	Thickness	Description	Note	Dk	Df	GlassTransTemp
	Top Overlay						
	Top Solder	0.015mm	Soldermask IPC-SM840	used on rigid parts	3.5	0.028	100°C
	Flex Top Coverlay	0.03mm	PI Coverlay IPC-4203/1	Polyimide + bonding film (Acr...	3.6	0.02	60°C
1	Top Side	0.03mm	Starting foil 1/4oz. after plating and processing				
	Dielectric 1	0.065mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.5	0.011	150°C
2	Inner Layer 1	0.017mm	ED Base Copper				
	Core 1	0.1mm	Core IPC-4101/127/128	FR-4.1 filled, halogen free	3.8	0.011	150°C
3	Inner Layer 2	0.017mm	ED Base Copper				
	Dielectric 2	0.174mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.7	0.011	150°C
4	Inner Layer 3	0.017mm	ED Base Copper				
	Polyimide 1	0.05mm	Flexible core IPC-4204/11	Flex Polyimide adhesiveless	3.4	0.002	220°C
5	Inner Layer 4	0.017mm	ED Base Copper				
	Dielectric 3	0.06mm	IPC-4101/127/128 + IPC-4203/1	MIX layer Prepreg + Bondply	3.2	0.011	150°C
6	Inner Layer 5	0.017mm	ED Base Copper				
	Polyimide 2	0.05mm	Flexible core IPC-4204/11	Flex Polyimide adhesiveless	3.4	0.002	220°C
7	Inner Layer 6	0.017mm	ED Base Copper				
	Dielectric 4	0.174mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.7	0.011	150°C
8	Inner Layer 7	0.017mm	ED Base Copper				
	Core 2	0.1mm	Core IPC-4101/127/128	FR-4.1 filled, halogen free	3.8	0.011	150°C
9	Inner Layer 8	0.017mm	ED Base Copper				
	Dielectric 5	0.065mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.5	0.011	150°C
10	Bottom Side	0.03mm	Starting foil 1/4oz. after plating and processing				
	Flex Bottom Cov...	0.03mm	PI Coverlay IPC-4203/1	Polyimide + bonding film (Acr...	3.6	0.02	60°C
	Bottom Solder	0.015mm	Soldermask IPC-SM840	used on rigid parts	3.5	0.028	100°C
	Bottom Overlay						

#	Name	Thickness	Description	Note	Dk
	Top Overlay				
	Top Solder	0.015mm	Soldermask IPC-SM840	used on rigid parts	3.5
	Flex Top Coverlay	0.03mm	PI Coverlay IPC-4203/1	Polyimide + bonding film (Acr...	3.6
1	Top Side	0.03mm	Starting foil 1/4oz. after plating and processing		
	Dielectric 1	0.065mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.5
2	Inner Layer 1	0.017mm	ED Base Copper		
	Core 1	0.1mm	Core IPC-4101/127/128	FR-4.1 filled, halogen free	3.8
3	Inner Layer 2	0.017mm	ED Base Copper		
	Dielectric 2	0.174mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.7
4	Inner Layer 3	0.017mm	ED Base Copper		
	Polyimide 1	0.05mm	Flexible core IPC-4204/11	Flex Polyimide adhesiveless	3.4
5	Inner Layer 4	0.017mm	ED Base Copper		
	Dielectric 3	0.06mm	IPC-4101/127/128 + IPC-4203/1	MIX layer Prepreg + Bondply	3.2
6	Inner Layer 5	0.017mm	ED Base Copper		
	Polyimide 2	0.05mm	Flexible core IPC-4204/11	Flex Polyimide adhesiveless	3.4
7	Inner Layer 6	0.017mm	ED Base Copper		
	Dielectric 4	0.174mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.7
8	Inner Layer 7	0.017mm	ED Base Copper		
	Core 2	0.1mm	Core IPC-4101/127/128	FR-4.1 filled, halogen free	3.8
9	Inner Layer 8	0.017mm	ED Base Copper		
	Dielectric 5	0.065mm	Prepreg IPC-4101/127/128	FR-4.1 filled, halogen free	3.5
10	Bottom Side	0.03mm	Starting foil 1/4oz. after plating and processing		
	Flex Bottom Cov...	0.03mm	PI Coverlay IPC-4203/1	Polyimide + bonding film (Acr...	3.6
	Bottom Solder	0.015mm	Soldermask IPC-SM840	used on rigid parts	3.5
	Bottom Overlay				

DIGITAL PCB STANDARDS – MATERIAL DATABASE

The description makes the difference, i.e. cores

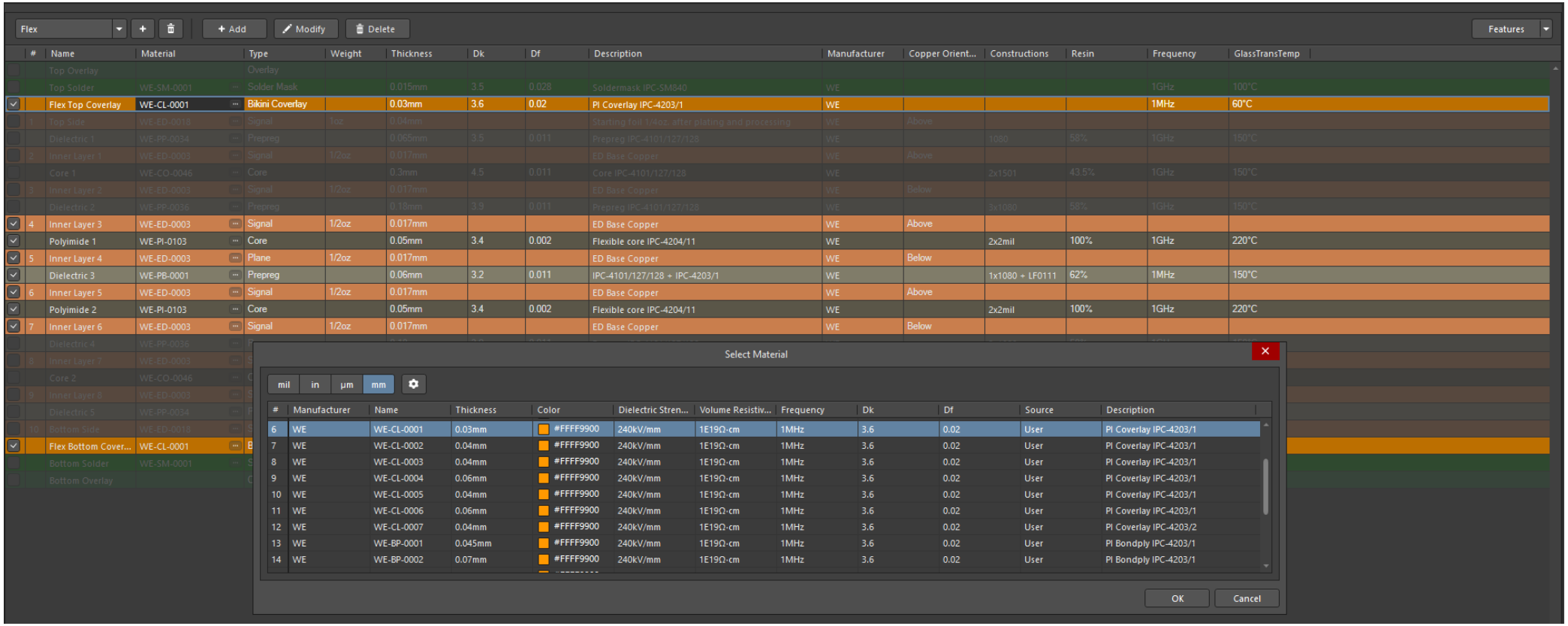
- **Example: RIGID.flex layerstack 3Ri-4F-3Ri – „Construction“ showing the used weaves (fabric)**



DIGITAL PCB STANDARDS – MATERIAL DATABASE

The description makes the difference, i.e. coverlay / bondply

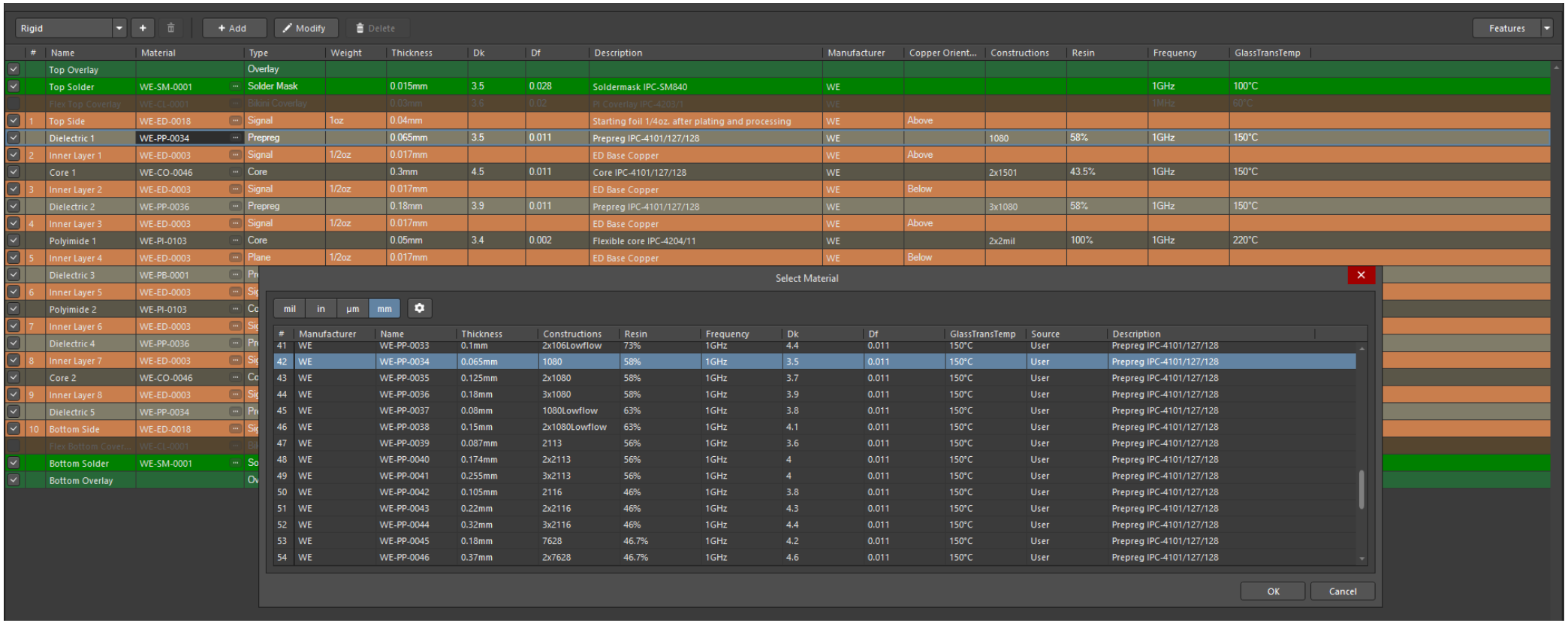
- **Example: RIGID.flex layerstack 3Ri-4F-3Ri**



DIGITAL PCB STANDARDS – MATERIAL DATABASE

The description makes the difference, i.e. prepreg

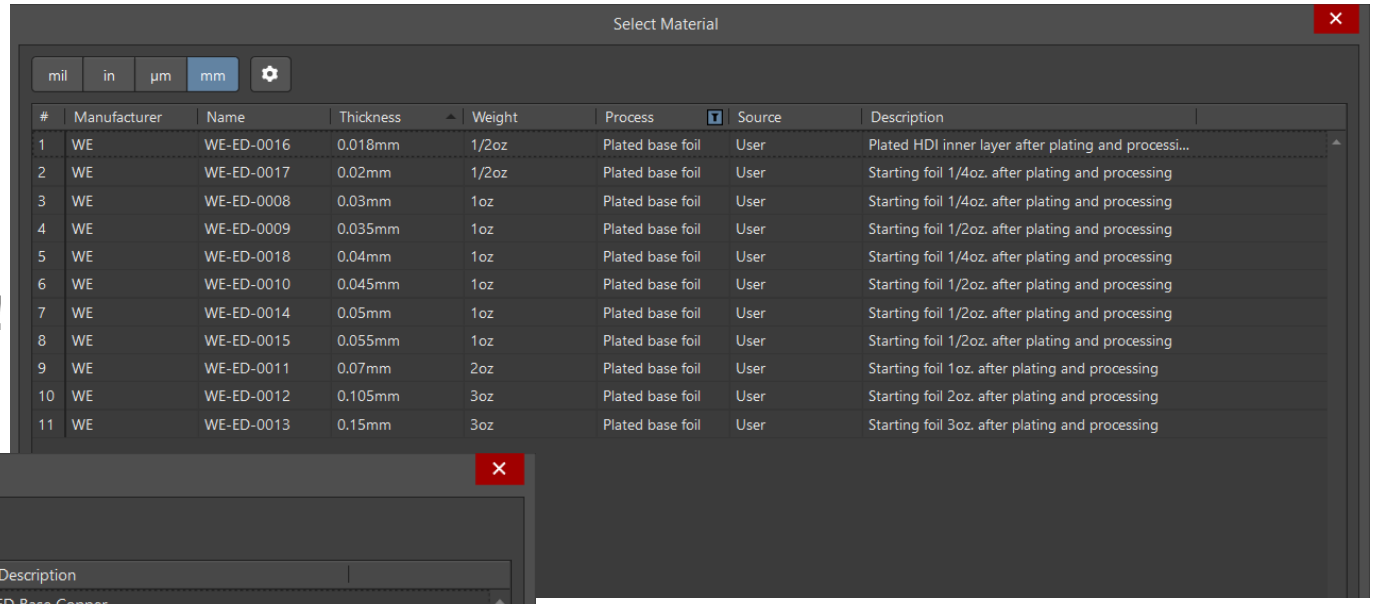
- **Example: RIGID.flex layerstack 3Ri-4F-3Ri – „Construction“ showing the used weaves (fabric)**



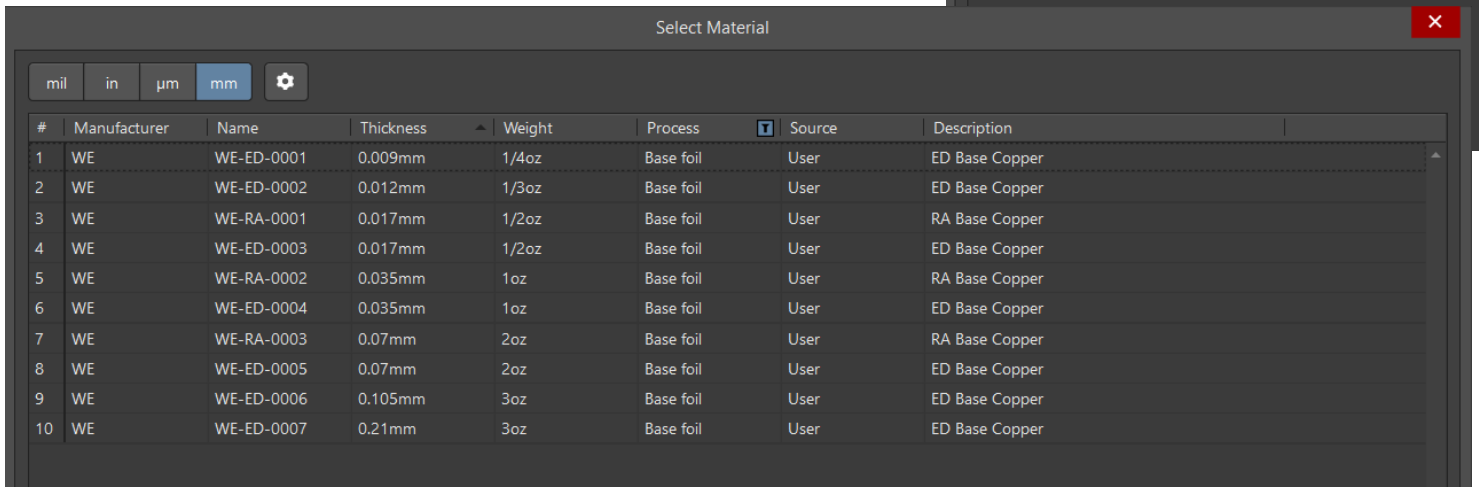
DIGITAL PCB STANDARDS – MATERIAL DATABASE

The description makes the difference: Copper foils

- **Filtering options**
  - Source (Altium / user)
  - Columns showing: Description!
  - Column order
- **The oz. values are inaccurate due to rounding!**



#	Manufacturer	Name	Thickness	Weight	Process	Source	Description
1	WE	WE-ED-0016	0.018mm	1/2oz	Plated base foil	User	Plated HDI inner layer after plating and processi...
2	WE	WE-ED-0017	0.02mm	1/2oz	Plated base foil	User	Starting foil 1/4oz. after plating and processing
3	WE	WE-ED-0008	0.03mm	1oz	Plated base foil	User	Starting foil 1/4oz. after plating and processing
4	WE	WE-ED-0009	0.035mm	1oz	Plated base foil	User	Starting foil 1/2oz. after plating and processing
5	WE	WE-ED-0018	0.04mm	1oz	Plated base foil	User	Starting foil 1/4oz. after plating and processing
6	WE	WE-ED-0010	0.045mm	1oz	Plated base foil	User	Starting foil 1/2oz. after plating and processing
7	WE	WE-ED-0014	0.05mm	1oz	Plated base foil	User	Starting foil 1/2oz. after plating and processing
8	WE	WE-ED-0015	0.055mm	1oz	Plated base foil	User	Starting foil 1/2oz. after plating and processing
9	WE	WE-ED-0011	0.07mm	2oz	Plated base foil	User	Starting foil 1oz. after plating and processing
10	WE	WE-ED-0012	0.105mm	3oz	Plated base foil	User	Starting foil 2oz. after plating and processing
11	WE	WE-ED-0013	0.15mm	3oz	Plated base foil	User	Starting foil 3oz. after plating and processing



#	Manufacturer	Name	Thickness	Weight	Process	Source	Description
1	WE	WE-ED-0001	0.009mm	1/4oz	Base foil	User	ED Base Copper
2	WE	WE-ED-0002	0.012mm	1/3oz	Base foil	User	ED Base Copper
3	WE	WE-RA-0001	0.017mm	1/2oz	Base foil	User	RA Base Copper
4	WE	WE-ED-0003	0.017mm	1/2oz	Base foil	User	ED Base Copper
5	WE	WE-RA-0002	0.035mm	1oz	Base foil	User	RA Base Copper
6	WE	WE-ED-0004	0.035mm	1oz	Base foil	User	ED Base Copper
7	WE	WE-RA-0003	0.07mm	2oz	Base foil	User	RA Base Copper
8	WE	WE-ED-0005	0.07mm	2oz	Base foil	User	ED Base Copper
9	WE	WE-ED-0006	0.105mm	3oz	Base foil	User	ED Base Copper
10	WE	WE-ED-0007	0.21mm	3oz	Base foil	User	ED Base Copper

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Minimum copper foil thicknesses according to IPC specification

- **Inner layers ➔ IPC designation „Internal Layer Foil Thickness after Processing“**
  - IPC-6012E Table 3-14 resp. IPC-6013D Table 3-18
  - Depending on Foil Starting Weight ➔ see „Thickness“ of base copper
  - With consideration of the minus tolerances of the copper foil as delivered
  - Minus the process tolerance reduction

- **Outer layers ➔ IPC designation „External Conductor Thickness after Plating&Processing“**
  - IPC-6012E Table 3-15 resp.. IPC-6013D Table 3-19
  - Depending on Foil Starting Weight ➔ see „Description“ of plated base foil
  - With consideration of the minus tolerances of the copper foil as delivered
  - Plus average (IPC-6012) resp. minimum (IPC-6013) plating depending on IPC class and IPC type
  - Minus the process tolerance reduction

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Example: Outer Layers ¼ oz. base copper (9µm)

- **IPC-6012E Table 3-15 for rigid PCBs**

Table 3-15 External Conductor Thickness after Plating

Weight[1,4]	Absolute Cu Min. (IPC-4562 less 10% reduction) (µm) [µin][5]	Plus average plating for Class 1 and 2 (20 µm) [787 µin][2] FOR REFERENCE PURPOSES ONLY	Plus average plating for Class 3 (25 µm) [984 µin][2] FOR REFERENCE PURPOSES ONLY	Maximum Variable Processing Allowance Reduction[3] (µm) [µin] FOR REFERENCE PURPOSES ONLY	Minimum Surface Conductor Thickness after Processing (µm) [µin]	
					Class 1 & 2	Class 3
1/8 oz.	4.60 [181]	24.60 [967]	29.60 [1,165]	1.50 [59]	23.1 [909]	28.1 [1,106]
1/4 oz.	7.70 [303]	27.70 [1,091]	32.70 [1,287]	1.50 [59]	26.2 [1,031]	31.2 [1,228]
3/8 oz.	10.80 [425]	30.80 [1,213]	35.80 [1,409]	1.50 [59]	29.3 [1,154]	34.3 [1,350]
1/2 oz.	15.40 [606]	35.40 [1,394]	40.40 [1,591]	2.00 [79]	33.4 [1,315]	38.4 [1,512]
1 oz.	30.90 [1,217]	50.90 [2,004]	55.90 [2,201]	3.00 [118]	47.9 [1,886]	52.9 [2,083]
2 oz.	61.70 [2,429]	81.70 [3,217]	86.70 [3,413]	3.00 [118]	78.7 [3,098]	83.7 [3,295]
3 oz.	92.60 [3,646]	112.60 [4,433]	117.60 [4,630]	4.00 [157]	108.6 [4,276]	113.6 [4,472]
4 oz.	123.50 [4,862]	143.50 [5,650]	148.50 [5,846]	4.00 [157]	139.5 [5,492]	144.5 [5,689]

Note 1. Starting foil weight of design requirement per procurement documentation.

Note 2. Process allowance reduction does not allow for rework processes for weights below 1/2 oz. For 1/2 oz. and above, the process allowance reduction allows for one rework process.

Note 3. Reference: Average Cu Plating Thickness
Class 1 = 20 µm [787 µin] Class 2 = 20 µm [787 µin] Class 3 = 25 µm [984 µin]

Note 4. For copper foil above 4 oz., utilize the formula provided in 3.6.2.15.

Note 5. For foil weights not listed in Table 3-14, the finished copper foil thickness **shall** be calculated using the following algorithms. For microns (µm) use [(34.3 X Weight) X 0.9] and for [µin] microinches use [(1.35 X Weight) X 0.9] X 1000.

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Example: Inner Layers ½ oz. base copper (17µm)

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- **IPC-6012E Table 3-14 for rigid PCBs**

Table 3-14 Internal Layer Foil Thickness after Processing[1]

Weight (µm) [oz./ft²]	Absolute Cu Min. (IPC-4562 less 10% reduction) (µm) [µin] FOR REFERENCE PURPOSES ONLY[2]	Maximum Variable Processing Allowance Reduction[3] (µm) [µin] FOR REFERENCE PURPOSES ONLY	Minimum Foil Thickness after Processing (µm) [µin]
5.10 [1/8 oz.]	4.60 [181]	1.50 [59]	3.1 [122]
8.50 [1/4 oz.]	7.70 [303]	1.50 [59]	6.2 [244]
12.00 [3/8 oz.]	10.80 [425]	1.50 [59]	9.3 [366]
17.10 [1/2 oz.]	15.40 [606]	4.00 [157]	11.4 [449]
34.30 [1 oz.]	30.90 [1,217]	6.00 [236]	24.9 [980]
68.60 [2 oz.]	61.70 [2,429]	6.00 [236]	55.7 [2,193]
102.90 [3 oz.]	92.60 [3,646]	6.00 [236]	86.6 [3,409]
137.20 [4 oz.]	123.50 [4,862]	6.00 [236]	117.5 [4,626]
Above 137.20 [4 oz.]	IPC-4562 value less 10% reduction	6.00 [236]	6 µm [236 µin] below minimum thickness of calculated 10% reduction of foil thickness in IPC-4562

Note 1. This table also applies to external, non-plated layers.

Note 2. Process allowance reduction does not allow for rework processes for weights below 1/2 oz. For 1/2 oz. and above, the process allowance reduction allows for one rework process.

Note 3. For foil weights not listed in Table 3-13, the finished copper foil thickness **shall** be calculated using the following algorithms. For microns (µm) use [(34.3 X Weight) X 0.9] and for [µin] microinches use [(1.35 X Weight) X 0.9] X 1000.

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Example: Outer Layers ¼ oz. base copper (9µm)

- **IPC-6013D Table 3-19 for RIGID.flex (Type 4)**

c. The minimum surface conductor thickness after processing values given in Table 3-19 are determined by the following equation:

Minimum Surface Conductor Thickness = a + b - c

Where:

a = Absolute copper foil minimum (IPC-4562 nominal less 10% reduction). No finished foil thickness measurement is required for plated layers. Some evidence of starting foil **shall** exist.

b = Minimum copper plating thickness (10 µm [394 µin] for Type 2; 20 µm [787 µin] for Type 3 and 4 ≤ 6 layers; 30 µm [1,181 µin] for Type 3 and 4 > 6 layers).

c = A maximum variable processing allowance reduction.

Table 3-19 External Conductor Thickness after Plating[1,2]

Weight[3,4]	Absolute Cu Min. (IPC-4562 less 10% reduction) (µm) [µin][7] FOR REFERENCE PURPOSES ONLY	Plus minimum plating for Type 2 (10 µm) [394 µin][5] FOR REFERENCE PURPOSES ONLY	Plus minimum plating for Type 3, 4 ≤ 1.5 mm [0.059 in] thickness (20 µm) [787 µin][5] FOR REFERENCE PURPOSES ONLY	Plus minimum plating for Type 3, 4 > 1.5 mm [0.059 in] thickness (30 µm) [1181 µin][5] FOR REFERENCE PURPOSES ONLY	Maximum Variable Processing Allowance Reduction[6] (µm) [µin] FOR REFERENCE PURPOSES ONLY	Minimum Surface Conductor Thickness after Processing (µm) [µin]		
						Type 2	Type 3, 4 ≤ 1.5 mm [0.059 in] thickness	Type 3, 4 > 1.5 mm [0.059 in] thickness
1/8 oz.	4.60 [181]	14.60 [575]	24.60 [967]	34.60 [1,362]	1.50 [59]	13.1 [516]	23.1 [909]	33.1 [1,303]
1/4 oz.	7.70 [303]	17.70 [697]	27.70 [1,091]	37.70 [1,484]	1.50 [59]	16.2 [638]	26.2 [1,031]	36.2 [1,425]
3/8 oz.	10.80 [425]	20.80 [819]	30.80 [1,213]	40.80 [1,606]	1.50 [59]	19.3 [760]	29.3 [1,154]	39.3 [1,559]
1/2 oz.	15.40 [606]	25.40 [1,000]	35.40 [1,394]	45.40 [1,787]	2.00 [79]	23.4 [921]	33.4 [1,315]	43.4 [1,709]
1 oz.	30.90 [1,217]	40.90 [1,610]	50.90 [2,004]	60.90 [2,398]	3.00 [118]	37.9 [1,491]	47.9 [1,886]	57.9 [2,280]
2 oz.	61.70 [2,429]	71.70 [2,823]	81.70 [3,217]	91.70 [3,610]	3.00 [118]	68.7 [2,705]	78.7 [3,098]	88.7 [3,492]
3 oz.	92.60 [3,646]	102.60 [4,039]	112.60 [4,433]	122.60 [4,827]	4.00 [157]	98.6 [3,882]	108.6 [4,276]	118.6 [4,669]
4 oz.	123.50 [4,862]	133.50 [5,236]	143.50 [5,650]	153.50 [6,043]	4.00 [157]	129.5 [5.098]	139.5 [5,492]	149.5 [5,886]

Note 1: The values in this table assume a single plating operation.
Note 2. When selective (button) plating is performed, refer to 3.6.2.16.
Note 3. Starting foil weight of design requirement per procurement documentation.
Note 4. For copper foil above 4 oz., utilize the formula provided in 3.6.2.16.
Note 5. Reference: Min. Cu Plating Thickness
Type 2 = (10 µm) [394 µin] Type 3 and 4 ≤ 1.5 mm [0.059 in] thickness = (20 µm) [787 µin]
Type 3 and 4 > 1.5 mm [0.059 in] thickness = (30 µm) [1,181 µin]
Note 6. Process allowance reduction does not allow for rework processes for weights below 1/2 oz. For 1/2 oz. and above, the process allowance reduction allows for one rework process.
Note 7. For foil weights not listed in Table 3-19, the absolute copper minimum **shall** be calculated using the following algorithms. For microns (µm) use [(34.3 X Weight) X 0.9] and for [µin] microinches use [(1.35 X Weight) X 0.9] X 1000.

SUMMARY & OUTLOOK

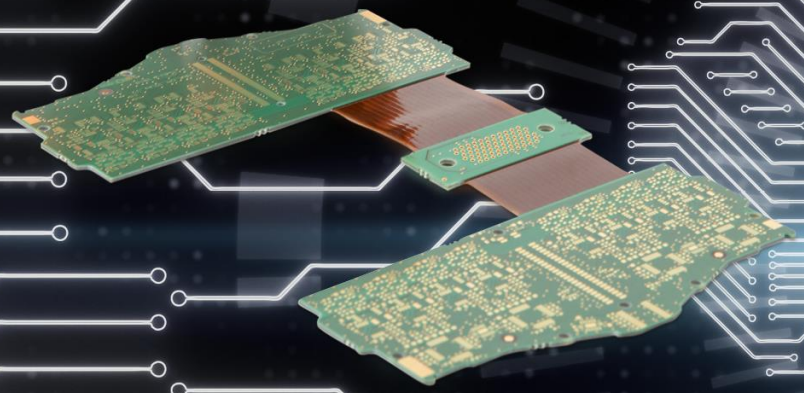
Digital Standards – material database

- **Digital material database is available for AltiumDesigner20**
- **Material Library for more EDA tools will follow**

- **Updating of all standards on the basis of the new MatLib revision 2.12: Delayed, should com within next 2 weeks.**
- **Offering rule sets for AltiumDesigner → Templates (stackup & rule set)**
  - First BASIC templates in Q3/2021
  - Advanced templates will follow
  - Other EDA tools will follow

- **Offers of collaboration for other EDA tools are very welcome. Please write in the question box or send me an email.**
- **Are you interested in our Circuit Board Technology webinars? Register for our newsletter here.**

WÜRTH ELEKTRONIK



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