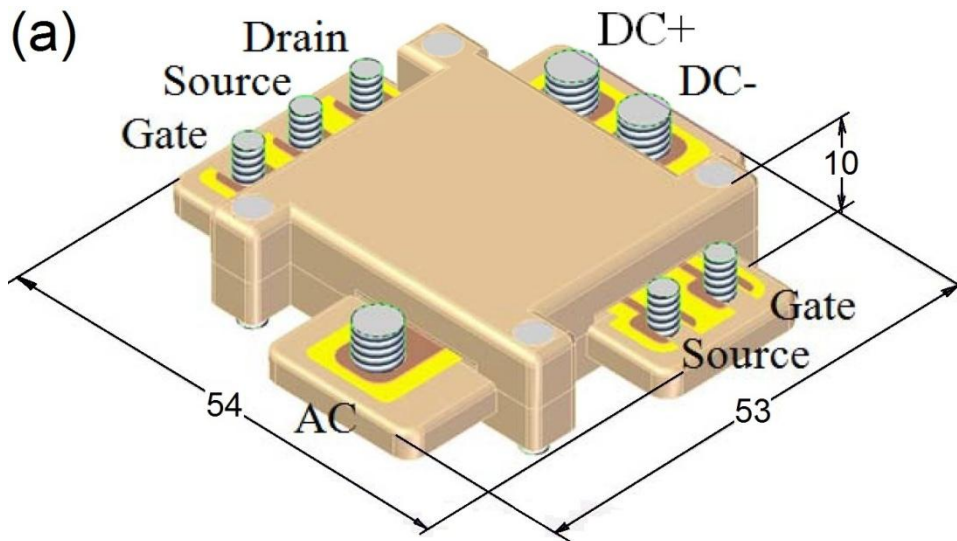


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Current & voltage	1200 V, 25 A (phase-leg rating)
Cooling	Single side cooled
Coolant temp / back pressure etc	N/A: cold plate, max temperature 115 °C
Choice of SiC die	SiC JFET plus Schottky diode
Electrical and thermal specification	Half bridge (leg) per substrate junction temperature range -60 to 200 °C

**Table 1 Original project Specification**



**Figure 1 3D View of the Power module**

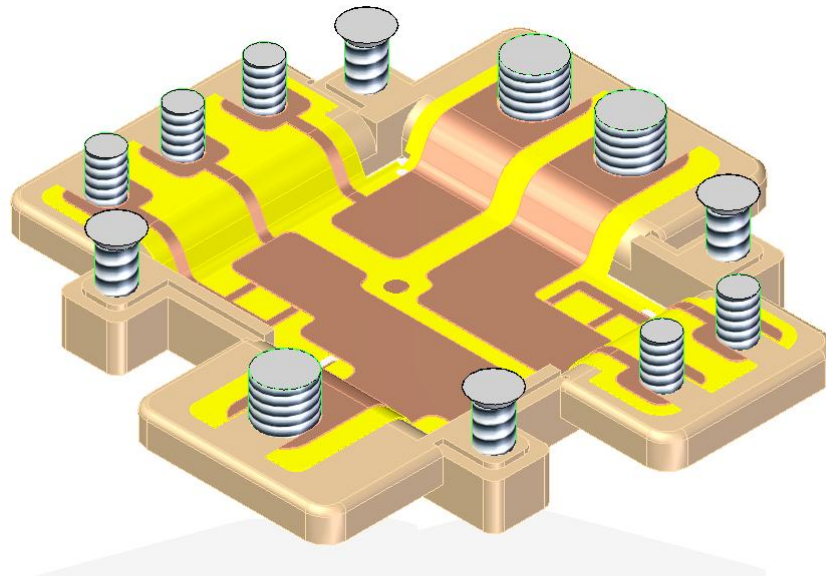


Figure 2 View of power module without lid

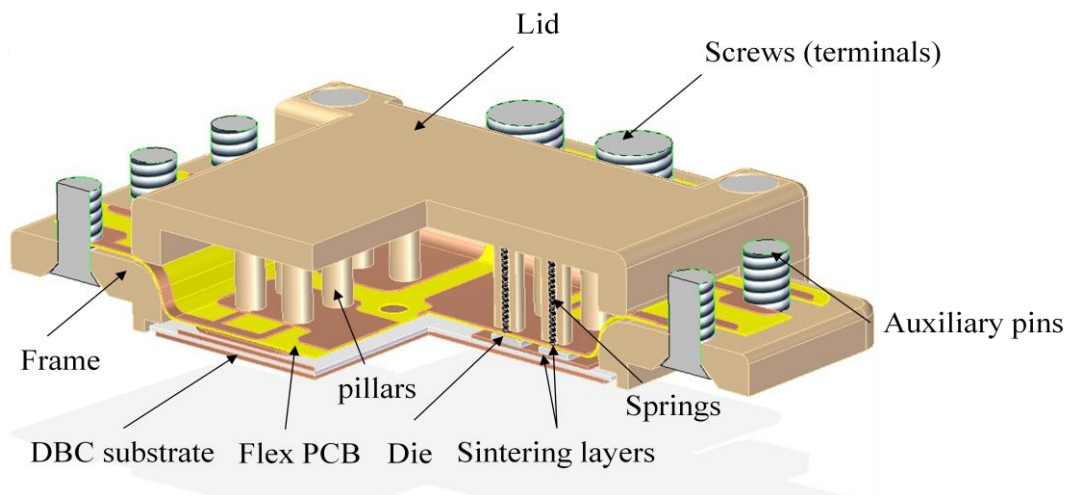


Figure 3 Cross section of the whole module

Component	Material Specification
Switch (JFET)	1200 V, 3.07×3.07×0.35 mm, SiC
Diode	1200 V, 2.35×2.35×0.35 mm SiC
Substrate	Silicon Nitride with silver finish
Supports	Copper ( 6×3×0.35 mm)
Die attachment	Nano Ag paste
Encapsulant	Silicone gel
Flex PCB	Kapton sandwiched with copper foil
Plastic	Tecator

Table 2 Material selection list

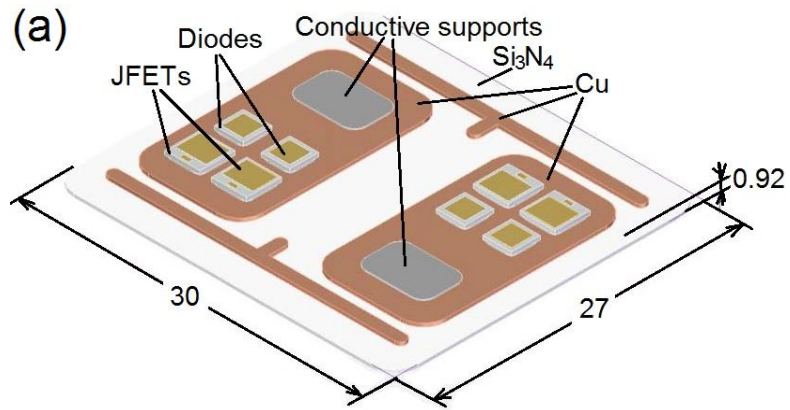


Figure 4 Substrate outline

	Materials	Thickness(mm)
Ceramic	$\text{Si}_3\text{N}_4$	0.32
DBC	Cu with Ag plating	0.3
Ag	Ag finish	<0.01

Table 3 substrate material specification

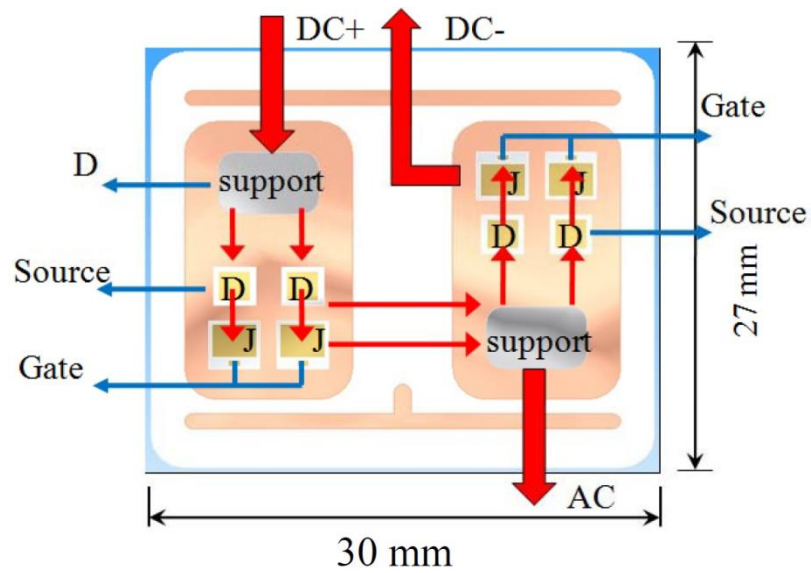


Figure 5 electrical layout

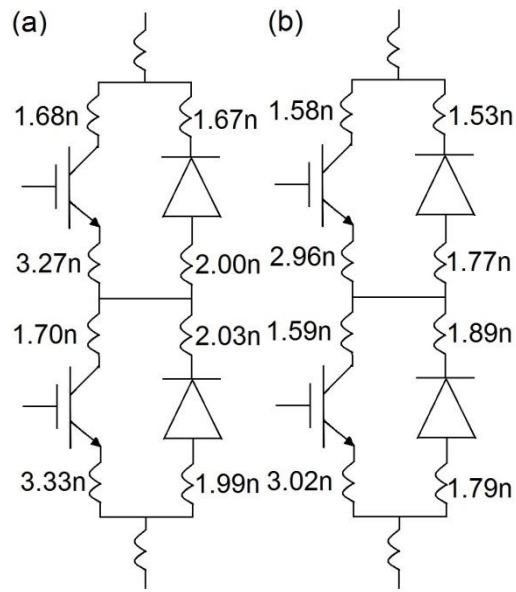


Figure 6 Equivalent circuit with extracted inductance at (a) 1kHz (b) 100kHz

	Materials	Thickness(mm)
Polymer1	Polyimide	0.1
Metal layer	Cu with Ag plating	0.1
Metal via	Cu	Ø0.2
Polymer2	Polyimide	0.05

Table 4 PCB material specification

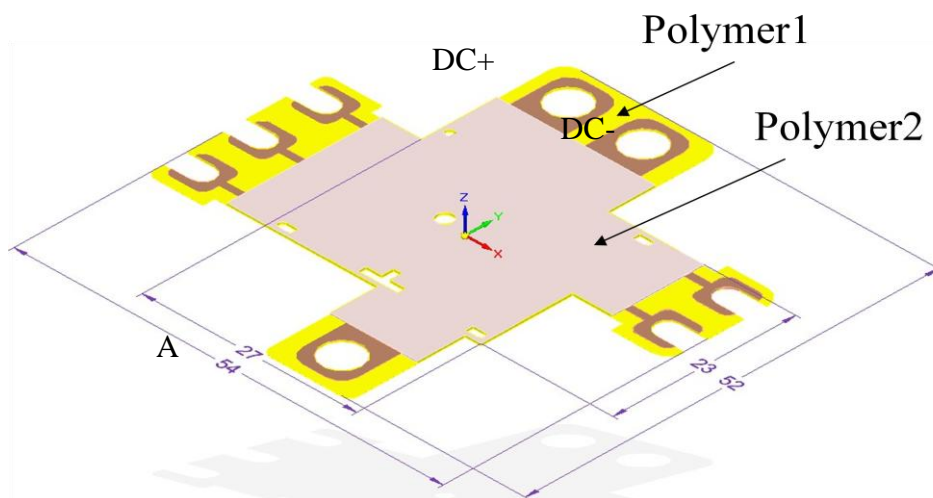


Figure 7 PCB Layout

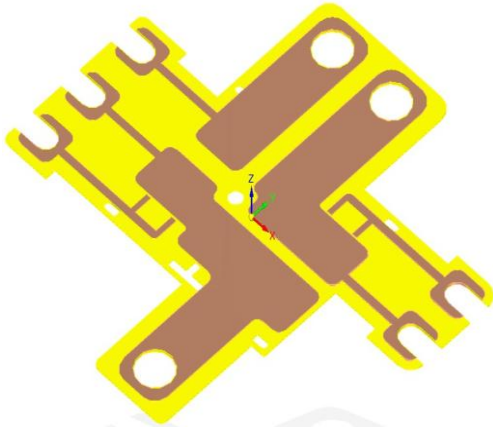


Figure 8 Top metal of PCB Layout

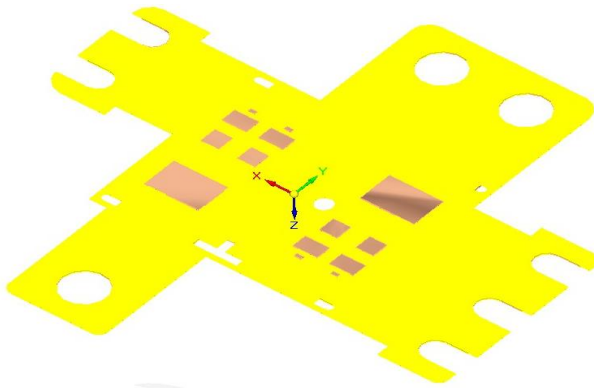


Figure 9 PCB Backside metal layout

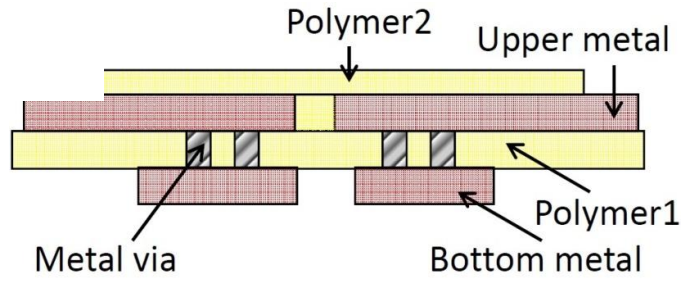


Figure 10 Cross section of PCB

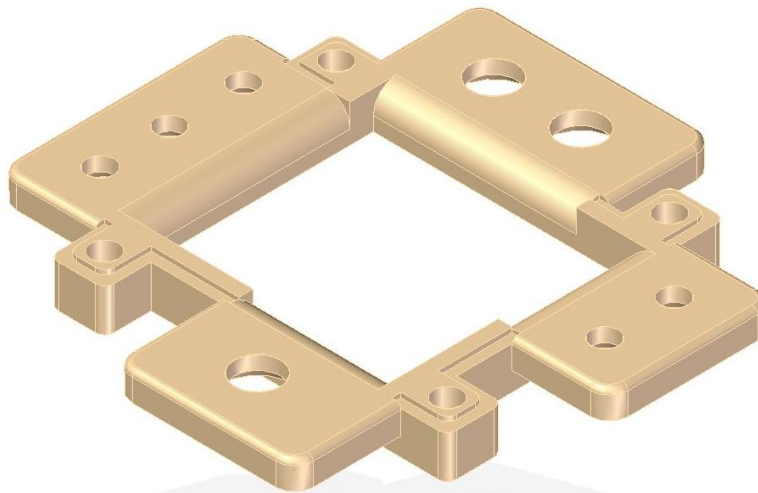


Figure 11 3D profile of the plastic frame

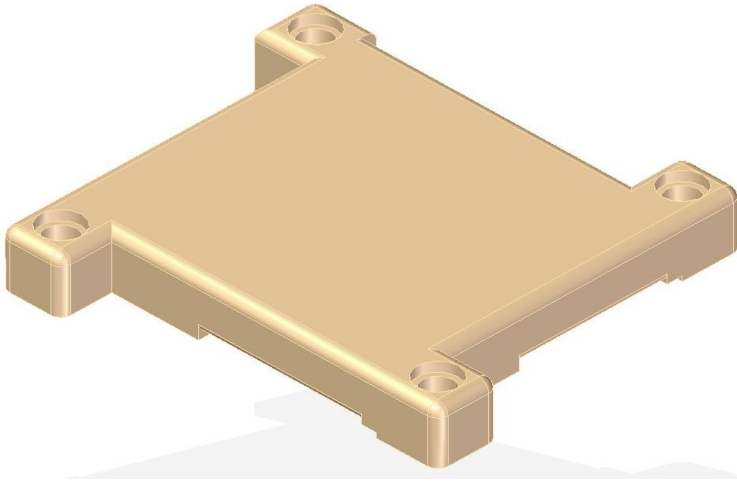


Figure 12 3D profile of the plastic lid

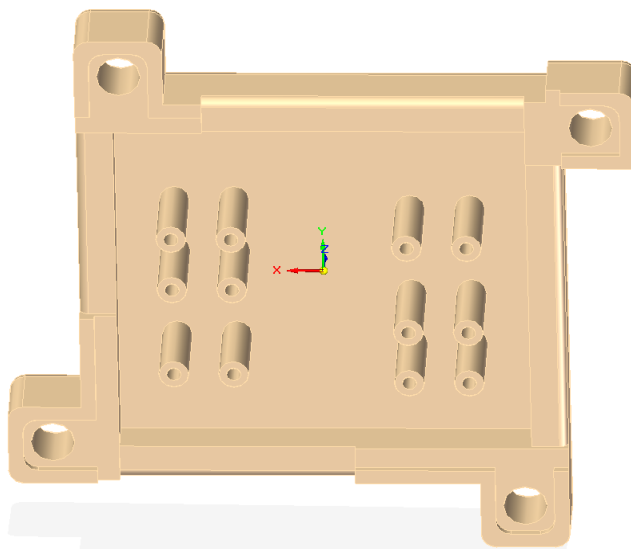


Figure 13 Backside view of the plastic pillars

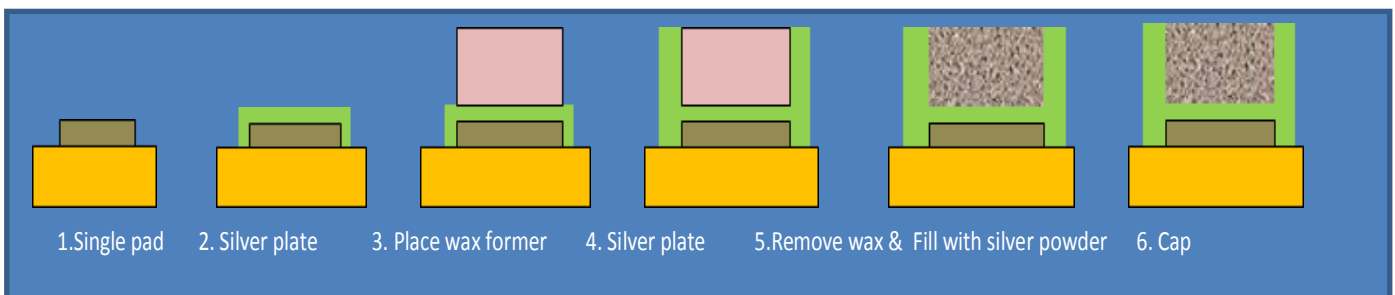


Figure 14 Schematic of Selective layer additive Manufacture process



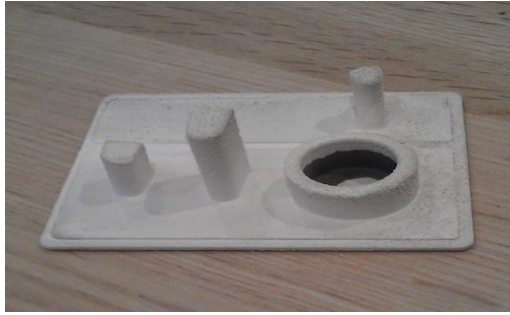


Figure 15 Silver plated wax coupons



Figure 16 Development Plating Tank



Figure 17 Thermal shock equipment

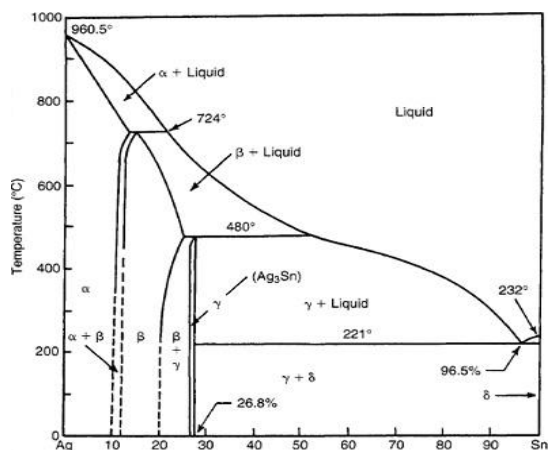


Figure 18 Equilibrium Diagram

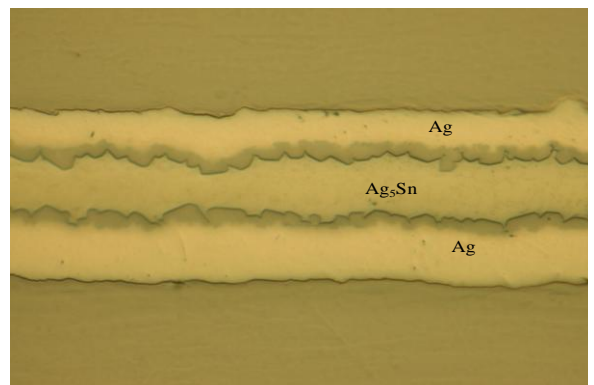


Figure 19 Multi layer plating



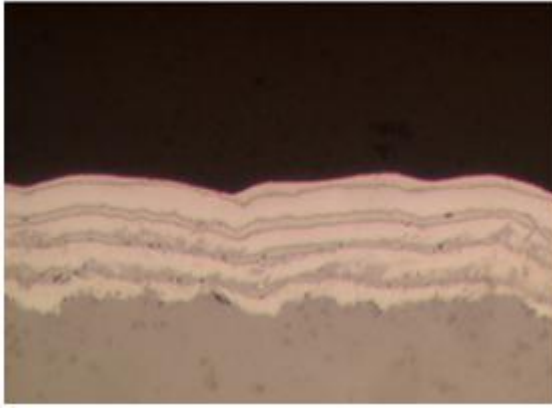


Figure 20 Single layer plating

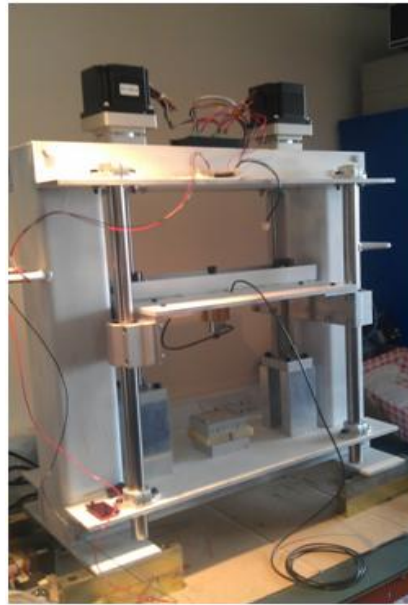


Figure 21 Pick/place machine



Figure 22 Fluidised bed



Figure 23 Photo's of Ormerod 3d printer and Eosint equipment

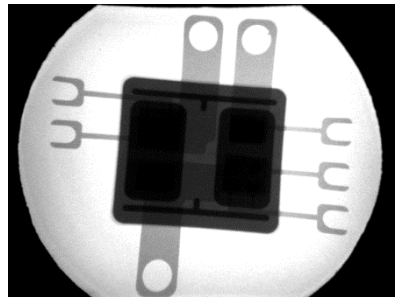
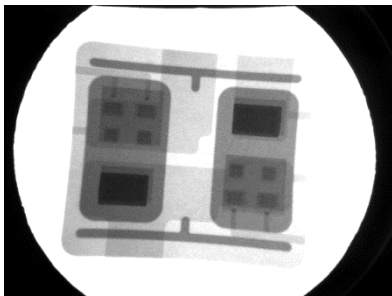


Figure 24 Xray images of the SAM

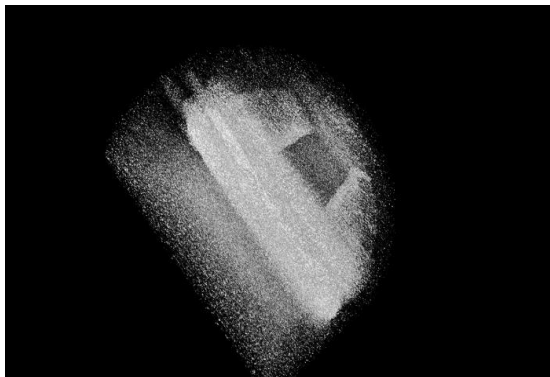
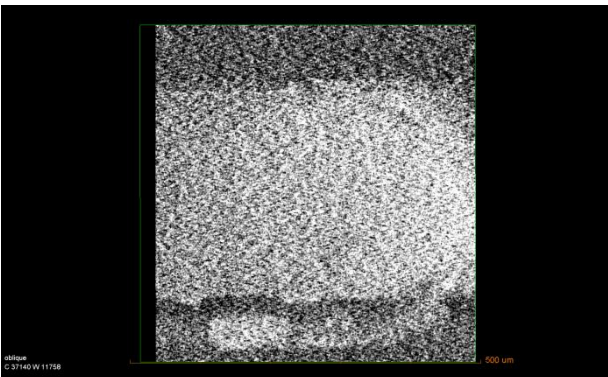
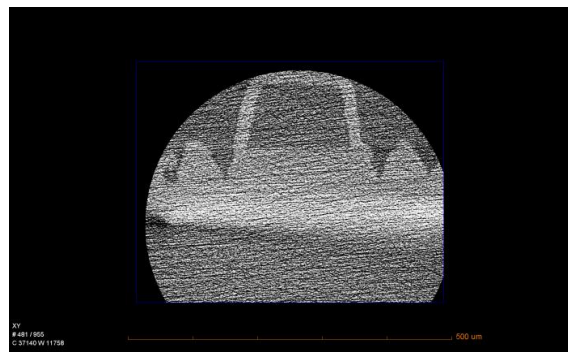
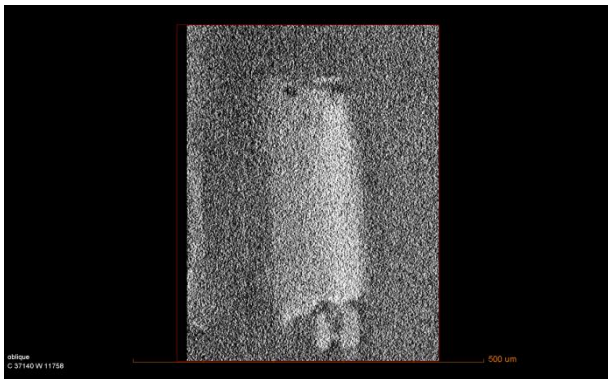


Figure 25 Tomography of sinter connection

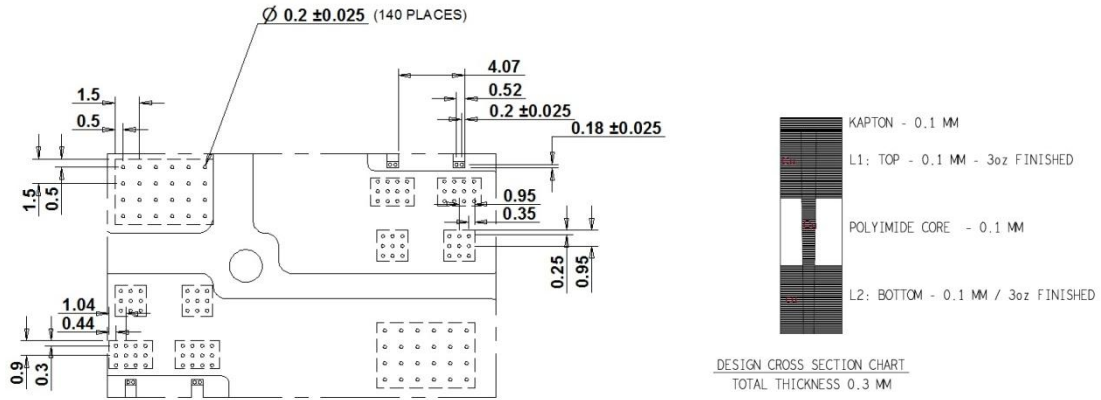


Figure 26 Cu-filled via size and distribution & Cross section of PCB

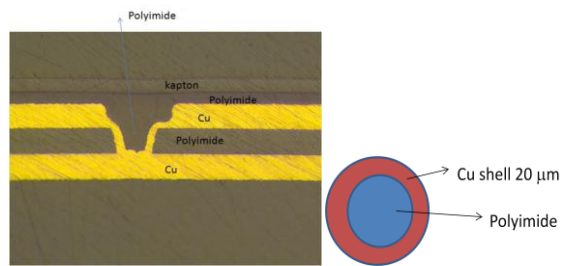


Figure 27 PCB Core Cross Section

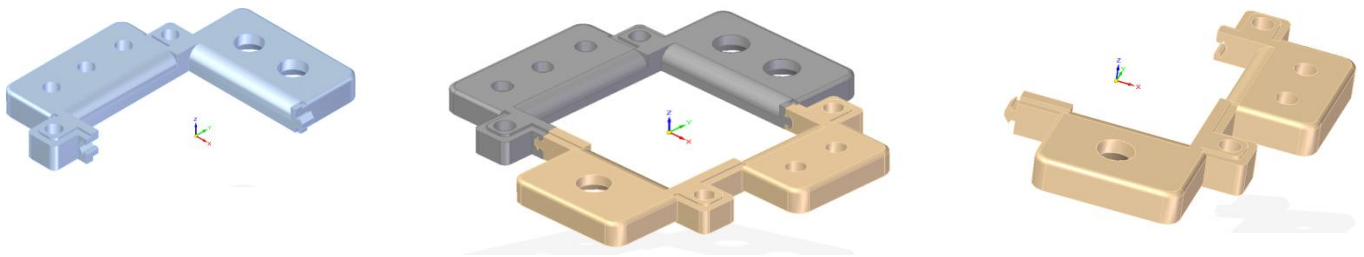


Figure 28 Frame design



Figure 29 New gel / old gel

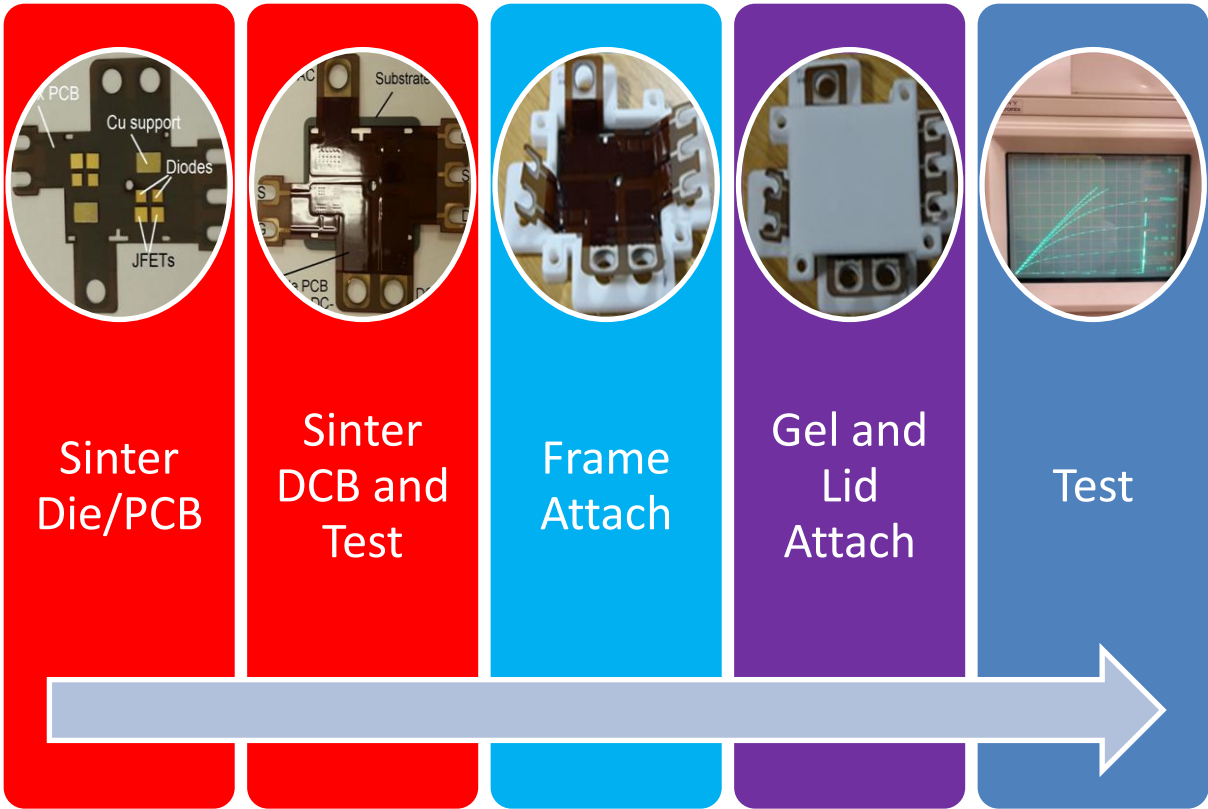


Figure 30 Final process route