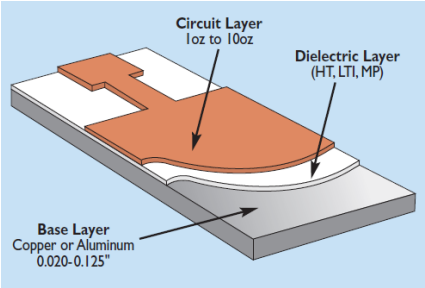
Processing of IMS with diamond coated tools

At high power LED's and power elements the quick heat conductivity of the thermal loss have a crucial impact in the lifespan of the semiconductor. Most significant parameter for an efficient cooling are the substrates specified as IMS (Insulated Metal Substrates, picture 1) or metal core pcb.



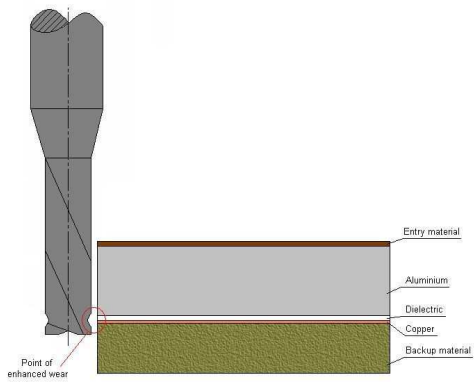
Source: dacpol.eu

Picture 1: Structure of IMS

For the base layer aluminum or copper are used as metal substrate. These metal substrates have mostly a thickness between 0.80 - 1.60 mm, in extreme cases up to 6.20 mm (picture 2).

Picture 2: 6.20 mm thick IMS (each)

If the IMS are designed for high thermal stress, more often copper is used as metal substrate. Advantages of copper are better thermal conductivity and storage capacity with coexistent lesser expansion coefficient against aluminum.
Beside the base layer the dielectric layer has high impact on the thermal conduction of the IMS. Particularly dielectric layer with high ceramic fillers reduces the tool lives of the drills and routers in the mechanical processing because the typically used tungsten carbide tools have a lower hardness than the ceramic fillers (picture 3).



Picture 3: High router wear from the dielectric of IMS

Therefore more and more manufacturer are using diamond coated tools for processing IMS. GCT is developing and producing all tools in Germany. An overview of different geometries for drilling, routing, producing of inner thread and scoring are shown in picture 4.

Picture 4: Diamond coated tools – Made by GCT in Germany

In cooperation with a big IMS manufacturer, GCT optimized the single flute end mill geometry with improved multi-layer diamond coating for the processing of copper IMS.

Picture 5: Diamond coated single flute end mill type 1312

Beside the tool geometry we investigate the drilling and routing parameter for copper IMS and optimized them to fulfil the higher requirements. Because of higher mechanical strength properties, in particular 3 times higher density, the machining of copper is more troublesome than of aluminum.

Comparison of routing parameter for router-Ø 2.0 mm:

	Aluminum	Copper	Difference
Spindle speed	34000 rpm	30000 rpm	- 12 %
Feed rate	up to 2.0 m/min	max 1.20 m/min	- 40 %
Tool life	100 - 120 m	50 - 60 m	- 50 %

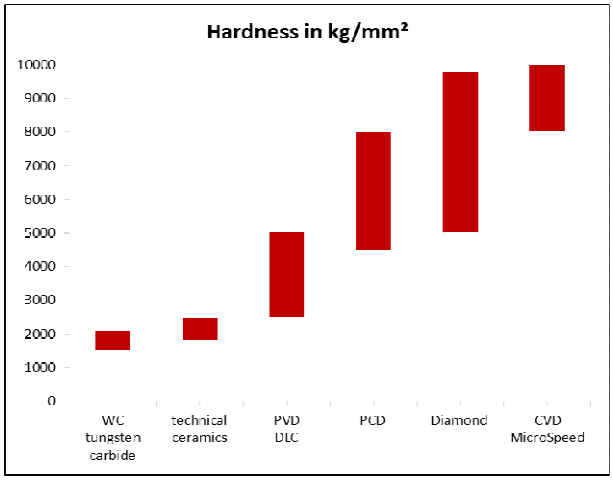
The updated drilling and routing parameter are ready for downloaded from the GCT website at https://www.gctool.com/en/applications/ims.html.

More often metric inner thread at IMS are required. Therefor tools with diamond coating (picture 6) are available too.

Picture 6: Diamond coated tool type 1940 for inner thread

Parameter recommendation for ISO thread M3 x 0.5 in aluminum IMS, 1.50 mm panel thickness
- Spindle speed 30000-35000 rpm
- In-feed 1.50 ± 0.50 m/min; depending of thread depth and quality requirement

Explanations why diamond coated tools allow 3-4 times higher feed rates and up to 20 times longer tool life shows the table in picture 7. The GCT MicroSpeed diamond layers are produced in a CVD process. Because of the purity grade of the coating process the hardness is as high as of natural diamond.



Picture 7: Hardness of different materials
Pictures 2-7: source GCT GmbH

Increasing quality requirements, as e.g. reference holes with diameter tolerances of 0/+0.008 mm and inner- or outer contours with dimension tolerances of ± 0.05 mm can be manufactured are reproducible with diamond coated tools.

Advantages of diamond coated tools:

- cost savings >25% due to higher tool life and improved quality
- increased productivity due to higher feed rates, fewer tool changing's and reduced handling
- process capability due to significant lower tool wear and higher dimensional accuracy
- the ability to machine new/or difficult to cut materials

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