Mechanical Processing of PCB for Power Electronics

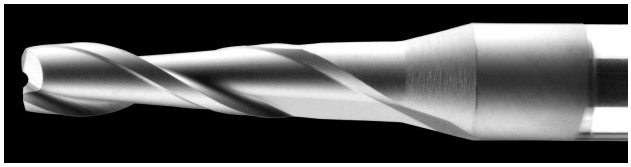
IMS - Insulated Metallic Substrate – are the ideal solution for thermal challenges in the LED- illuminating market, for power conversion, motor relays and heat-rail applications. They have a minimal thermal expansion, minimal heat spreading and a very efficient heat removal.

Aluminium with a thickness between 1.0 and 3.0 mm is mostly used in metal carrier; more seldom copper with a thickness between 1.0 and 1.50 mm is used. FR4 prepreg or ceramic layers are used as dielectric fluid.

The processing of IMS, mostly aluminium with a thickness of 1.60 mm thickness and very often with ceramic dielectric layer, is a challenge for all production departments. Special tool geometries are ideally adopted for drilling and routing metal carriers. The optimization of process parameters requires a lot of experience. In addition, the machines have to fulfill certain requirements, e.g. marginal vibrations and collet run-out. Minimal quantity lubrication is perfectly suited for routing.

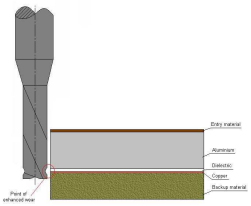
Diamond coated drills (picture 1) and end mills (picture 2) become more and more accepted for the mechanical processing of IMS.

Picture 1: diamond coated drill - GCT Type 1638



Picture 2: diamond coated end mill - GCT Type 1322

Ascertainment:
At IMS with ceramic dielectric the tool life is reduced drastically due to the ceramic layer (picture 3). Depending on required quality and backup thickness re-setting of the router tip height increases tool life.



Picture 3: increased tool wear caused through the ceramic layer

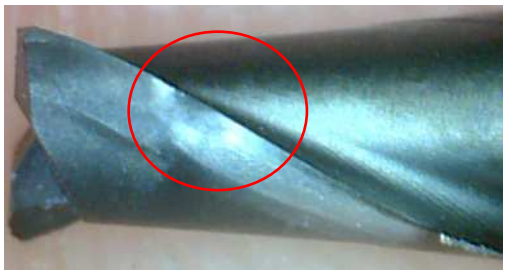
Application drilling:

- material	Denka KGW15 Z5 2W-Al5052-70µm ceramic	
- thickness	1.60 mm	
- drill	GCT 1638, Ø 1.55 x 7.0 mm	special design of uncoated drill, Ø 1.55 x 9.0 mm
- spindle speed	42000 rpm	35000 rpm
- infeed fz	1.70 m/min	1.40 m/min
- hit count	1000 hits	250 hits with step drilling in 5 steps

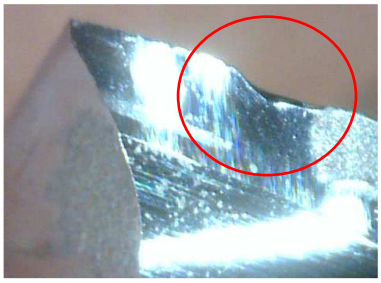
Picture 4: drills after use

Application routing:

1. material	ITEQ	
- thickness	1.60 mm single panel	
- end mill	GCT 1322, Ø 2.0 mm x 6.0 mm	uncoated end mill, Ø 2.0 mm x 8.0 mm
- spindle speed	33000 rpm	26000 rpm
- feed rate fxy	0.90 m/min = 15 mm/s	0.24 m/min = 4 mm/s
- tool life	60 m	7.50 m

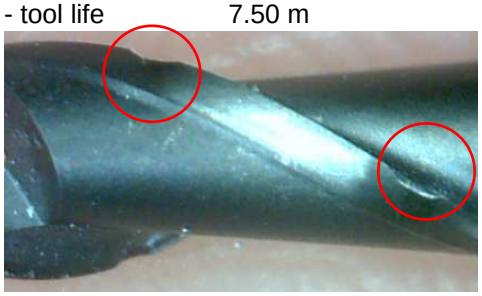


Picture 5: diamond coated 2f end mill

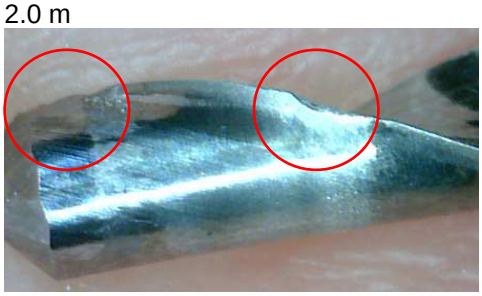


Picture 6: uncoated end mill

2. material	Bergquist Thermal Clad	
- thickness	1.80 mm, 2 panel/stack	
- GCT end mill	1322, Ø 2.0 mm x 6.0 mm	uncoated end mill, Ø 2.0 mm x 8.0 mm
- spindle speed	33000 rpm	26000 rpm
- feed rate fxy	0.72 m/min = 12 mm/s	0.24 m/min = 4 mm/s
- tool life	7.50 m	2.0 m



Picture 7: diamond coated 2f end mill



Picture 8: uncoated end mill

Advantages of diamond coated tools:

- increased productivity due to 3-4 times higher feed rate
- cost savings due to longer tool life by factor 12
- process capability due to obvious less tool wear and higher dimensional accuracy
- considerable better quality due to the low friction coefficient of diamond and the very low tendency to form a built up edge
- less tool changing's and less handling

Summary:

- The costs of mechanical processing of IMS are primarily affected by the appropriate choice of tools and parameter. Diamond coated drills and end mills assure a high dimensional accuracy and process capability and are used globally in the meantime. Particularly diamond coated tools have become widely accepted with the mechanical processing of IMS as well as with printed circuits boards' materials with fillers.
- From the technical view particularly collet run-out and vibrations have a high impact on tool life and surface quality.
- In the mechanical processing of IMS tool life and quality are positive affected by using of a minimal quantity lubrication unit.
- With ceramic dielectrics the recommended spindle speeds have to be reduced by 20 %. The tool life will be reduced approx. to 25% in comparison to FR4 dielectrics.

GCT GmbH in Weingarten is a worldwide leading manufacturer of diamond coated tools for the mechanical processing of printed circuits boards. To meet the fast growing demand a further investment into capacity of 1.0M diamond coated tools is planned in the next few months.

Author: Johann Schmidt, Head of Technical Department GCT GmbH, 88250 Weingarten, Germany, johann.schmidt@gctool.com, www.gctool.com