

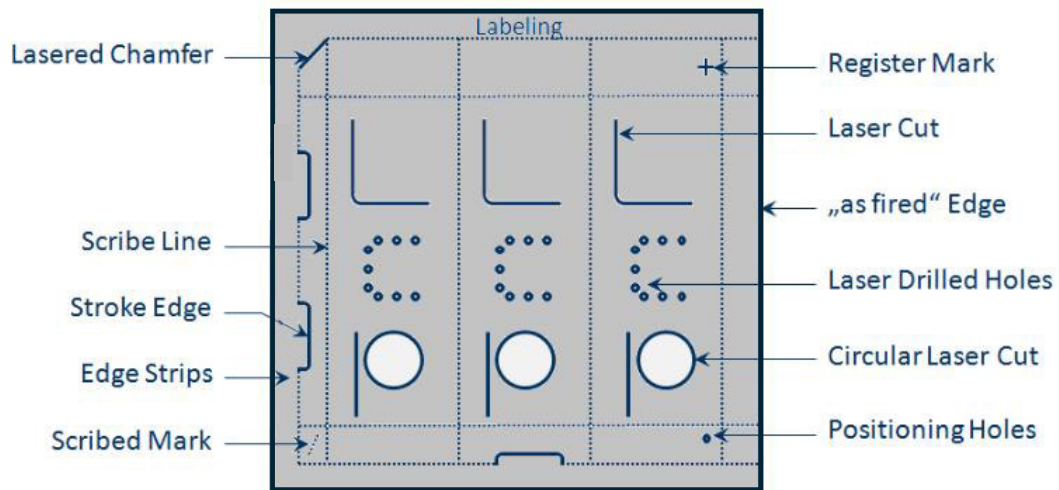


Laser Processing (Scribing, Drilling, Cutting, Ablation)

Below you will find an overview of the design guidelines, quality standards and test methods used in the processing of Al<sub>2</sub>O<sub>3</sub> benefit substrates.

In addition to our standard raw substrates, we also laser process ceramics with thicknesses between 0.09 and 2.0 mm and maximum dimensions of 350x350 mm<sup>2</sup>. By default, CO<sub>2</sub> laser sources are used. The laser processing is independent of the shaping process of the substrates.

The following illustration shows an overview to the different possibilities of laser processing in thick-film alumina substrates. Moreover, the layout can be aligned with camera systems by using the edges of the blank material, register/ print marks or similar objects.

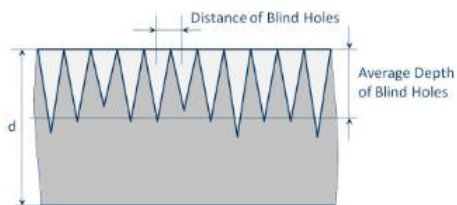




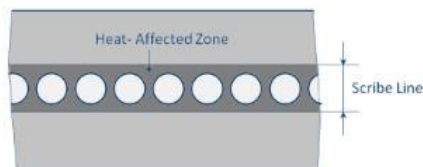
## Design Guideline Ceramic AL<sub>2</sub>O<sub>3</sub>-applications

Laser Scribing Among other things the LCP Laser-Cut-Processing GmbH offers the laser scribing in ceramics. With this process closely in a row positioned blind holes were generated in the surface of the material to originate a perforation line which is used as predetermined breaking point by separating the ceramic parts. The depth and distance of the blind holes are also realizable by the customer's specification.\*

Scribe line - cross section



Scribe line – top view



a. Position accuracy of scribe lines (unseparated condition)

Nominal dimension  $\pm 0,050$  mm

The tolerance is valid for the distance between scribe lines among one another as well as the distance between scribe lines and scribed external contours (unseparated condition) in case of generating them in the same process. If external contours are already present, the position accuracy refers to the declared attachment points or position marks

b. Distance between scribe lines

To separate scribed contours near it is recommended to have a distance of three to five times of the substrate thickness between the scribe lines among each other and between first scribe line and external contour. The edge between the customer's component and the external contour is usually removed. The behavior during separating along the scribe lines is affected by the substrates quality and the chosen parameters for depth and distance of the blind holes

c. Tolerances of length/ width between scribed external contours depending on substrate thickness (separated condition)

Substrate thickness d [mm]	Tolerance limits [mm]	
$\leq 0,63$	- 0,050	0,150
$\leq 1,00$	- 0,050	0,200
$\leq 1,50$	- 0,050	0,350
$\leq 2,00$	- 0,050	0,500

d. Distance and depth of blind holes depending on substrate thickness (from break edge to break edge)

	Substrate thickness d [mm]	distance [mm]	depth [mm]
96% Al <sub>2</sub> O <sub>3</sub>	0,25	0,140 $\pm$ 0,020	0,140 $\pm$ 0,040
	0,38	0,140 $\pm$ 0,020	0,170 $\pm$ 0,050
	0,50	0,150 $\pm$ 0,020	0,200 $\pm$ 0,050
	0,63	0,150 $\pm$ 0,020	0,250 $\pm$ 0,050
	0,76	0,150 $\pm$ 0,020	0,300 $\pm$ 0,050
	1,00	0,160 $\pm$ 0,020	0,400 $\pm$ 0,050
	1,27	0,180 $\pm$ 0,020	0,500 $\pm$ 0,050
99% Al <sub>2</sub> O <sub>3</sub>	0,25 - 1,00	0,100 $\pm$ 0,020	(see 96% AL <sub>2</sub> O <sub>3</sub> )

The tolerances are valid for at least 90% of the blind holes. The named distance is an average value of not less than 10 blind holes. Other specifications according to the blind holes of scribe lines.