Scribing and cutting of silicon and alumina ceramics using fibre lasers

A. Rosowski[1,2], N. Walsh[1,3]

1- SPI Lasers UK, Pulsed Applications Laboratory, Unit 3, Wellington Park, Southampton, SO30 2QU, UK
2- Institute for Manufacturing (IfM), Department of Engineering, Cambridge University, 17 Charles Babbage Road, Cambridge CB3 0FS, UK
3- Department of Physics, University of Bath, Claverton Down, Bath, BA2 7AY, UK

Corresponding author: adam.rosowski@spilasers.com

Scribing and cutting are very important processes for the electronic industry including solar cell manufacturing to separate electronic elements or preparing substrate for further manufacturing steps. Historically cutting was performed using diamond saws or water jets, but it was a very expensive and difficult process, especially for thin wafers which are very commonly used.

Currently laser machining is the most popular method to separate semiconductor and ceramic elements. Lasers offer a non-contact method, a lot of flexibility, good quality and very high cost efficiency. In case of laser processing there are two methods: cutting and scribing. If the full cut is made all the way through the material, this can cause some damage to the edge quality. The 'scribe and break' method involves making a scribe along the wafer, this initiates a crack over the crystal plane along which the silicon can then be snapped. By doing this less physical cutting is needed and minimizes the damage done to the crystal structure.

Green and UV lasers are commonly used to process semiconductors and ceramics mainly due to high absorption coefficient and opportunity to achieve small spot size. It results in very high-quality scribes, but at low speed and at very high costs.

However, nanosecond fibre lasers can offer acceptable quality, but at massively higher processing speeds at more attractive costs. The success of fibre lasers is mainly due to good beam quality, high stability, flexible pulse parameters, low cost $/W and no requirement for maintenance. The key advantage of MOPA based pulsed fibre lasers is the electronic control of pulse characteristics which allow users to optimise pulse shape to achieve higher processing speed at better quality.

In this presentation influence of beam quality, temporal pulse shape including pulse peak power and pulse duration of nanosecond fibre lasers on cutting and scribing of selected semiconductor and ceramic materials will be presented. Correlation between laser parameters and achieved grove shape will be shown in detail and discussed. This presentation will be focused on monocrystalline and polycrystalline (the most important material for solar cell industry) silicon and aluminium oxide ceramic.