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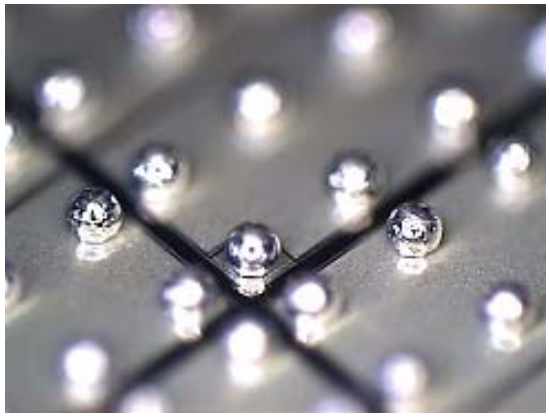
Application Note No. 104

Cutting of Wafer Bump Stencils with SYNOVA Laser-Microjet®



Description of Product

Solder mask stencils are metal or plastic perforated sheets used to apply solder paste to land locations where the paste will be re-flowed to attached electronic components.

The wafer bump stencils are used for screen-printing solder paste or conductive adhesives onto wafers for bumps used in Chip-on-Board connections. By fabricating "wafer bumps" as the chip interconnections, these connections have several advantages over standard lead-frame packaging.

More compact board designs are possible since the chip connectors are directly under the chip. This results in much shorter chip interconnections and lower parasitic noise.

Description of Material

Stencils are made of stainless steel, Nickel or Polyimide (Kapton®). Thickness ranges between 50 and 100 microns.

Description of Manufacturing Task

A big number of small apertures must be drilled in the metal or plastic sheet. The apertures must be made a slight angle allowing the paste to be detached from the mask. The apertures can be square or round and the radius of square/rectangular holes must be as small as possible. Precision, quality and speed are paramount.

Description of Conventional Manufacturing Process (State of the Art) and Problem

The apertures can be achieved by punching, etching or laser cutting. The laser cutting has the advantage of high flexibility, speed, and is able to cut very small apertures. The actual problem of the laser cutting is the cut quality. In fact, the laser cutting needs a post-treatment to clean the stencil and remove burrs on the backside.

Water Jet Guided Laser Technique

In 1993, scientists at the Institute for Applied Optics at the Swiss Federal Institute of Technology Lausanne succeeded in creating a water jet-guided laser, called by its inventors Laser-Microjet®. The laser beam is focused in a nozzle while passing through a pressurised water chamber. The geometry of the chamber and nozzle are decisive to coupling the energy-rich laser beam in the water jet.

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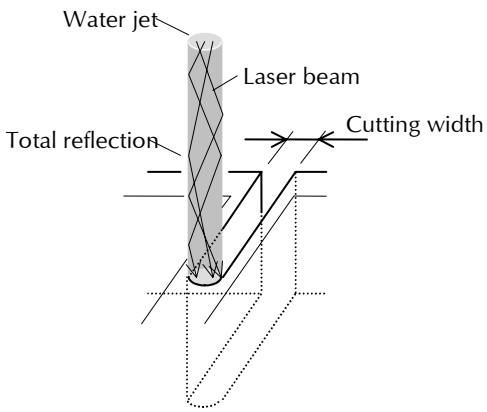
The low-pressure water jet emitted from the nozzle guides the laser beam by means of total reflection at the transition zone between water and air, in a manner similar to conventional glass fibres. The water jet can thus be referred to as a fluid optical wave-guide of variable length.

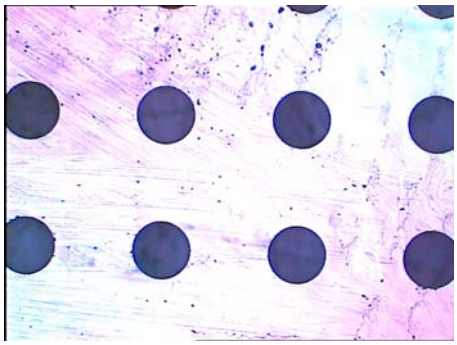
Because a pulsed laser is used, the continuous water jet is able to immediately re-cool the cut, resulting in only a very slight depth of thermal penetration. The result is a very narrow, parallel, burr-free, clean cut, without any thermal damage.

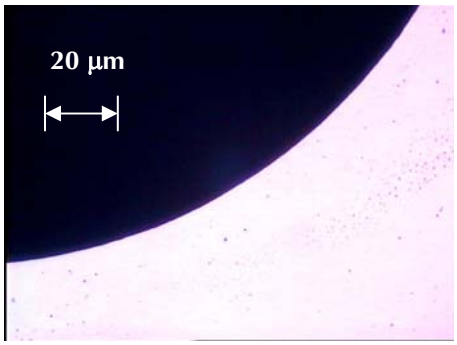


Cutting with water jet guided laser

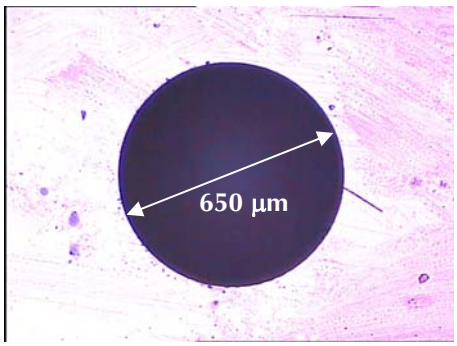
Solution with Laser-Microjet® Process

The holes can be drilled in two ways: firstly, in moving the axes in a circular motion ("trepanation drilling") or secondly, without moving the axes ("percussion drilling"). For the trepanation, the hole diameter is at least three times bigger than the laser beam diameter. Very precise holes are possible. Percussion drilling allows very small holes and high speed but the roundness is less precise. Results of trepanation drilling:

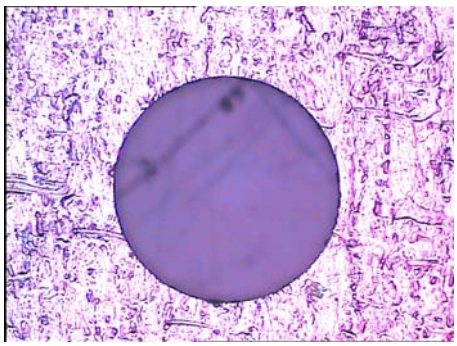

Matrix of 10x10 holes in a 50-micron thick stencil



500x magnification



hole, front


hole, back

The Laser-Microjet® can cut up to 120 round apertures per minute in a 50 micron thick nickel stencil, applying the trepanation method.

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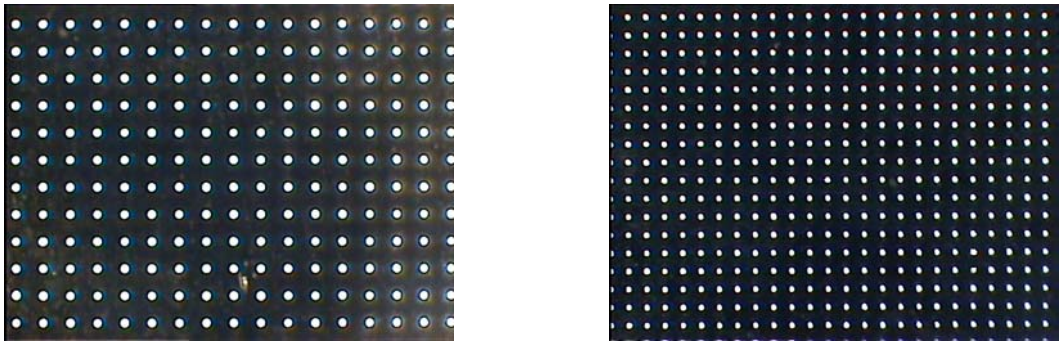
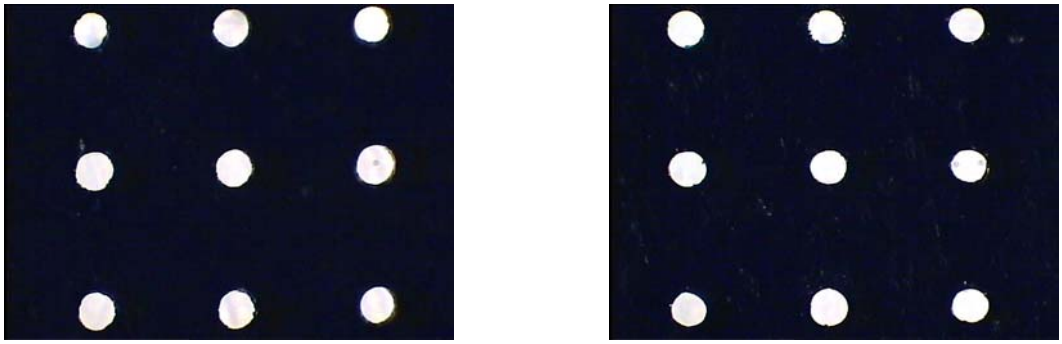
Results of percussion drilling:



Matrix of 50x50 holes (2500/cm^2) in a 50 um thick foil



60 micron diameter hole, front *50 micron diameter hole, back*

The Laser-Microjet® can drill up to 300 round apertures per minute in a 50 micron thick stencil, while applying the percussion drilling method. Drilling time is between 50 and 200 ms per hole, resulting in a speed of up to 72,000 holes per hour.

Benefit for the customer

The customer obtains now the following advantages:

- High speed
- Excellent cutting quality
- Burr-free
- No post treatment necessary
- Very low tolerances
- No heating of the sheet, no warping and thermal deformation
- No mechanical damages, no scratching
- Machine laser class1, completely closed, clean room compatible
- Very compact machine due to gantry axes (fixed stencil – moved laser head)
- No cutting gas
- More ecologically conscious process, because particles are absorbed in the water

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Consequence of the benefits

Because of the important improvement in quality compared to conventional laser stencil drilling; the Laser-Microjet® process will be the best choice for wafer bump stencil cutting in the future.

Machine for Laser-Microjet®[1] Cutting of Wafer Bump Stencils

Synova offers a state-of-the-art machine, especially adapted for the cutting of Wafer Bump Stencils. Optimum cutting parameters are preloaded. The machine designation is LSS 800. Due to the gantry axes system, the machine size is very small, the stencil does not move. Water jet diameter can be from 30 to 75 microns

The machine has a precision of +/- 5 microns, a processing area of 700 x 900 mm, a maximum axis velocity of 1000 mm/s. The system is equipped with a CCD camera and fast image treatment software, allowing automatic alignment and inspection.

The operation interface is a 15-inch flat colour screen with touch panel, the machine software is based on MS Windows NT®[2]. The machine can be connected to a LAN network for data transmission. The integrated modem allows remote diagnostic service. Adapted CAM software can convert all DXF and Gerber data, fast and easy without any special programming.

A complete list of options is available such as chiller, alternative laser sources, water treatment system, reference scales, and transformers.

The Synova machines have been repeatedly field proven and are used for 24h industrial production.

[1] Laser-Microjet® is an international protected trademark of Synova S.A, Switzerland.
[2] Windows NT® Is a trademark of Microsoft Corp.

