Development of Laser Drilling Systems for 300mm Vertical Probe Cards

D. M. Karnakis, J. Baker, A.J. Kearsley, A. Ferguson, M.R.H. Knowles
Oxford Lasers Ltd., Moorbrook Park, Didcot, OX11 7HP, United Kingdom Tel: +44 1235 814433

Introduction

- increasing demand for full area 300mm wafer probing
- for vertical probecards, pin position over these larger areas is critical
- results in higher accuracy demand on the drilling technology.

Mechanical and laser drilling are the most commonly used drilling technologies. As pin count per card increases then drilling reliability must increase to avoid poor yield.

Pin position is effected by the hole position and hole geometry.

- true position accuracy of the XY motion axes
- machine stability (thermal, mechanical and vibrational). holes.

Vertical Probe Card Drilling Requirements

- 2 or 3 drilled plates per assembly.
- Typical hole diameters 50 micron (2mils) to 100 micron (4mils)
- Tolerances in the range +/-1 to +/- 4 microns.
- Mainly circular drilled holes, some square, rectangular or elliptical holes.
- Materials include polyimide type polymers, ceramics and silicon.
- Hole position accuracy to within +/-1 to +/-3 microns 2D true position over full area (up to 300mm diameter).

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Laser Drilling System Design

Key requirements are accurate and repeatable hole geometry and accurate hole positioning.

Analysis shows that final performance of the tool depends on more than one sub-system.

	Primary	Secondary
Laser	Hole Geometry	Hole Position
Optical System	Hole Geometry	Hole Position
Mechanical Structure	Hole Position	
Positioning System	Hole Position	
Vision System	Hole Position	
Software		
Process Conditions	Hole Geometry	

Mechanical Structure

For high accuracy tool such as this, granite is material of choice and has the following advantages :

- Good damping properties
- High thermal stability
- High & dynamic stiffness
- Free of stress
- Corrosion free, non magnetic
- Extremely flat - necessary for use with air-bearing XY axes
- Low maintenance

Main mechanical structure consists of a large granite base and an upper granite platform supported by two large granite pillars permanently bonded together resulting in highly stiff structure.
Granite base is separated from the machine frame by a system of vibration dampers which isolate the machine from floor vibrations above 7 Hz.

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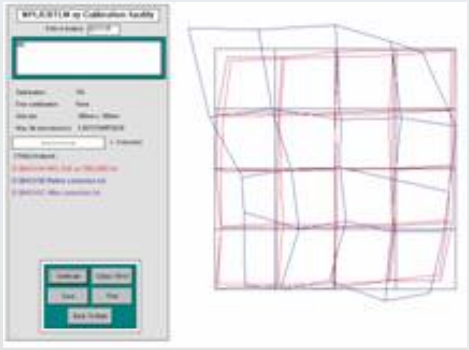
Positioning System

Air-bearing systems are employed, resolution 1nm linear
Repeatability +/- 0.2 micron and accuracy +/-0.5 micron respectively.

Main sources of 2D errors are orthogonality, straightness, pitch, roll and yaw.
Without 2D calibration then the maximum 2D position error is 3.8 microns.
Following 2D calibration then maximum error is 1 micron.



Blue - before 2D Calibration
Purple - after 2D Calibration

Optical Trepanning System

- Proprietary 3rd generation laser optical trepanning system.
- Scans the laser beam in a perfect circle at high speed
- Produces a rounder hole and with better wall and edge quality than any other method.
- Precise computer control of the exact hole diameter (programmable increments of 0.05 microns diameter).

Optical Taper Correction System

- Enables the user to program exact changes in the optical taper
- Used to produce perfectly cylindrical holes or holes with positive or negative taper.
- Enables the user to produce the perfect hole profile match to their requirements.

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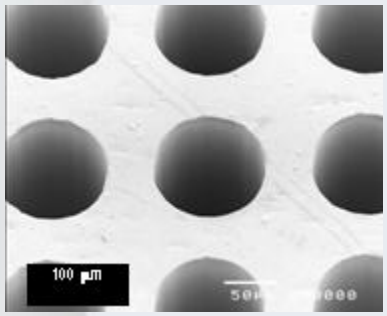
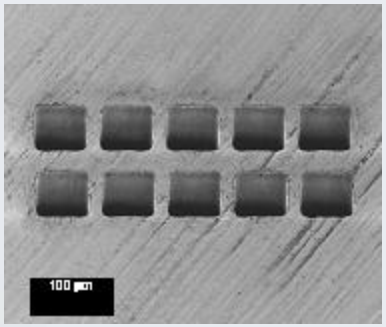
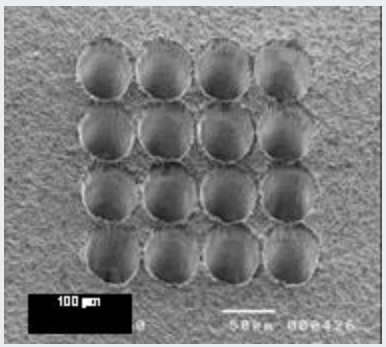
Process Results



100 µm holes in polyimide



Rectangular holes in SiN



50 µm holes on 60 µm pitch in SiN

Laser Tool

Automated laser drill tool
Class 1 laser enclosure
Library of Drilling Modes and Settings