Die Zukunft ist dreidimensional - 3D MID Technologie in der Sensorik
Häcker Automation GmbH

- Machine manufacturing company
- Owner-managed
- Based in Germany
- Operating since 1995
- Approx. 50 Employees
- Core areas of competence
  - 3D Micro Assembly
  - Micro + Nano Dispensing
  - Micro Laser Soldering
Häcker Automation GmbH – Die Zukunft ist dreidimensional

- **Products**
  - **VICO processing platform**
    - Machine platform for complex packaging and interconnection
    - Flexible, 3D ready, precise and robust
    - Wide spectrum of technologies integrated
  - **Service & Maintenance**
    - Availability guarantee
    - Preventively maintenance & inspection
    - Long-term security for your costs
  - **Technology Partner**
    - Technology consultancy
    - Project support through specialists
    - Flexibility and dynamics
  - **Alliance of Innovators**
    - Strategic alliance of innovative partners
    - Tightly coordinated product and process innovation
    - Edge through exclusivity within the market
Approach: Using a highly modular machine concept

- **Aims**
  - Precision
  - Flexibility
  - Scalability

- **Standard machine platform**
  - Providing standard functionality required by modern industrial micro assembling processes
  - Offering capabilities for flexible expansion of functionality

- **Extension modules**
  - Standardized devices with defined functionality
  - Interoperable
  - Easy installation, set-up and removal
Standard machine platforms

- **VICO X Tec**
  - 3D Micro Assembly System
  - High precision movement system
    - Working area: approx. (500 x 500 x 150) mm
    - Repeatability: ±0.001 mm
  - Control software
    - Win32-Application with GUI

- **VICO Laser**
  - Micro Laser Soldering System
  - Class 1 laser
  - High precision movement system
    - Working area: approx. (500 x 500 x 150) mm
    - Repeatability: ±0.001 mm
  - Control software
    - Win32-Application with GUI
Extension devices

- Standard machine platforms can host extension devices
- Covering various application fields
- Over 70 devices (at the moment)
  - freely combinable
  - permanently evaluated and improved
  - device pool steadily enhanced
- Communication between base machine and extension devices by CAN industrial bus system
  - short set-up times
  - easy (re-)configuration of machine/devices
  - real-time communication
Main challenges of 3D MID

2D Substrates
- Placing/Dispensing on plane surfaces
  - i.e. PCB

2D Recognition
- (X,Y,Θ) Recognition/inspection of plane surfaces

2D Adjustment
- (X,Y) Moving of substrate/tool to match exact position for placing/dispensing process
Main challenges of 3D MID

**3D Substrates**
- Placing/Dispensing on uneven surfaces
- i.e. 3D MID

**3D Recognition**
- \((X,Y,Z,\Theta)\) Recognition/Inspection of uneven surfaces/object positions

**3D Adjustment**
- \((X,Y,Z,\Theta_{X,Y,Z})\) Moving of substrate/tool to match exact position for placing/dispensing process
3D Recognition

- 3D Camera Head
  - Extension device for VICO platform
  - Characteristics
    - Several modules with search areas (3.25 x 2.425)mm or (6.5 x 4.85)mm
    - Accuracy from ±2 μm up to ±4 μm
  - Functionality
    - Angularly mounted cameras
    - Control software calculates from captured image data component’s surface condition (X,Y,Z)
  - Benefits
    - Automated 3D recognition of substrates/parts
    - Correction from level offset of components to ensure a coplanar assembly
3D Adjustment

- 3D Alignment Support
  - Extension device for VICO platform
  - Function: to get working position horizontally adjusted
  - Tool head can reach every point within complete half-space above substrate
  - 2 Axis movement system
    - Rotation axis (>360°)
    - Tilt axis (≤100°)
  - High precision movements
  - Adapter to enable mounting of substrates of different designs

- Inline 3D Alignment Support
  - 3D Alignment Support in combination with SMEMA conveyor
  - Optional: light source and heating
3D Manipulation

- 3D Manipulation Unit
  - consists of 3 linear and 2 rotating axes offering real 3D adjustment
  - can host parts as well as tools
  - by combining several 3D manipulation units complex movement sequences can be implemented
  - hand-over of components
  - full space adjustment and sophisticated micro assembly processes (i.e. folding flex PCB)
Extension Devices

- **3D Adjustment** (3D Substrate Carrier)
- **3D Recognition** (3D Vision System)
- Dispensing Options
- Substrate Transport
- Placement Options
- Wafer and Part Handling
- Selective Laser Soldering
Dispensing Options

- **Dispensing Heads**
  - Feedback loop-controlled dispensing
    - Robust against changing characteristics of dispensing material
  - Capable of solder paste application
    - Solder class: 3 – 6
    - Volumes: >4 nl

- **Direct Dispensing Station**
  - Applying structures on substrates (pin transfer, stamping)
  - Areal application of fluids on subside of parts

- **Assistance Devices**
  - Needle Calibration Unit
  - Needle Cleaning Unit
  - High-Precision Balance
Placing Heads

- 2D Placement Head
  - Z-Axis stroke: max. 150 mm
  - Positioning accuracy: <±5 µm

- 3D Placement Head
  - 3D Adjustment of parts in order to compensate geometrical differences
  - Adjustment
    - Tilting: Θ_{XY} = ±4°
    - Rotation: Θ_{Z} > 360°
  - Z-Axis stroke: max. 150 mm
  - Positioning accuracy: <±5 µm

- Pick-and-Place tools
  - Tools of standard and process-dependable design

UV-Curing Head

- Single/Multiple Spot
Laser Head

- Reflow soldering and wave soldering not possible because of plastic material
- Solution: Selective laser soldering
- Extension device: Laser head
  - Pyrometer-based control loop for energy input
  - Spot diameter: >0.3 mm
  - Soldering profiles for each spot definable
- Successfully processed:
  - 01005 SMD on plastic material
  - LED modules on concave MID
Part and Substrate Handling (I)

- **Flip Station**
  - Bare die processing
- **Waffle Pack**
  - 2 to 4 Inch
- **Gel-Pak®**
- **Tape Feeder**
  - 8mm to 44mm
- **Conveyor**
  - SMEMA-compatible
  - Width-adjustable or fixed
- **Vibratory Conveyor**
Part and Substrate Handling (II)

- Wafer handling
  - Several wafer frames
  - Wafer up to 8 inch
  - Wafer Changing Unit
Future Challenges

- Main goal: release full potential of 3D MID!
- Improving accessibility of working positions on MID’s surface
  - Working range of tool head’s Z-axis
    - Larger cavities
  - Greater working space
    - Half space → Complete space
- Improving batch production capabilities
  - Flexible feeding options
    - 3D MID
    - Parts and components
Conclusion

- Reliable solution for real 3D Micro assembly
- Proven in batch-production since 2001
- VICO systems + Extension devices
  - getting utmost precision and staying very flexible
  - Easy
    - scalable
    - reconfigurable
    - combinable
- Automated inspection as part of assembly process
Thank you very much for your attention

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ありがとうございました

Vielen Dank für Ihre Aufmerksamkeit
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