nanosystec
PRECISION AUTOMATION

NanoWeld

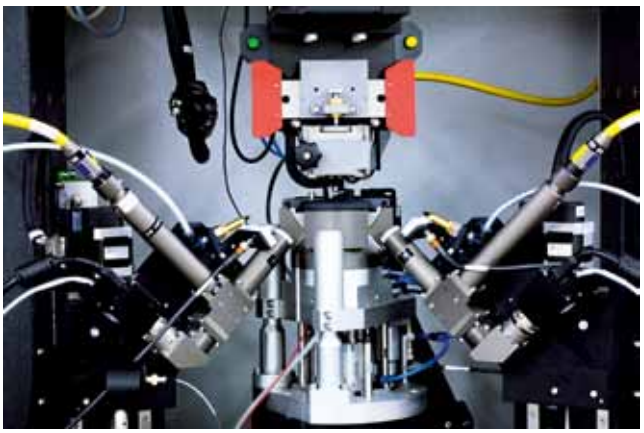
Advanced Alignment and Laser Welding Station for High-Yield Production

NanoWeld

Versatile Production Solution

The NanoWeld stations provide the ideal platform for the development and production of opto-electronic components, like single- and multi-channel transmitters and receivers.

The station works with exchangeable trays and grippers accepting all device housing types and lenses, optical fibers or receptacles to be aligned and attached. Cycle times for the rapid mass production of TOSA type assemblies reach less than 25 seconds while it takes several minutes for complex devices.



NanoWeld Coaxial
A half sphere floating on an air cushion ensures a uniform contact between the two welding surfaces. This results in perfect weld joints with high strength and minimum shift.

Modular Architecture with Device Trays

All components and subassemblies to build the NanoWeld station are of highest quality and performance. Even customized systems start from a common platform which minimizes development time and cost.

By using device-specific trays and grippers, the time to change between different batch processes or device types is reduced to the minimum. Loading and unloading of these trays is performed on a separate loading station outside of the automated NanoWeld. The automated alignment starts from a known reference position.

Working with two identical trays exploits the expensive automated process time most efficiently: one tray is processed inside the NanoWeld system while the operator prepares the next device set outside and just swaps the trays when the process is finished.

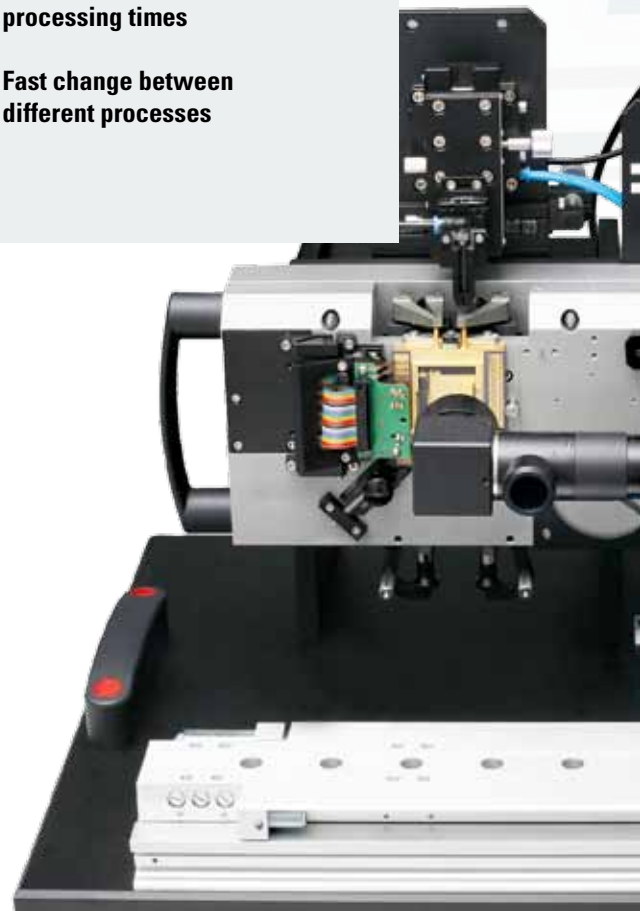
High Precision Alignment

Linear encoders on the alignment stages with linear or DC motors provide 20 nm resolution and a repeatability deviation of less than 100 nm. The stages with stable crossed-roller bearing combine long travel ranges with high speed. This is an excellent basis for unparalleled performance and uptime over a long life time. Fast alignment algorithms pick the initial signal and optimize it by spiral searches, scan routines actuating several axes simultaneously and the feedback via various channels. The starting position is defined by mechanical references and machine vision routines, including edge detection, pattern recognition and autofocus.

Auxiliary axes for moving the weld heads and other equipment are robust stages with stepper or BLDC motors with optical encoders. Their carriages rest on pre-loaded recirculating ball bearings and ensure excellent stability and reliability while the compact size gives high flexibility for the optimum machine design.

Benefits of NanoWeld

- **Fast precision alignment**
- **Low weld shift**
- **Modular building blocks**
- **Tray concept for short processing times**
- **Fast change between different processes**



Laser Welding with Minimum Shift

The design of NanoWeld is optimized for minimum weld shift. Special assemblies using air bearing technology and force sensing bring the parts to be joined into a uniform surface contact.

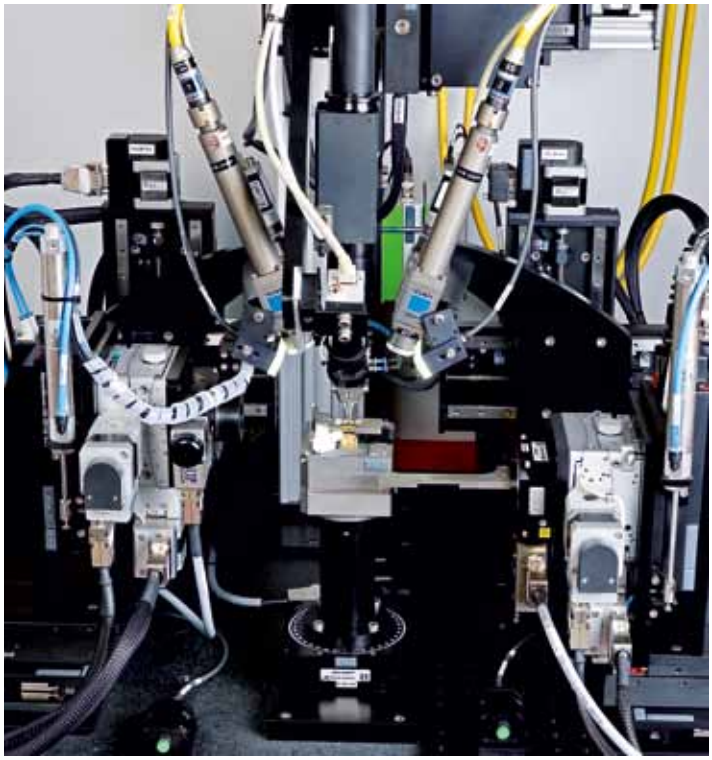
The coaxial system geometry is based on a half sphere floating on an air cushion which self-aligns the welding surfaces. This procedure is fast and does not introduce any unbalanced force. For standard devices, no additional correction welds or bending are introduced. This increases process stability, reduces part failures and shortens process times.

In the linear set-up, auxiliary grippers for weld clips ensure a precise insertion of these structures inside the package with a known force and without tilting. As it is more complicated to control all tolerances in this device geometry, bending procedures correct for the mechanical shift either by applying additional weld spots or by a gentle mechanical procedure using special features in the gripper.

During the system design and process development, all factors influencing the weld shift are considered. The weld laser maintains the splitting ratio with less than 1% deviation among the weld heads and their high precision optics ensure identical spot sizes for the individual partial beams. Spot size and weld parameters are adjusted in order to introduce only the energy which is required for the necessary mechanical strength. In addition, a symmetric weld spot pattern reduces possible shift. Offset values are verified during process development. They are introduced before the respective weld procedures avoiding the known displacement.

Superimposed cross-hairs are adjusted to the center of the CCD cameras which are mounted on the weld optics. The high imaging quality allows for automated machine vision in order to set the weld spots in the ideal positions. Stored pictures of the weld spots support process control.

Loading stations outside of the system are used for mounting the devices and the cycle time inside the automated station is reduced to the minimum. Working with two identical trays provides maximum throughput.



NanoWeld Linear
The precise positioning of the weld heads and their symmetrical orientation ensures repeatable weld joints in the ideal position.

Versatile Software and Process Programming

The process software TestMaster serves as development and production solution with different user interfaces and access levels. Its file structure is process-oriented making it easy to run various device types or batch processes on the same system maintaining a clearly defined structure.

This powerful software package is the result of several decades of practical experience and continuous development. It is programmed in LabVIEW and all instruments and functions are organized in separate VI's. Only the modules for the system hardware will be activated. However, additional functions or instruments can be integrated at a later point in time.

An easy to be programmed sequence editor controls all processes. It is organized in line code but does not require programming knowledge, just a clear understanding of the desired process. Only the commands and hardware configured for the system will be accessible. This reduces typing errors to a minimum. Full access to these programs allows modifying the processes, adjusting parameters and creating new functions.

For users who want to integrate their own LabVIEW programs nanosystec offers a Software Development Kit which documents and defines common interfaces from the TestMaster.

The operator interface for the automated processes is fully customized, e. g. to display important values as well as start and stop buttons for the desired process steps. This interface limits the operator access during the automated process and reduces the complexity.

For the free beam alignment of diode modules, NanoWeld comes with a unique optical path of up to several meters which allows for a precise pointing and focus adjustment.

Special Applications

The NanoWeld stations can be customized in order to meet the requirements for specific assembly procedures. Examples for such specialized stations include the following alignment and assembly tasks:

- **Free-beam diode modules with excellent pointing and focus accuracy**
- **Subassemblies for optical instrumentation**
- **Stirling coolers with friction free pistons**
- **Hermetically sealed detector assemblies**

NanoWeld for Free Beam Diode Modules

In many machine vision and metrology applications, diode modules operating in the visible spectral range require that the central mechanical axis of the modules and the emitted laser beam have to be superimposed perfectly. In addition, the beam needs to be focused in a certain distance or to infinity.

Based on the NanoWeld coaxial configuration, the half sphere holds the diode laser and the tray clamps the precision cylinder containing the collimating/focusing optics. The correct pointing direction and therefore the centering of the laser beam relative to the central mechanical axis of the module is performed with the XY alignment axis.

Moving the position of the diode laser in Z-direction changes the focus position. Corner cubes mounted onto a high-precision long travel stage extend the unique optical path to the desired distance. An appropriate sensor measures the beam diameter in the required distance and serves as feedback signal for the alignment.

The alignment results in a module emitting a laser beam perfectly centered to the precision housing with a focus in a distance between a few centimeters and several meters. Now the parts are welded together and form a robust assembly with excellent optical and mechanical performance data.

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