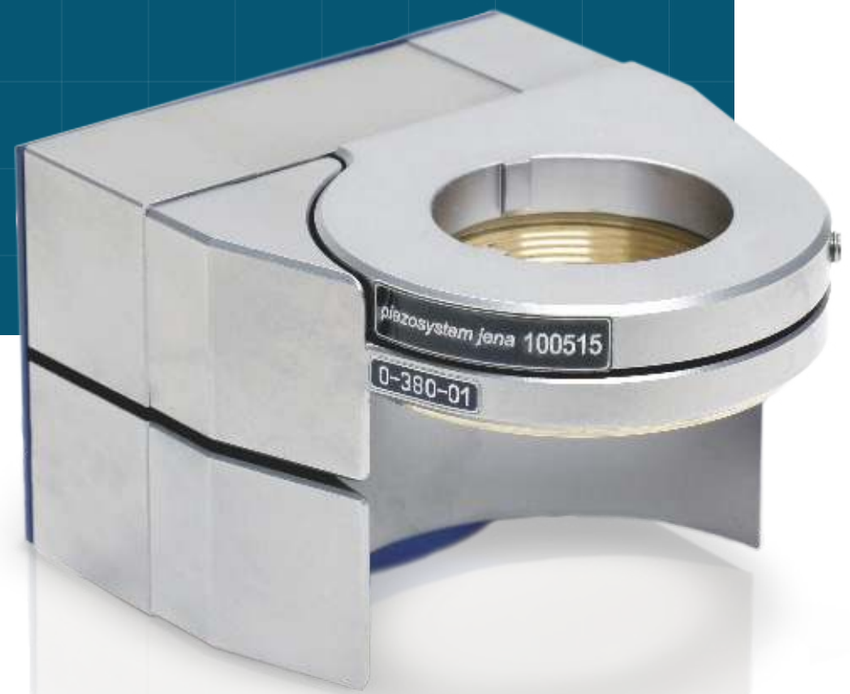
www.piezosystem.com

MIPOS
PIEZO FOCUS POSITIONERS

piezosystem jena
incredibly precise

piezosystem jena is the prominent nanopositioning solution provider based in the “optical valley” in Jena, Germany. Working with both small research institutes to large scale OEM industries, the company designs and manufactures over 900 different piezo mechanic nanopositioning systems implemented in a broad range of manufacturing processes, research applications and semiconductor industries. piezosystem jena specializes in finding innovative ideas to derive optimized solutions for custom specific requirements by combining advanced mechanical design with smart electronics.



PRECISION AT THE NEXT LIMIT

The demand of new advancements in technology is bringing conventional semiconductor manufacturing technologies to its limits. The development of structures in the nanometer range demands extremely precise production processes. To achieve the highest resolution in display manufacturing and semiconductor inspection calls for tools with the highest precision and least possible offset.

Performance Parameters

- SUB NM RESOLUTION
- LOW LATERAL RUN-OUT IN X AND Y
- HIGHLY REPEATABLE, ACCURATE Z MOTION
- SETTLING TIME IN MS
- HIGH LINEAR MOTION

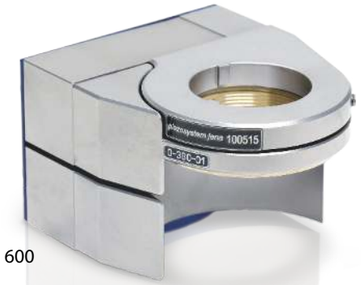
The use of Objective Positioner Systems in semiconductor manufacturing

Semiconductor manufacturers design chips with structures down to 4nm. This requires positioning systems with the highest level of precision in terms of minimal deviation, high resolution and fast step-settle times. For inspection tools it is critical to focus on specific points as repeatable and as accurate as possible, with nearly a 0% failure rate.

The MIPOS series is the solution to position objective lenses and other optical devices to focus precisely and scan with sub-nanometer resolution in Z-direction. Due to its stiffness of up to 4N/µm it can move in Z-direction with minimal deviation in X and Y. Travel range span can be up to 600µm. The MIPOS is available in open-loop configuration, which is optimal for high speed motion and scanning applications. In applications where accuracy is critical, closed-loop systems can be used to eliminate non-linear behavior. This allows high repeatability and long-term positioning stability. MIPOS systems are guided by flexure-hinges that are optimized using finite element analysis to ensure high stiffness and reliability. The resulting design offers outstanding resonance frequencies of up to 950 Hz and hence rise time in the ms range. Closed-loop systems can be built with strain gauge and capacitive sensors, depending on customer resolution requirements, operating temperature expectations and the space allotted.

MIPOS 20

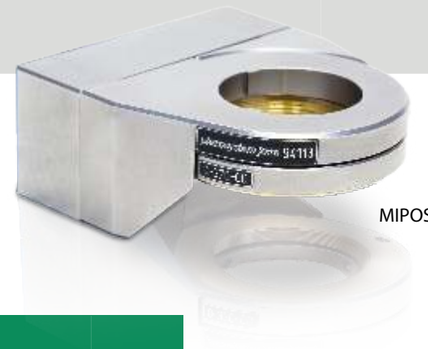
MIPOS 100



MIPOS 600

		MIPOS 20SG	MIPOS 100 PL CAP	MIPOS 250 CAP	nanoMIPOS 400 CAP	MIPOS 600SG
Stroke in Closed-Loop	µm	16	100	200	320	500
Resolution in CL	nm	1	4	1	1	12
Sensor Type		strain gauge	capacitive	capacitive	capacitive	strain gauge
Repeatability	nm	5	7	8	10	12
Non-Linearity	%	0.26	0.065	0.034	-	0.23
Rotational Error	µrad	<5	<4	<6	<5	<20
Resonant Frequency	Hz	950	410	320	300	190
Min. Possible Rise Time for Full Stroke	ms	0.6	5.7	8.0	4.7	16.5

nanoMIPOS 400

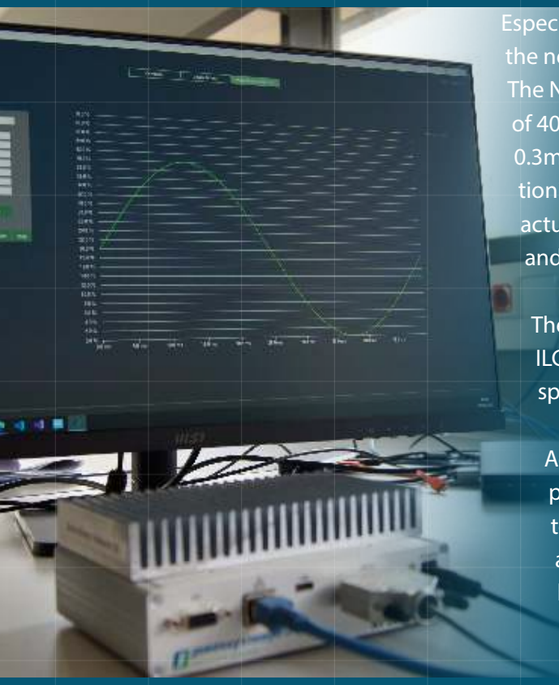


MIPOS 250

Academic Success Story

As an example of functionality, a piezosystem jena MIPOS objective positioner was critical in the success of Professor Stefan W. Hell and his team's research on membrane lipids in the nanometer scale. Based on the outstanding contribution in super-resolution microscopy, Stefan W. Hell was awarded the Nobel Prize in Chemistry.
The high-resolution axial position was adjusted and kept in steady position with a MIPOS 250 closed-loop system.

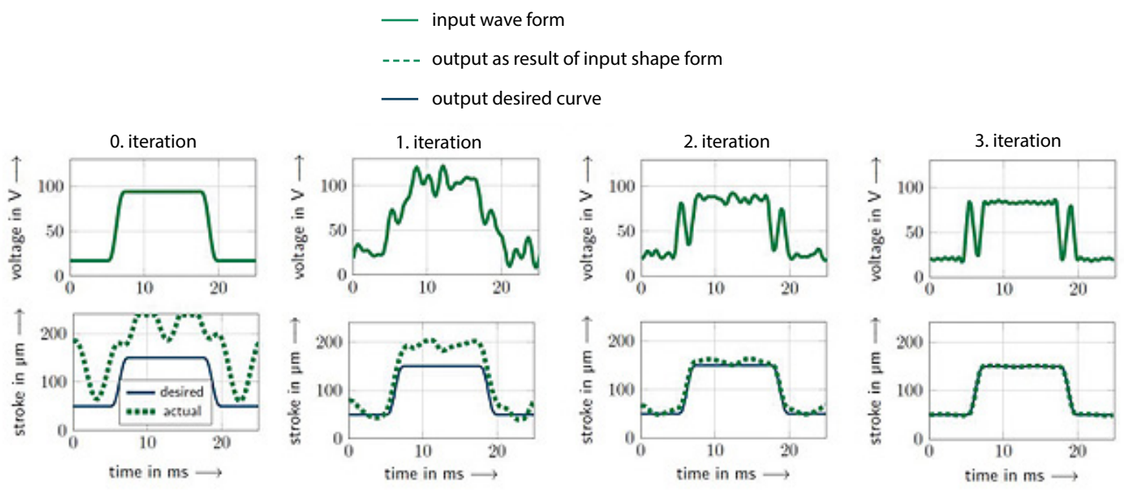
The NV200 D Net & PiSoWorks



Especially for use with MIPOS Systems, piezosystem jena has developed the next generation of smart controllers with a new software interface: The NV200/D Net - a digital piezo controller with a max output current of 400mA (peak current). With 16-bit resolution and a noise level of 0.3mV, the NV200/D guarantees fast response times and high positioning accuracy. The customer can easily integrate and control the actuator with different interfaces such as SPI and Ethernet for local and remote control.

The NV200/D comes with an integrated close-loop control, as well as ILC (iterative learning control) for closed-loop precision at open-loop speeds.

Actuator and stages from piezosystem jena are based on the piezoelectric effect from using PZT ceramics as motion technologies. As a smart material piezos are extremely fast, precise and generate high forces. Their natural characteristics also include hysteresis and drift, which can lead to non-linear motion profile. By using closed-loop control and smart algorithms these effects can be reduced to a minimum.



By iteratively changing input waveform, the output waveform is improved by ILC.

PiSoWorks & ILC

piezosystem jena has developed and integrated the new software PiSoWorks with the NV200/D Net giving the user complete control over both the actuator and its motion profile. The user only needs one cable.

PiSoWorks allows for control of the actuator's exact position, speed and open and closed-loop control. The software includes a function generator for open and closed-loop control, and positions are stored in a data recorder.

The software has two different modes - easy and advanced. Easy mode allows for quick function tests. In the advanced mode there are several additional controlling options such as:

• PID CONTROLS

A regular PID controller uses a control-loop mechanism employing feedback implemented in industrial control systems. It calculates an error value as the difference between the set point and a measured process variable and applies a correction until it reaches minimal deviation of the desired set-point value of the actuator.

• SET-SMOOTH

A function where the movement of an actuator is realized with the fastest possible settling time with the least possible deviation at the target point. The Set-smooth function is a practical solution when accurate stable movements should be acquired in the span of milliseconds when moving from one target point to the next, hence avoiding ringing.

• ITERATIVE LEARNING CONTROL (ILC)

A proprietary algorithm to determine the settling curve by performing iterations and adjustments on measured curves. ILC learns the unique behavior of each actuator and compensates for unwanted motion. This helps generate higher closed-loop speeds compared to regular PID control. It is especially useful in applications where precise repetitive actuator motion is required. With ILC the customer can achieve open-loop speed with closed-loop accuracy.

Applications

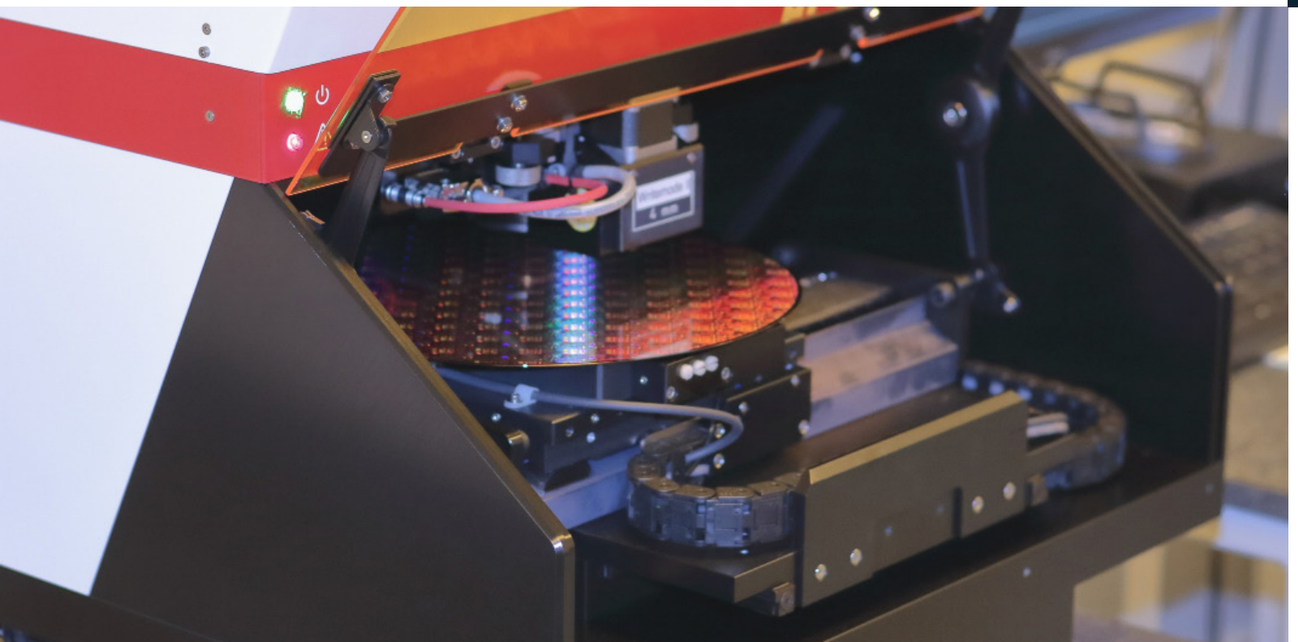
The manufacturing process in semiconductor industries can be time consuming and costly. MIPOS solutions from piezosystem jena have been implemented in specific manufacturing processes like wafer manufacturing, laser beam positioning in chip manufacturing etc. to make complex processes more precise and consequently increasing efficiency.

Display Manufacturing and Inspection

High levels of accuracy are required in the manufacturing of advanced displays, where minimizing contamination and defects are absolutely critical. In this methodology every nanometer and every delicate change in a positioning value makes a difference. One challenge is to focus the laser beam at a desired position with the least deviation. The high stiffness of the MIPOS series combined with the Set-Smooth (set,st) function of the controller enables this solution to hold the laser beam in focus on the surface in order to carry out the process to the exact nanometer. Minimal offset and the least possible deviation at the sub-nanometer level are achieved by combining customized hardware with smart electronics.

Wafer Slicing

In the world of wafer production, time consumption and material losses are X factors. A crucial factor in the increased cost of producing SiC devices is the high loss of material leading to low production output from a single ingot. MIPOS positioners can be used in a new ingot slicing method, where a separation layer is formed at a specified micrometer depth by continuously irradiating an ingot with a laser. A MIPOS system achieves precise focus and repeatability for steady processes in the production of wafers from the ingot. This reduces the processing time, which results in an increase in the number of wafers produced by a factor of 1.4.



Technology is advancing; 5G, AI, IoT, data management and blockchain are pushing hardware requirements. As a result the demand for high precision manufacturing solutions within OEM industries, such as semiconductors has increased. Hence these industries have to optimize, update and develop their processes in order to reduce time, and increase production - without having to sacrifice quality and details.

Over the last 30 years piezosystem jena has continuously expanded its product portfolio to serve industry needs by learning from firsthand customer demands. Working together with customers a wide range of customized optical positioning solutions have been developed. The combination of nm accuracy, kHz speed, high stiffness, compact design, smart electronics and industrial connection standards makes these systems the optical solution for next level OEM applications.

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