

Ultraprecision Machining

NANO
less than 1 μm

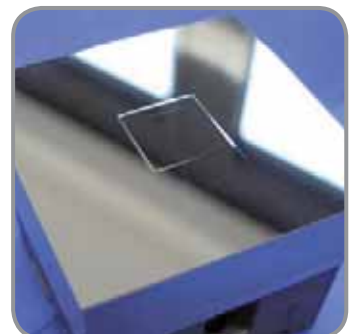
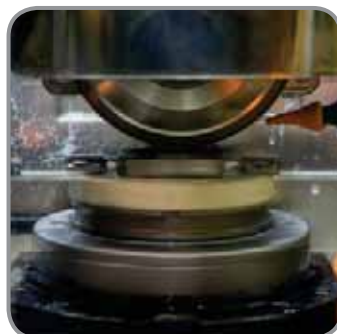


with MacroNano & MatrixNano

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“
System 3R's MatrixNano
has met all our high
expectations... “



Product description – MacroNano & MatrixNano

- ... Extremely high accuracy.
- ... High-precision machines are linked together in the production chain, without detracting from the extreme accuracy.
- ... Feedback to the machine for supplementary machining after inspection is possible. This feedback is only meaningful if the pallet system is at least as accurate as the measuring machine.

Workholding for Nano Precision

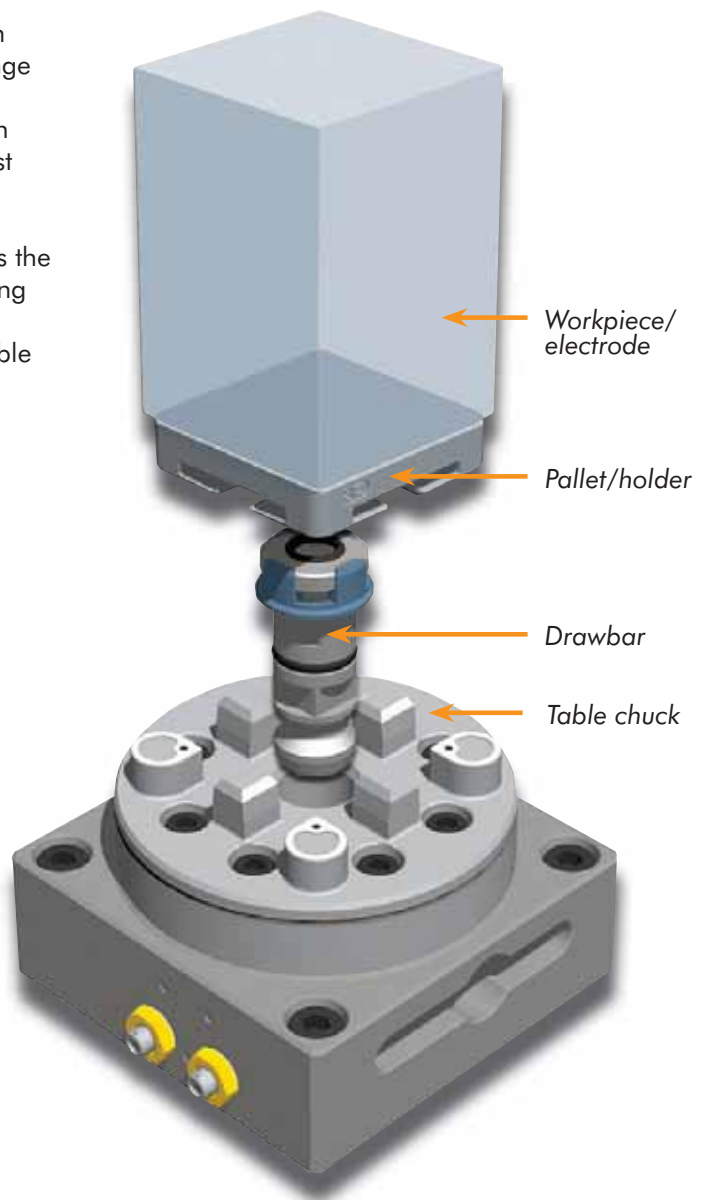
Nano-precision machining requires nano-precision referencing of workpieces and tools- a real challenge even with state of the art solutions available in the market. This becomes even more challenging when the references need to be established in the shortest possible time.

Nano system is best described in two words as precise and quick! The Nano clamping system links the production chain through an ultra-precision coupling both for workpiece and tool holding.

Both the MacroNano & MatrixNano are compatible with their respective standard system.

MacroNano

- Repetition accuracy – within 0,001 mm
- Locking force – 6000 N
- Fixed index positions 4x90°



MatrixNano

As well as extreme accuracy, Matrix features low built-in height, ultra-precise indexing, a drawbar with through hole. The through hole allows high/long workpieces to be sunk into the chuck for stable/rigid fixation.

- MatrixNano only available in 110 & 142 sizes.
- Repetition accuracy – within 0,001 mm
- Locking force up to 12 000 N
- Fixed index positions 4x90°



Prepared for automatic chuck adapter.



Spherical rolls.



Inlets on side & underneath.



Low built-in height.



Pre-alignment studs.



Matrix application:
The pallet is turnable for machining of both sides of a optical lens.

Case – Fraunhofer Institute for Production Technology IPT.

System 3R Sub-Micron Palletizing System for Ultraprecision Machining Processes

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Current Drawbacks of Ultraprecision Machining Set-Ups

Problem:

- Full 3D-ultraprecision machining requires a permanent change of the work piece set-up
- Loss of reference when detaching the work piece

Approach:

- Development of a work piece clamping system with a repeatable accuracy in the sub-micron range to meet today's ultraprecision machining requirements

State of the Art 3D-Ultraprecision Process Chain

Planarizing of the work piece surface to create a reference surface



Determination of the surface planarity with inter-ferometer measurements

Offset detection with an optical measurement microscope

Linear structuring of the work piece surface by diamond milling

System 3R MacroNano Chuck:

High Precision Palletized Work Piece Clamping System

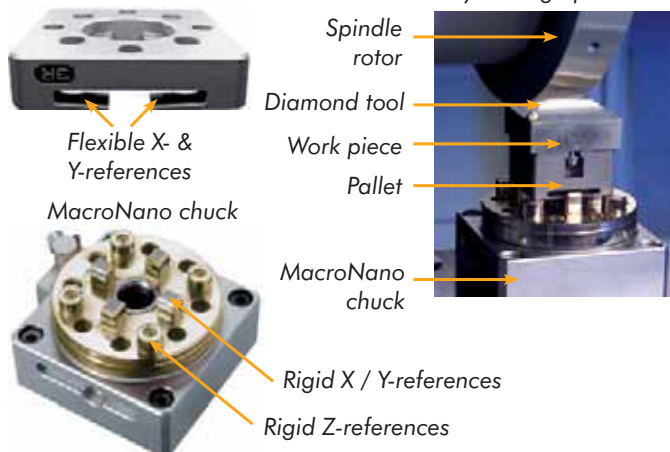
- Fixed receiver chuck on the machine-tool
- Standardized pallets are used to carry the work pieces and to enable sub-micron work piece exchange

Features:

- Relocation of the work piece within $\pm 0.5 \mu\text{m}$
- Indexing of the work piece at 90° with four indexing positions

Work piece pallet with flexible references

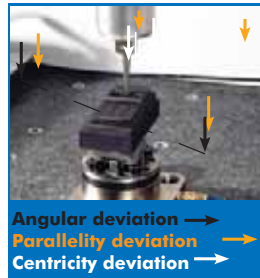
Application of the MacroNano chuck in fly-cutting operation



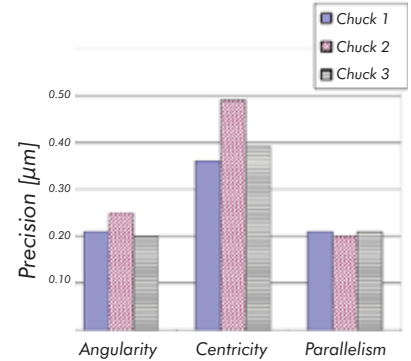
Determination of the System Accuracy of the MacroNano Chuck

- Testing of three chucks with ten different pallets
- Measurement of the relocation precision of the pallet of each combination

Calibration normal mounted on the pallet to determine the relocation precision

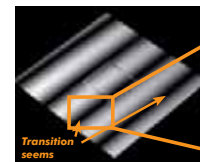
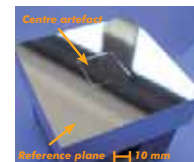


Evaluation of the measured values



Sample Machining for Evaluation of the MacroNano Chuck

- Machining of a symmetric centre feature using the 90° indexing function of the chuck
- Assessment of the transition seems which result from deviations between the tool path and the chuck's reference plane:
 - Determination of the step heights at each transition (Δh_i)
 - Low variation in the step heights implies high clamping repeatability
- Largest deviations from the average step heights have been determined to an absolute value of $0.5 \mu\text{m}$



Diamond machined test sample

Deflectometry record of the sample

Measurement of the step heights at each transition

Section	Average step height (μm)	Δh_1 (μm)	Δh_2 (μm)	Δh_3 (μm)	Δh_4 (μm)
A	2.2	0.1	0.2	0.2	-0.5
B	1.9	0.1	0.0	0.3	-0.5
C	1.6	0.1	0.0	0.3	-0.4
D	1.2	0.1	0.0	0.3	-0.4
E	0.9	0.0	0.1	0.3	-0.4

Deviations from the mean step heights at each transition

Conclusion

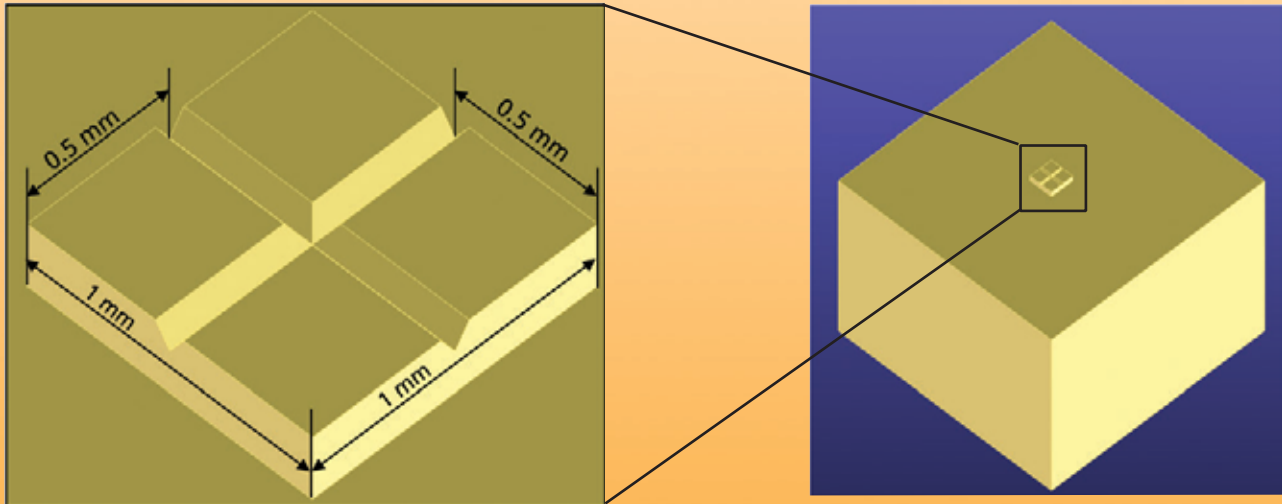
- The System 3R MacroNano chuck provides a work piece clamping device with sub-micron repeatability
- The system accuracy of the MacroNano chuck has been characterized to $< 0.5 \mu\text{m}$ by direct measurement on the pallet
- Form measurements of a test sample which has been diamond machined on the MacroNano chuck, have approved the submicron repeatability

Contact

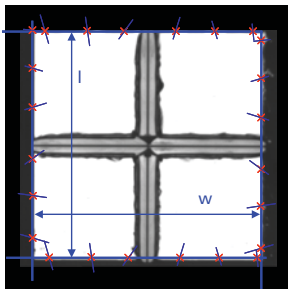
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Application example – Microstructuring with Diamond Machining

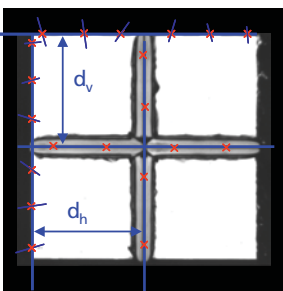
Micro features produced with nano precision



This micro structure is produced by Diamond Flycutting operations on two different machines, each equipped with a MacroNano chuck. The square in the middle of the workpiece (right picture) is produced by plane milling on 1st machine, making use of indexing feature of the MacroNano system. The pallet carrying the workpiece is then transferred to the chuck on 2nd machine to produce the micro-grooves, once again using the indexing feature. The zero reference was determined only once on the 1st machine and then carried through the whole process chain using both the indexing precision and the system precision of the MacroNano system; overall structure deviation is less than 0.5 micron.



Measurement of the cube dimensions

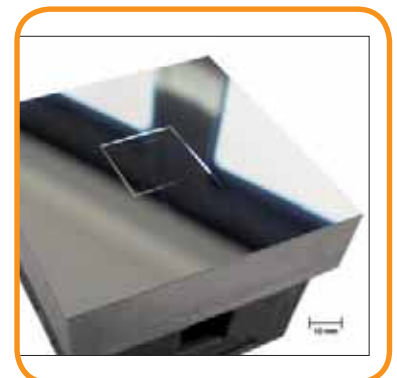


Measurement of groove positions

	Width (mm)		Length (mm)		Vertical dist. (mm)		Horizontal dist. (mm)
W ₁	0,9996	l ₁	0,9999	d _{v1}	0,4988	d _{h1}	0,5013
W ₂	0,9996	l ₂	0,9999	d _{v2}	0,4993	d _{h2}	0,4995
W ₃	0,9996	l ₃	0,9999	d _{v3}	0,4996	d _{h3}	0,5001
W ₄	0,9997	l ₄	0,9999	d _{v4}	0,4991	d _{h4}	0,4995
W ₅	0,9996	l ₅	0,9998	d _{v5}	0,5010	d _{h5}	0,5001
W ₆	0,9996	l ₆	0,9998	d _{v6}	0,5007	d _{h6}	0,5002
W ₇	0,9997	l ₇	0,9999	d _{v7}	0,4996	d _{h7}	0,5012
W ₈	0,9996	l ₈	0,9999	d _{v8}	0,4992	d _{h8}	0,5009
W ₉	0,9997	l ₉	0,9999	d _{v9}	0,4996	d _{h9}	0,5009
W ₁₀	0,9996	l ₁₀	0,9998	d _{v10}	0,4998	d _{h10}	0,5008
W	0,9996	l	0,9999	d_v	0,4997	d_h	0,5004

Mean values

Overall structure deviation < 0,5 μm



Case – Nagase Integrex Co. Ltd.

Published in Incredible Concept (Japan)



Written by Kiyondo Adachi.

Grinding time halved by high-speed oscillation

Around 20 years ago, Nagase Integrex Co., Ltd. developed a special machine to grind components for, amongst other things, punching and cutting tools. The goal was that, using diamond or boron nitride discs, it should be possible for stamped profiles (and similar) to have mirror finishes. Many hundreds of machines have been installed since then and, for their users, have become practically indispensable in the production of high quality moulding tool components.

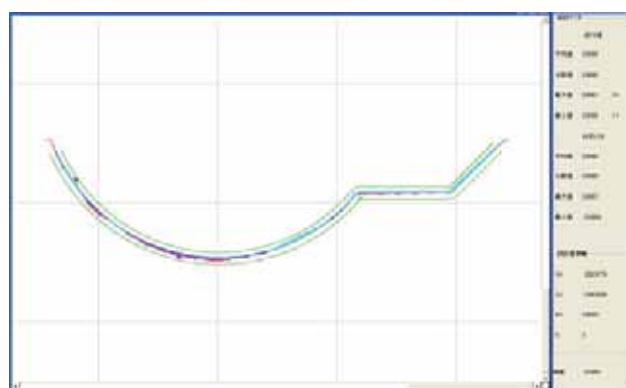
At JIMTOF 2012, Nagase introduced its latest special grinding machine. This, the SHSD-80α, is notable for its extremely high speed – 2,000 oscillations a minute. Yes, a full 2,000 backwards and forwards movements a minute! What this involves as regards vibration damping during acceleration and retardation, stresses on slide bearings, etc. is hard to imagine. However, in a single stroke, the machining time offered by earlier machines had been halved. This was achieved without compromising either precision or surface quality. Mirror finishes, but now in half the time!

Plus pallet system

The grinding of complex moulds entails frequent retoolings on the machine table. Halving the machining time is of little benefit to the end results if the total production process is constantly interrupted by time-consuming and intricate setting up. It must also be remembered that we are now in the age of miniaturisation and, as regards both shape and finish, measurements in μm .

Thus, a high quality reference system is needed. A stable pallet system that, besides accuracy, not to say precision, also weighs as little as possible. Remember that the machine table travels backwards and forwards 2,000 times a minute. Think also how an unwieldy fixture or a solid, heavy chuck would load the machine and, consequently, affect the machining results.

Fortunately, the characteristics of Matrix, one of System 3R's many reference systems, include precision and, thanks to the hollow chuck, minimal weight. In other words, Matrix could have been made for Nagase's ultra-fast special grinding machine.

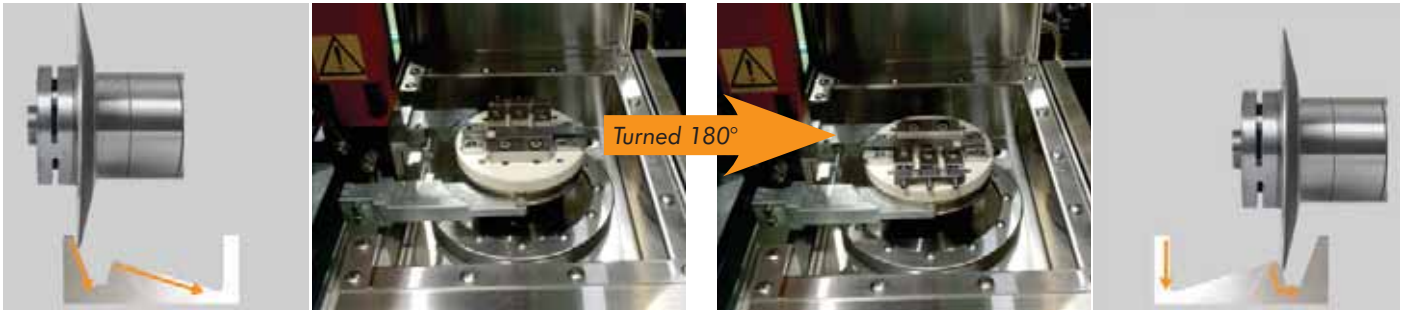


Mould precision using the SHSD-80α (2,000 oscillations a minute).

	SHSD-80	SHSD-80 α
Grinding wheel	SD400MVD $\varnothing$ 125 end R0.1mm wheel angle 15°	
Longitudinal inversion	840 inversions/min	2000 inversions/min
Processing speed	0.3mm/min	0.6 mm/min
Shape accuracy	$\pm 0.5 \mu\text{m}$	$+0.7 \mu\text{m}/-0.6 \mu\text{m}$
Surface roughness (Rz)	0.16 μm	0.15 μm
Processing time	2h 40min	1h 20min

Machining in two different machines.
SHSD-80α equipped with Matrix pallet system.

Application example at Nagase – Makes it possible to complete the grinding operation in one Machine set-up.



Operation #1, grinding

...the pallet with workpiece turned 180°

...operation #2, grinding

Plus automation

Although we are talking about halved machining time, the overall manufacturing frame is still hours and not seconds. After all, production here involves grinding, complex moulds and extreme finishes. There is more to it than simply feeding in the workpieces. Advantage has to be taken of every second in the day. This leads unavoidably to automated pallet changing!

System 3R's wide programme of handling equipment includes the WorkPal Compact pallet changer. This unit changes workpieces (on their pallets) between a magazine and a pneumatic chuck on the machine table. A WorkPal Compact requires minimal floor space, is simple to install and easy to aesthetically adapt to the machine in question (which Nagase did).

On top of this, WorkPal Compact can be complemented with a suitable intermediate station. In this case, a rotating station that turns the pallet (with its workpiece) 180° between two grinding operations. This was necessary to fully exploit available grinding technology.

Thus, what Nagase presented at JIMTOF was not just an ultra-fast special grinding machine but, in fact, a fully automatic production cell with a production capacity that had never previously been approached. No wonder that it excited attention in the high quality moulding tools manufacturing industry!



Completed workpiece mounted on Matrix pallet.



Production cell that the Japanese Chamber of Commerce and Industry awarded the "President's prize". On the left side "behind the cover" Automation solution from System 3R – WorkPal Compact Servo.

System 3R's MacroNano workholding system gets top marks from Nottingham University's Institute of Advanced Manufacturing

Published in CMM international



When only the best will do, Nottingham University turned to System 3R tooling for use on their metalcutting machines in their newly-opened Institute of Advanced Manufacturing (IAM).

This £3.5 million facility was opened by David Willetts, Minister of State for Universities and Science, in September 2012 who said, "It is vital that business benefits from the very best and latest technologies in order to compete in the



System 3R's MacroNano pneumatic chuck

global marketplace and be a driving force for growth."

It focuses on driving the development of cutting-edge technology with the aim of radically improving all aspects of advanced manufacturing and has links with industry and has partners in such diverse sectors as aerospace, automotive, medical, instrumentation, defence, power engineering, sustainable energy, textiles and clothing, recycling and consumer products.

The increased demand for micro and nano precision manufacturing processes – especially within most of these industry sectors – led the IAM to fit MacroNano tooling on their latest EDM machine, a Sodick AQ750 wire erosion machine. 3R tooling is also fitted on their Sodick AP1L die-sinker spark, complete with an 8-position toolchanger and an AP200L wire machine.

MacroNano delivers repeatable sub-micron accuracy levels – as measured in tests by the world-renowned Fraunhofer



MacroNano workholding system in the wire erosion machine

Institute for Production Technology IPT in Aachen, Germany. In ultraprecision machining of workpieces, initial measurements showed repeatability and system accuracy 'well below 1 micron'. The best observed values were as low as 0.1 micron! Workpieces and cutting tools and/or electrodes are mounted with the same precision and accuracy.

The assured repeatable accuracy gained from the mounting of workpieces for electrode manufacture on Macro pallets also guarantees that once the initial datum is entered, a part can be transferred from one machining process to another, without compromising its tolerance and positional integrity. The ability to run cost-effective lights out production has therefore now become a reality – especially where long cycle times on complex electrode manufacture is unavoidable.

The IAM's Kern Evo machining centre has a pneumatic MacroNano chuck which, together with the pallets, incorporates System 3R's innovative VDP (vibration damped palletisation) technology that provides a very rigid coupling on the machine table – not affected by the machine's frequency and vibration. The mechanical interface between machine table, workpiece, machine spindle and tool is constant whether milling, grinding, turning or in an EDM machine.

Lab Manager, Daniel Smale, says, "Ideally we would like to put System 3R tooling on all our machines, but budgets are always under pressure.

"It helps minimise the errors between machines and saves time in switching a workpiece from each process, as complicated fixturing has become a thing of the past. Planning jobs is easier and if we need to get a part on a machine fast, the flexibility we have can be vital."

Apart from the machines in the IAM, the PhD students at Nottingham

University also benefit from System 3R technology, as they have access to a Sodick AQ750L machine that is fitted with a range of tooling for their projects. So System 3R is helping to advance the boundaries of cutting-edge manufacturing for the engineers of today and tomorrow!



Electrodes are fitted to Macro holders in the die-sinker's toolchanger, which provide assured repeatable accuracy in the EDM process.

Case – Plastic Design Corp (PDC)

Published in MICRO Manufacturing



All Systems Go

Shop takes 'systems' approach to holding microparts



Image courtesy Plastic Design.

A micromold machined at Plastic Design is positioned on a Hermann Schmidt magnetic chuck mounted on a unit of System 3R's Nano reference system.

Accurately machining and measuring a part requires it to be located and clamped with precision that matches or exceeds specified final tolerances. Generally, a shop can combine good machine tools, vises and tooling to get a good result. But when working with micron-level tolerances, good is not good enough. Beyond assembling high-accuracy workholding components, it is crucial to control how they relate to each other as an integrated system, and assure they are applied in a repeatable, systematic manner.

Zero-point palletizing, or referencing systems, can maximize precision in machining operations. In these systems, workholding pallets feature a centrally located drawbar or stud drawn into a machine-mounted chuck to provide consistent positioning.

"In the case of developing or validating a process with small tools or small features, at some stage you have to remove the part and take it to a dedicated metrology device to inspect your results," said John Bradford, micromachining R&D team leader for Makino Inc., Mason, Ohio. "You then put it back in the machine, make adjustments to your process and continue machining. You must be able to remove, check and replace the part without repeating the whole setup process."

Microcavity challenges

Plastic Design Corp. (PDC), Scottsdale, Ariz., deals with those challenges every day. The company manufactures molds and uses them to produce small medical devices, microfluidic circuits and in-vitro labware.

"We are cutting true microcavities," said PDC President Mark Kinder. "Typically, we are doing one- and two-cavity tools; a luxury for us is a four-cavity mold. In the case of microfluidic devices, he said, "the X-Y of the cavity may be pretty big—3" × 5"—but we are cutting features in the 30µm to 50µm range."

Machining features as small as 10µm, he said, "is no big deal." However, there are many variables that affect the shop's ability to consistently generate those tolerances. For example, all rotary chip-removal systems feature some degree of spindle whip. "When you bring the machine up to speed, the centerline shifts subtly," said Kinder. "It's a centripetal phenomenon. The better the spindle, the less there is, but it occurs. We've mapped all of our machines. We can predict it, but it is never an exact thing. It's subtle—tenths (10-thousandths of an inch) or microns."

In consideration of that and other variables, Kinder regularly checks part dimensions while machining. The parts are taken from a VMC or EDM to a Nikon NEXIV VMR-3020 optical/laser 3-D CMM, inspected and returned for re-machining, if necessary. The actual steps followed are dictated by a shop's familiarity with, and confidence in, a specific operation, as well as the tolerances of the part being machined.

"If we have a high level of confidence, we will make the cut and check the part just for verification," Kinder said. If the part is out of specification, it's either scrapped or, if possible, refixtureed for further machining.

On the other hand, if tolerances are especially tight, Kinder said he takes a different approach. The initial CAM program is written to cut the part to slightly larger-than-final dimensions. Then the part is inspected, the program is adjusted and the part is refixtureed for machining to final tolerances.

For that reprogramming and remachining to be accurate, the part must be positioned identically for measurement and machining. About 2 years ago, PDC was having trouble repositioning work after removing it for inspection. "When you get down to splitting tenths, measuring the part is difficult enough," Kinder said. "But getting it back into a location where we could take a 0.00004" (1µm) cut is where we were really struggling. We were spending 2 hours on a good day, and 4 to 5 hours, on average, getting the block trammed back into the machine."

A palletizing system might eliminate much of the time spent repositioning the molds, Kinder observed, but standard systems didn't provide accuracy high enough for his needs. Then he saw a demonstration of the Nano referencing chuck system from System 3R USA, Elk Grove Village, Ill. "Repeatability was basically unmeasurable," Kinder said. "It was something on the order of magnitude of 0.000010"."

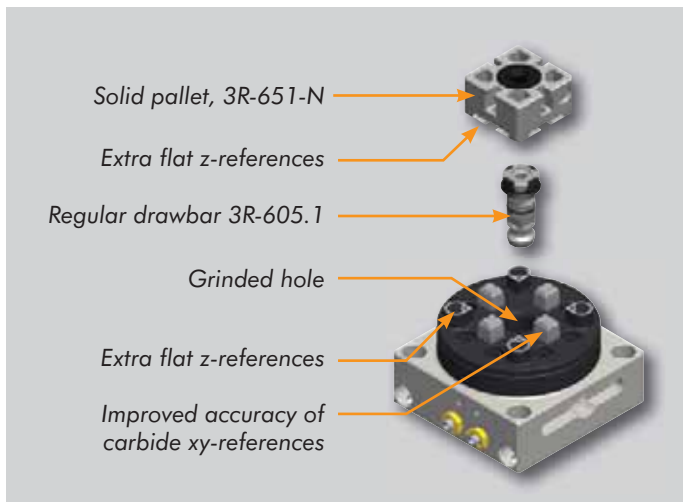


Image courtesy System 3R.

The Nano reference system is a “tweaked and finessed version” of System 3R’s standard Macro chuck system. Chuck components are ground and lapped to maximize accuracy and produce repeatability better than $1\mu\text{m}$, according to the company.

Tweaked and finessed

Jack Sebzda Jr., System 3R Northeast regional manager, said the Nano system is a “tweaked and finessed version” of System 3R’s standard Macro chuck system. “We take standard chucks out of the production line and basically balance and blueprint them, sort of like they do to an automobile engine to improve its performance,” Sebzda said. “The chuck is hand-lapped and hand-measured; everything is done with the goal of making it as accurate as possible.”

For example, he said, instead of being simply rough-milled and tumbled, the locking surfaces of the pallet drawbar are ground so those dimensions are consistent drawbar to drawbar. “It’s overkill for what you might normally expect, but we want the same exact pull force to be exerted on the pallets every time,” Sebzda explained. The result is repeatability better than $1\mu\text{m}$, he said.

Kinder enlisted his workholding supplier, Hermann Schmidt Co., South Windsor, Conn., to integrate Schmidt’s workpiece-holding chucks with the System 3R palletizing system.

PDC required precision vises and different styles of magnetic chucks for its machining center and EDM, said Peter Schmidt, president of Hermann Schmidt. The company provided $6'' \times 6''$ magnetic chucks ground to better than $0.00005''$ square. When mounting the magnetic chucks to the System 3R pallet chucks, Schmidt said, “we indicated the rail around the outside of the magnetic chuck (against which the part rests) from the centerline of the System 3R reference chuck, so that in multiple chucks the work offset is within $0.00003''$ square and parallel from the center location.”

A step higher

Palletizing is a long-established technology and most suppliers will guarantee their products to repeat within $2\mu\text{m}$. However, while $2\mu\text{m}$ repeatability is good enough for most applications, “Mark Kinder’s world is a whole other step higher,” Schmidt said. “Mark wanted to take a pallet out of one machine, put it in another machine, and repeat to $1\mu\text{m}$ or better. We are talking about going from $0.00008''$ repeatability in one machine down to $0.00004''$ repeatability machine-to-machine.

Hermann Schmidt takes the prefinished chuck and bolts it to the referencing system. When two objects are bolted, they are stressed, so at some point in the process one of the surfaces is lightly machined to qualify it. For example, the flat plate on the back of a magnetic chuck will be requalified via grinding and lapping.

PDC just had to mount the chucks and tram them in. “It has become our standard workholding system,” Kinder said. The pallets are installed on PDC’s VMC, sinker EDM and CMM. Some hold magnetic chucks, some grinding vises and some System 3R electrode holders. After initial machine setup, no further setup is required.

Such precision is not inexpensive, Kinder noted. “We put as much money into that system as we would a machine tool,” he said. “Originally, when we priced the system out, I had an ROI of 3 years on it, based on the shortened setup time after measurement.” However, because of the system’s positive effect on constraint management at PDC (see sidebar below), the payback period was 9 months.

Systematic approach required

Peter Schmidt stressed that this kind of precision workholding system is not a set-and-forget proposition. “It requires a systematic approach not only in how we build it, but in how they use it,” he said. “If they don’t use it the same way every time, if they change that procedure, they are not going to hold tolerance.”

Jack Sebzda agreed. “That last 10-millionths is an expensive and difficult thing to get at,” he said. “Maintenance, cleanliness and consistency are critical. You can put the best chuck in the world in a shop and you’ll fail miserably if the machines are not

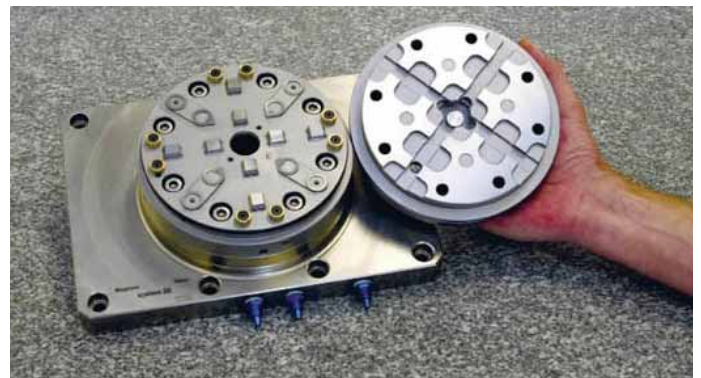


Image courtesy Plastic Design.

Pallets in the System 3R Nano referencing system can be removed and replaced with repeatability at levels less than $0.5\mu\text{m}$ (500nm), according to the company. Image courtesy Plastic Design.

maintained properly, or the operators don’t handle things with care.”

Some variables, inconsequential in macro applications, become significant in micromanufacturing. For example, System 3R specifies that even the air pressure used to actuate the chucks be tightly controlled. “If we want the reaction of this chuck to be identical every time, the procedure for opening and closing the chuck must be as accurate as everything else,” Sebzda said. While System 3R recommends air pressure in the range of 5 to 7 bar (about 70 to 100 psi) to operate its standard chucks, it recommends air pressure for the Nano should always be 6 bar.

One manufacturing challenge is that advances in machine tool accuracy may limit the usefulness of some palletizing systems, according to Makino’s Bradford. He cited machines such as Makino’s Hyper 2J VMC that features $0.000000020''$ (0.5nm) scale feedback with guaranteed positioning accuracy of $\pm 0.3\mu\text{m}$ ($\pm 0.000012''$) and repeatability accuracy of $\pm 0.2\mu\text{m}$ ($\pm 0.000008''$).

In actual applications, he noted, the machine has provided positioning accuracy and reliability on the level of $\pm 30\text{nm}$ ($0.030\mu\text{m}$). When machining parts or features that take advantage of those machine capabilities, removing the part from the machine for measurement may not be an option since part tolerance might only be a few microns.



Image courtesy Hermann Schmidt.

A System 3R Nano reference system unit fitted with a Hermann Schmidt vise.

As the machines are introduced with repeatability in the 70nm to 80nm range, more accurate workholding systems are a must, he added. "If your tooling only gives you repeatability of 700nm to 800nm, you are losing the benefit of the machine's accuracy and stability." In those cases, he said, machine tools will offer increasingly sophisticated on-board measuring systems that permit inspection without removing the part.

However, according to Sebzda, advanced palletizing systems are already in the same tiny ballpark as the machines Bradford described. System 3R's Nano referencing system can repeat at levels under $0.5\mu\text{m}$ (500nm), but the problem has been how to prove it, he said. "By placing optical sensors on both the pallet and reference surface of the chuck, we are able to monitor and confirm system performance." Testing of the system has taken place in the optical grinding industry, he said, including work with the Fraunhofer USA Applied Research Institute.

The whole package

To remain competitive, shops must continually seek out and apply new technology. Regarding workholding systems, Schmidt said there are micromanufacturers who struggle because they are unaware of new equipment and integration services that enable high precision. To those who struggle, Schmidt says,



Image courtesy Makino.

A micromold positioned in a referencing system is machined on a Makino Hyper 2J vertical machining center.

"You can buy it. There are people who understand what you are talking about and your problems."

Sebzda said all machining elements must be included in the upgrade. "I can put the most expensive tires possible on a Yugo, and it's still a Yugo," he said. "The whole package has to be there. Sometimes that package has to be chosen from a variety

of suppliers. It all has to be researched and constantly reviewed because there is always a better way to do it.

"What is coming down the pike must be understood, accepted and embraced," Sebzda continued. "Unless you move with the changes, you are going to be behind the times. We are coming to the point where our industry is doing the elite work; the no-brainer mold work, the blow molds, cheap toys and things like that are all gone. What's left are the upper-level, tip-of-the-pyramid processes that only a few can truly achieve." μ

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Conquering constraints

Plastic Design Corp. operates under the theory of constraints, also known as constraint management and debottlenecking, according to company president Mark Kinder.

"We look at the aggregate efficiency of the shop, not the efficiency of a given machine tool," he said. "We will yank a setup if there is another job that we need to get through that piece of equipment to keep the overall workload in the shop moving."

Most shops focus on reducing downtime for individual machines. Kinder counters that "if you throw away micro profit centers and efficiencies based on single operations and look at overall plant efficiencies, you can really achieve a lot more with limited resources."

High-precision, palletized workholding helps PDC make decisions on shop-wide workflow. Kinder described a situation where the shop followed a run of high-precision EDM electrodes on its V-22 Makino VMC with a hard-milling job. A programming error on the sinker EDM produced features that were too shallow. "We didn't scrap the block, but all the electrodes were consumed," he said. "We looked at the shop schedule and decided that the block being burned was more critical than a job we were hard-milling."

The decision was made to take the hard-mill job off the VMC, switch the machine back to mill electrodes, remake the electrodes and finish the EDM sinker part that day. Prior to implementing an integrated System 3R/Hermann Schmidt palletization system, such a change would require hours, Kinder said.

Kinder authorized the change back to electrode machining and went to lunch. Upon his return he found operators working on the hard-milling job. When he asked why the electrodes weren't being remade, he was told they were already done. "With the pallet system, the operators could interrupt the hard-mill program, pop that pallet off and drop in the electrode pallet. The electrode program was stored in the machine and, fortunately, we hadn't pulled the endmills we were using for the EDM work."

The electrode pallet had a vacuum box for dust removal, and the VMC was configured to handle either flood and mist coolant or vacuum dust collection. "They were set up and running electrodes in about 10 minutes," Kinder recalled.

— B. Kennedy

Less than one thousandth of a millimetre



Koyei Engineering K.K. is famous for its expertise in manufacturing high quality moulding tools, prototypes and precision components.

Its customers are mainly from:

- The optical industry (with its nano-machining of moulding tools and parts for light plates and lenses).
- The aerospace industry (with its milling of “difficult” materials such as titanium and Inconel).
- The automotive industry.

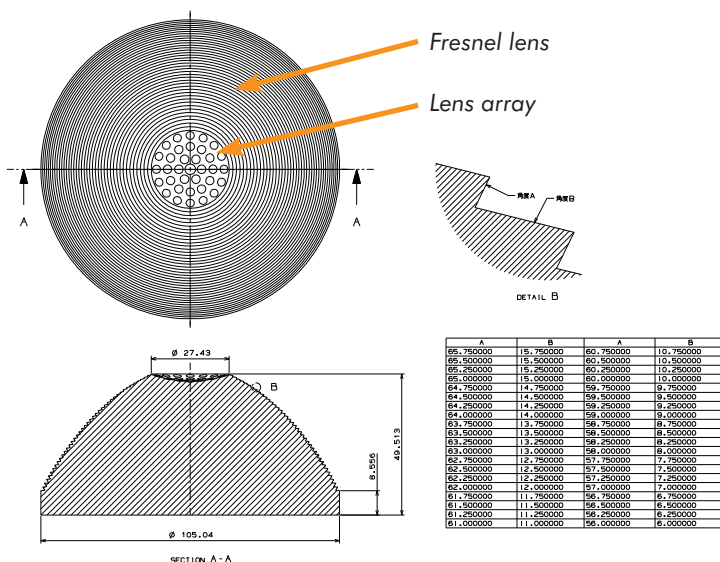
The end customers’ extremely high demands in respect of precision have led to Koyei Engineering having a long collaboration with System 3R. To guarantee Koyei Engineering’s capacity to produce the required precision, a wide spectrum of pallet systems (Macro, MacroMagnum, Delphin and GPS240) with and without vibration damping have been supplied.

One example of Koyei Engineering’s operations is the manufacture of moulding tools for Fresnel lenses. This is certainly not run-of-the-mill production. A Fresnel lens has “saw-tooth” microgrooves that refract the light in, for example, solar energy collectors.

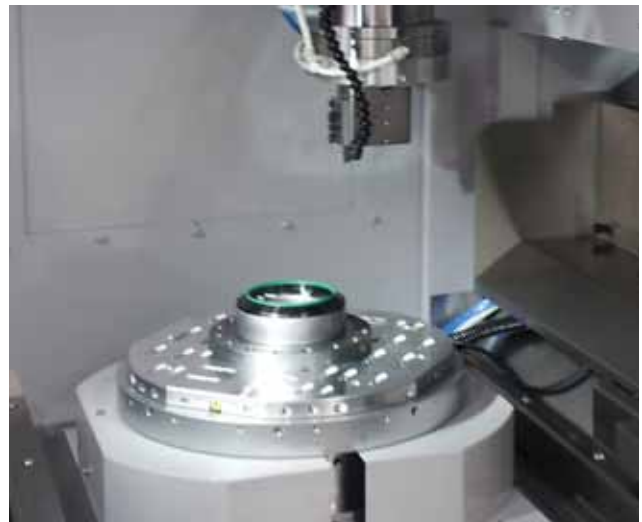
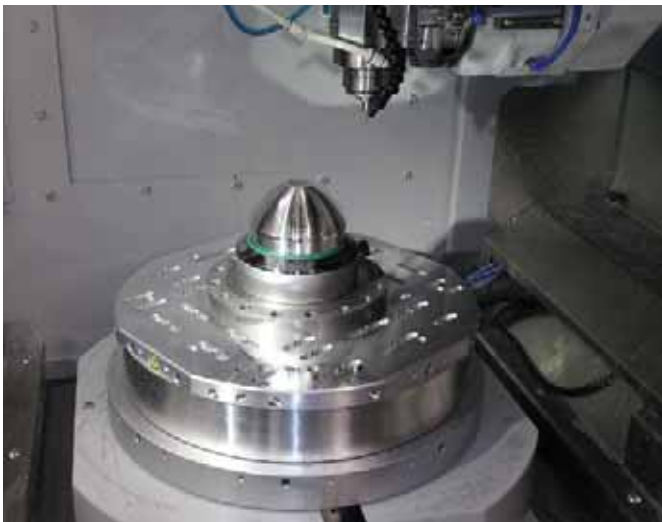
“System 3R’s MatrixNano has met all our high expectations...”



Kunihiro Haga & Keiichi Kojima – visibly pleased with the Matrix pallet system.



Tool for sun-focusing lenses – Fresnel part on bottom and a lens array at the top.



Machine in turning mode... and milling mode with Matrix pallet system on the machine table.

MatrixNano – groundbreaking precision

The insert for the moulding tool for solar energy collectors is machined in a Toshiba machining centre that can switch between turning and milling. Turning uses a diamond and milling uses a small, ball nose, cemented carbide cutter.

Switching between milling and turning is not entirely straightforward when, between operations, the workpiece must also be checked in a measuring machine. This is especially the case when it is a question of nano-machining. We are here talking about precision to less than one thousandth of a millimetre!

Having to set-up the workpiece a number of times cannot be avoided and manual alignment is practically impossible. The time required for such a procedure would be crushing for productivity. This is where System 3R's new MatrixNano pallet system has a decisive impact on the precision and profitability of work. Nonetheless, the mounting of the workpiece it is not the only consideration. To avoid a so-called "centre artefact" that would result in the workpiece having to be scrapped, the diamond cutter must be exactly positioned in the turning operation's X and Y axes.

The process chain for the insert is as follow:

- The diamond cutter is mounted in the machine (which is in turning mode).
- A test piece is mounted on a pallet and, for the purpose of "test turning", set-up in the chuck on the machine table.
- To ensure that the "centre artefact" phenomenon has not occurred, the test piece is measured in the measuring machine.
- The insert (on its pallet) is mounted in the chuck on the machine table and the turning phase of Fresnel lens manufacture is carried out.
- The machine is reset from turning to milling and the turning cutter is replaced with a ball nose milling cutter.
- A test piece (on its pallet) is set up in the table chuck. Test milling.
- Measuring and any adjustment.
- The turned insert (on its pallet) is mounted and milling concludes the machining of the lens array.



Toshiba machining centre with Matrix pallet system.

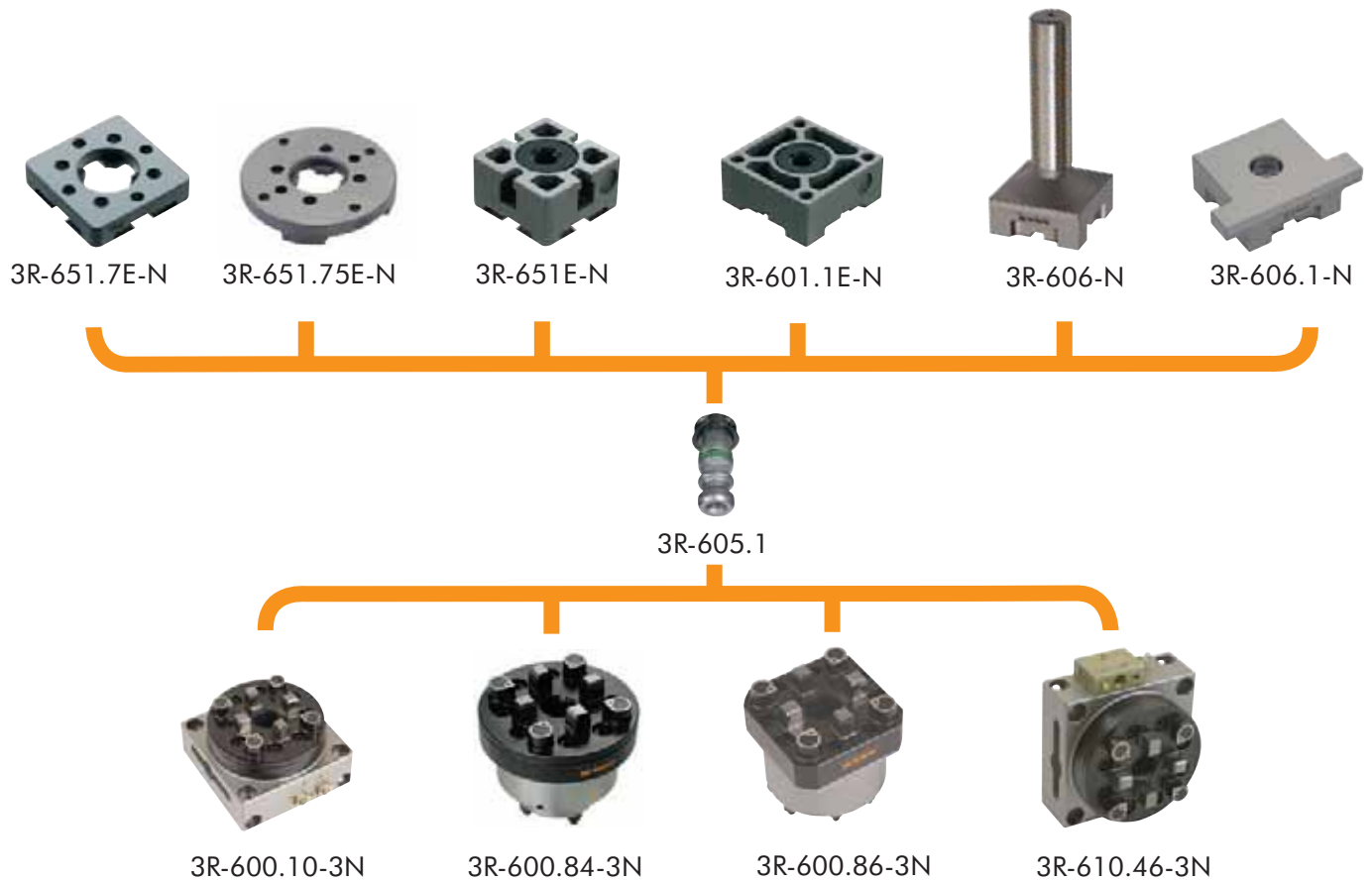
The future...

Kyoei Engineering states that System 3R's MatrixNano has met, if not exceeded, all its high expectations – precision engineering and economic alike. These can be summarised as: rapid and exact set-ups in the machine; rapid and precise changes between the machining and measuring processes; massive time savings with the palletisation of workpieces; and, markedly increased productivity.

Results have been so good that the company is now planning to implement MatrixNano in more of its production processes. This upgrading will increase the company's market competitiveness. Or, not to put too fine a point on it, will allow Kyoei to focus on the machining operations that it alone is able to carry out.

Product program – MacroNano & MatrixNano

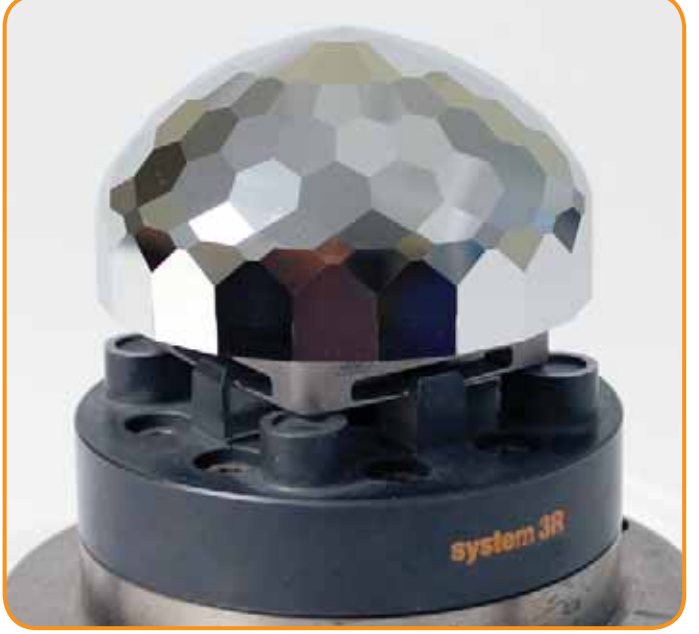
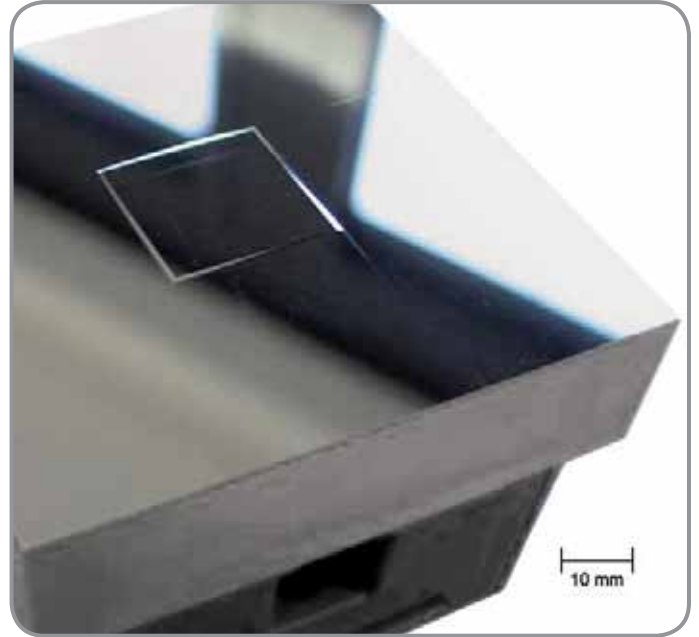
MacroNano – Chucks, Pallets & Accessories



MatrixNano – Chucks, Pallets & Accessories



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