

This Issue at a Glance...

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Customer Spotlight: Technical University of Berlin

The latest installation of the *Nanotech*[®] 350FG (shown below) was recently completed at TU Berlin. In this instance, the machine incorporated 5 axes of simultaneous motion (X, Z, Y, B, & C), plus a 100,000 rpm liquid cooled air bearing micro milling & grinding spindle, Video Viewing System, and Optical Tool Setting System.

For more information about TU Berlin's specialized activities in Micro-machining, Scientific & Industrial Research, please contact Mr. Dirk Oberschmidt at the following email address:

dirk.obereschmidt@ipk.fhg.de

Nanotech 220UPL

The latest machine offering from Moore Nanotechnology Systems has proven an instant success since its launch at the IMTS in Chicago last September. The *Nanotech*[®] 220UPL has been purchased by several Japanese & Taiwanese optics manufacturers who first viewed the system during the JIMTOF in Tokyo a month later.



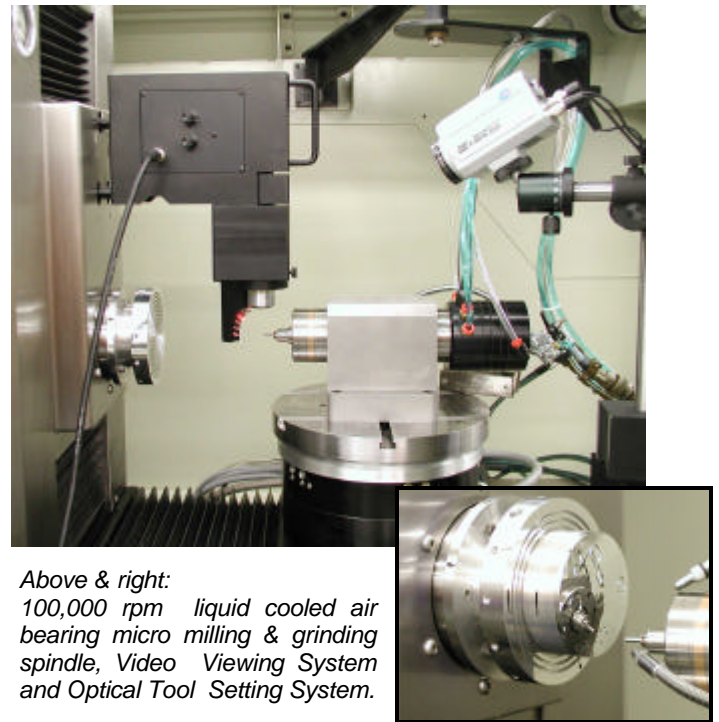
Nanotech[®] 220UPL Compact Ultra-Precision Lathe

Several machines have already been commissioned in Asia, and installations are scheduled in the USA and Europe in the near future. Initial customer response is overwhelmingly positive.

Featuring **1 nanometer programming resolution, with an unprecedented feedback resolution of only 0.034 Nanometers**, the machine is capable of achieving surface finishes of less than 1nm Ra, and form accuracy of less than 50nm PV by single point diamond machining. **Other Unique Features Include...**



- PC Based CNC with Windows 2000 OS
- Linear Motor Drives
- Hydrostatic Oil Bearing "Box-way" Slides
- 200mm Slide Travels
- 15,000 rpm Air Bearing Work Spindle
- 220mm diameter swing capacity
- Compact Size



Above & right:
100,000 rpm liquid cooled air bearing micro milling & grinding spindle, Video Viewing System and Optical Tool Setting System.

Nanotech on target!

With installations already throughout North America, Europe, and Asia, **Moore Nanotechnology Systems is on target to have supplied and installed more than 50 *Nanotech*[®] multi-axis Ultra-Precision machining systems by the end of 2003**

Moore Nanotechnology Systems Strengthens European Sales & Service Support...

Nanotech & ess...

Moore Nanotechnology Systems is pleased to announce its strategic partnership with **ess Mikromechnik** of Germany. Commencing Immediately, ess will provide both Sales & Service support for Nanotech's range of Ultra-precision Machining Systems throughout Continental Europe.



Exhibition Update

The latter half of 2002 proved a busy period as **Moore Nanotechnology Systems** unveiled the latest addition to its family of products, the **Nanotech[®] 220UPL**.

Nanotech exhibited the system at IMTS Chicago, ASPE St. Louis, & the JIMTOF show in Tokyo.

SPIE Photonics West, in San Jose, was the forum for the launch of the machine specifically to manufacturers of advanced electro-optical components and systems. A wide range of ultra-precision machined samples was also on display.



2003 SPIE Photonics West & the Nanotech[®] 220UPL

In the coming months you can meet **Nanotech** at the following shows...

OPTIFAB: Rochester NY, USA 20th-23rd May 2003

Interopto: Tokyo, Japan 15th-18th July 2003

OPTO Taiwan: Taipei, Taiwan 23rd-26th July 2003

ess Mikromechnik, based in Stockach in Southern Germany, was formed 12 years ago. Employing more than 20 people, ess specializes in the design, manufacture, sales and support of a range of air bearing devices including rotary and linear stages. ess has developed a particular presence in Europe, addressing the needs of the micro-mechanics, metrology, optics and semiconductor industries.

Moore Nanotechnology Systems will closely support ess in their endeavours, with the support of Gavin Chapman now focussing on the Asian markets where 'Nanotech' has become well established. Gavin will also provide regular support to ess.

Visit...

www.ess-mikromechnik.com

Extensive Support in Asia...

Recognizing the unique requirements of its Asian customers, Moore Nanotechnology Systems is pleased to work with the following Sales and Service Representatives throughout the region.

Singapore:

Laser 21

Mr. Chingwat Chia

chingwat.chia@laser-21.com

Taiwan:

Edward Keller

Mr. P.Y. Huang

py.huang@edwardkeller.com.tw

Korea:

SK Trading

H.J. Park

hjpark@sktrading.co.kr

Japan:

Itochu Mechatronics

Mr. Takigoro Suga

t-suga@itcm.co.jp

China:

Prof. Han Rongjiu

rjhan@public.cc.jl.cn

India:

CN Technologies

Mr. Siddarth Raman

cnt@vsnl.in

Rest of Asia:

Focal Dimensions Ltd.

Mr. Gavin Chapman

gavin@focaldimensions.com

Technical Brief

Understanding Spindle Motion Errors...

Disregarding all error sources, it can be said that a single point diamond turned surface will exhibit rotational symmetry about its axis of rotation.

Evidence has shown that apart from more random errors, such as distortion due to clamping, the work spindle motion errors are a significant contributor to these varying levels of asymmetry. The central region of a generally shallow workpiece geometry will be predominantly effected by the spindle's axial motion errors, while radial motion errors will come in to play at the outer regions of a generally steep geometry.

Although the effects of such motion errors might result in asymmetrical irregularities of just 100nm P-V or less, the slope characteristics are often extremely undesirable. Such spindle motion errors not only effect directly machined workpieces, but can also reproduce themselves on injection molded lenses, produced from single point diamond machined mold inserts. For example, while a 100mm diameter surface might tolerate a 1mm region of high slope errors at its center, a 2mm diameter surface will be dominated by such errors, resulting in decreased Strehl ratio, and subsequent degradation in contrast or resolution.

Axial motion errors, if uncontrolled, typically manifest themselves as so called "spindle star pattern" or other phenomena such as "once per rev error".

Star pattern has been seen in some cases due to geometric irregularities within the spindle thrust bearing, but is more frequently caused by "Motor Pole Print Through". The ability of the bearing to resist such forces, caused by the effects of the motor, is a major benefit to final workpiece accuracy. Careful selection and setting of the spindle drive amplifier is also of prime importance.

"Eliminating the sources of such errors was a significant consideration for Nanotech in its spindle specification and selection process"

In collaboration with **Professional Instruments** of the United States, the worlds leading supplier of air bearing spindles, Moore Nanotechnology Systems has adopted the unique patented **"Groove Compensated"** air bearing design. This has proven superior in performance to alternative air bearing designs, typically known as "Orifice Compensated".

The Orifice Compensated air bearing spindle will typically have a number of orifices of a certain diameter, feeding into an air film of given thickness.

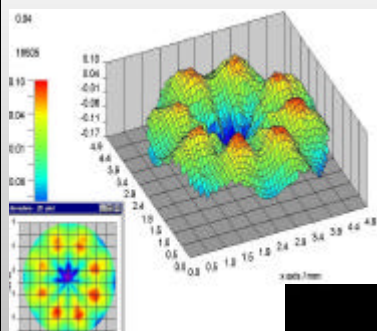
The orifice creates a pressure drop and a flow restriction before the air reaches the air film. Any force will try to move the air bearing rotor off center. The role of the air bearing compensation is to resist this force and keep the air bearing rotor at the central or neutral position.

In the case of the orifice compensated air bearing, there is a measurable time lag between the original force and the application of

the restoring force. Due to the relatively low average pressure in the air film, and the volume of the air film and airflow restriction at the orifice, the restoration force will over shoot the central or neutral position. The air bearing rotor will go through a measurable decaying restoration pattern until returning to the central or neutral position. This results in inherently poor central stiffness and poor step response.

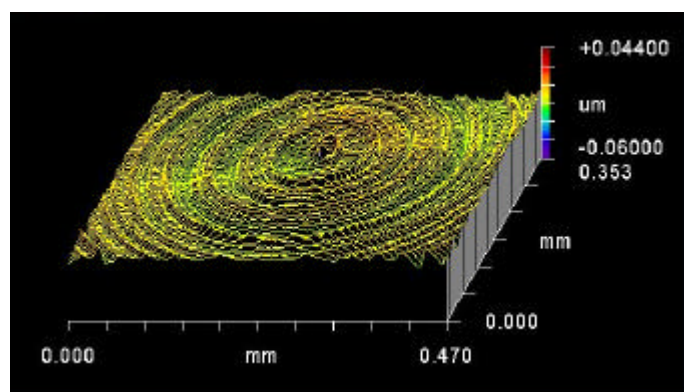
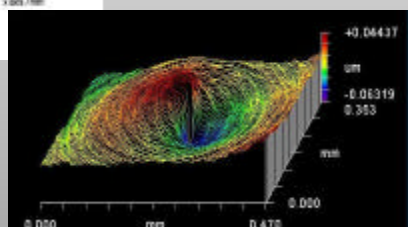
The Groove Compensated air bearing spindle will typically have a number of grooves of a certain geometry, again feeding an air film of a given thickness. Since there are no upstream restrictors in a groove compensated bearing and the grooves are an integral part of the air film, a groove compensated air bearing has 100% of the inlet air pressure and zero restriction of the airflow feeding the grooves.

The Undesirable Effects of Spindle Motion Errors



Left: A severe example of "spindle star" - probably caused by Motor Pole Print Through.

Right: "Once per rev" errors - dominating the central area of a micro lens.



Comparative results from Nanotech Groove Compensated air bearing, illustrating smoothness & symmetry.

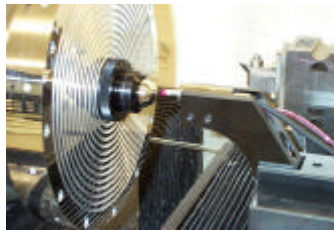
The combination of a relatively thin air film, and groove compensation with high average air pressure in the air film, generates the restoration force to keep the air bearing shaft in the central or neutral position. A force is resisted almost instantaneously and without the over shoot seen in orifice compensated air bearings. Groove Compensated air bearing spindles exhibit inherent Central Stiffness and have nearly instantaneous Step Response, and are used exclusively on the entire range of Moore Nanotechnology Systems products.

Workpiece Measurement & Error Compensation System (WECS)

The measurement of the surface geometry of complex optics, particularly Aspheres, has long been a challenge. Methods such as interferometry with combined null lenses or CGH's can be prohibitively expensive for prototypes or small batch quantities. Profilometry is well proven, but like interferometry, requires removal of the workpiece for metrology purposes.

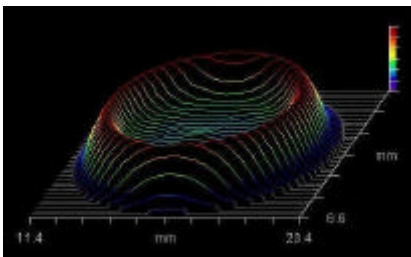
With Nanotech's Workpiece Measurement & Error Compensation System (WECS), both spherical and aspheric forms can be measured "on-machine", minimizing handling and reducing time consuming set up. In principle, any axisymmetric form that can be diamond machined or ground, can also be measured. Following system calibration, measurements can be taken using a fast-scan mode which samples data at predetermined spacing.

Perhaps the greatest benefit is the ability of WECS to compensate for any residual geometry errors. For this, a more precise point-to-point probing routine is adopted.

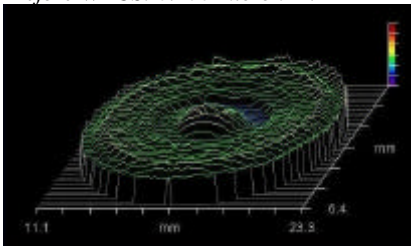


Advanced Windows based analysis software allows power removal that properly identifies and analyzes radius error in the part scans, allowing the user to determine the exact radius of the cutting tool and minimize power error in the final part profile. Advanced radius removal enables the operator to exchange power error for reduced form error.

Recent enhancements include coordinated X-Z probe motions resulting in increased measurement accuracy, as well as a dramatic reduction in part scan and calibration times of up to 50%. Also, updates to the user interface, plotting routines, and error handling/reporting.



Before WECS: 0.406 micron PV



After WECS: 0.061 micron PV

The example to the left shows a 12mm diameter sphere machined with a non controlled waviness diamond tool. Prior to measurement and error compensation using WECS, a clear form error is visible. In a single iteration, this is reduced to some 15% of its original value. The results depict an independent analysis by interferometer.

Employee Spotlight...

Emphasizing a commitment to continual product innovation, and the research of critical core technologies, Moore Nanotechnology Systems takes this opportunity to introduce Dr. Yazid Tohme and Dr. Sinan Badrawy. Together they head up Nanotech's Research & Development, and Engineering departments, respectively.



Yazid (left) earned his PhD at the University of Florida - Gainesville. Studying under the late Prof. George Tlustý, his work focused on advanced control and drive systems, and high precision mechanical structures. Joining the company in mid 2001, Yazid has contributed greatly, and in particular, to the fundamental design of the *Nanotech[®] 220UPL*.



Sinan, (right) a more recent recruit, spent three years as Post Doctorate Fellow, also at University of Florida - Gainesville. Prior to that, Sinan earned his PhD at the Technical University of Berlin, in his native Germany. His work included research related to chatter prediction, the analysis & optimization of high speed spindles, and advanced machine tool design.

Alternatively... DIFFSYS[®]

The capabilities of Diffsys Programming Software are well established for Diffractives, Fresnels & Hybrids: All types of zoned components can be generated, with either constant or variable step heights. DIFFSYS can accept a wide range of zone data formats.

New!

Diffsys now allows TALYSURF[®] Measurement Corrections...

The TALYSURF[®] is well established for the off line measurement of aspheres. DIFFSYS automatically folds, averages, centers and smooths the measured data, and creates a corrected tool path for subsequent machining.

