

APPLICATION NOTE
*Precitech's Nanoform 250 Ultra
combined with TMC's STACIS[®]
increases yield.*



Increasingly, low frequency, low amplitude building floor vibration has become a limiting factor in the performance of extremely high resolution micro-manufacturing tools. Among these tools are diamond turning machines which are used to create ultra-precision optical components.

A major manufacturer of consumer electronics was experiencing significant yield concerns during the manufacture of molds used to create small, high volume precision optics. The mold inserts were being machined with a Precitech Nanoform 250 Ultra diamond turning machine.

A few millimeters in diameter and oddly shaped with changing curvatures, these molds are made of nickel phosphorus, a very hard metal of high purity. Only a nanometer or two of unwanted motion can cause a defect in the mold.

Compounding the manufacturer's low yield problem was the difficulty in measuring the mold quality, which was done through visual inspection of scattered light under a microscope. Any questionable molds were discarded along with the defective ones, further contributing to the low yield.

After an investigation, Precitech suspected ambient floor vibration in the factory was contributing to the low yield. This was a surprise to the customer since the building floor design included vibration isolated floor sections beneath the diamond turning machines.

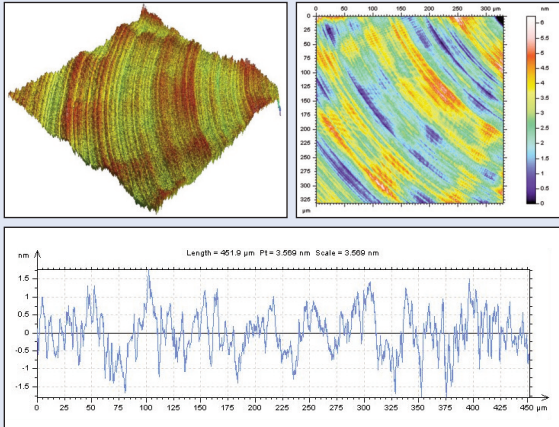
Precitech turned to TMC, the world leader in precision floor vibration control. Both Precitech and TMC are businesses under AMETEK Ultra Precision Technologies.



Precitech's Nanoform 250 Ultra diamond turning machine already has an embedded TMC MaxDamp[®] pneumatic vibration isolation system and finite element analysis optimized dual sub frame construction which is adequate for most applications in many floor vibration environments. MaxDamp[®] is a low frequency, highly damped, isolator designed to isolate horizontal and vertical building floor vibration starting at 2-3 Hz. *(continued on page 2)*



Nanoform 250 Ultra supported by STACIS[®] Active Piezoelectric Vibration Cancellation System

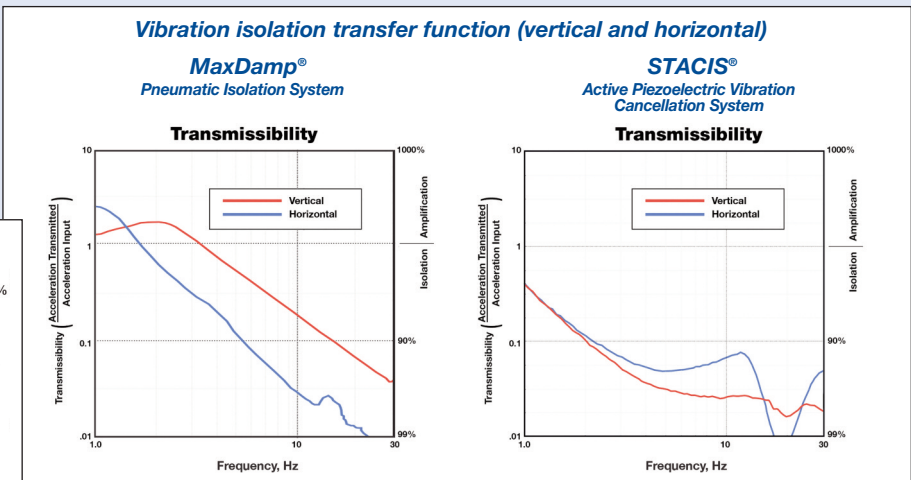
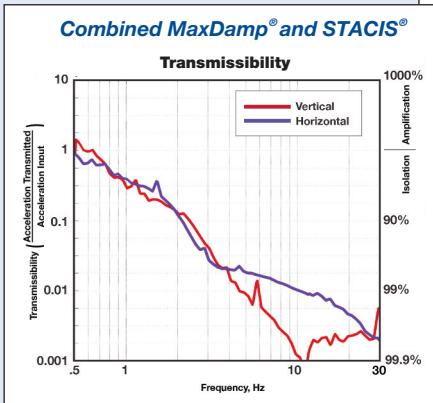


Taylor Hobson's CCI confirms improvements

Taylor Hobson, also a business under Ametek Ultra Precision Technologies, measured the surface finish with its CCI white light interferometer. A 50x objective was used to measure the surface heights of a 0.3 mm square area with a lateral resolution of 0.3 microns and a height resolution of less than 0.05 nm. The areal data is plotted in 2D and 3D. A 2D line profile was created in the lower plot by taking a diagonal section through the data. The profile was taken across the curved tool marks. The center of rotation of the mold is off of the upper right corner of the 2D areal plot. Note the vertical scale in nanometers. This surface was analyzed with its nominal curvature removed to give a finish of 0.52 nm Ra. This is a 2x improvement over the tool's finish spec when combined with STACIS.

Images courtesy of Precitech.

The combined performance of the MaxDamp® isolators supported by a STACIS® platform system results in performance that is the sum of the two vibration isolation transfer functions.



Additionally, the MaxDamp system rapidly dampens the motion induced by the tool's motorized positioning stage which weighs 200 pounds and accelerates at up to 0.2g.

A TMC vibration expert conducted an extensive site survey of the manufacturer's floor and of the tool itself and confirmed that extremely low frequency building floor vibration – from forklifts, HVAC units, other machinery, even walking past the equipment – exceeded the tool specification and was, in fact, limiting the quality of the molds. A finding driven more by the extremely demanding application than by a particularly severe floor environment. The “vibration isolated” sections of concrete floor were, in fact, not isolating critical low frequency vibration but rather amplifying it, a common finding during floor surveys. Though the floor beneath the tool was a separate slab of concrete, decoupled from the rest of the floor by a vibration absorbing material, the beneficial effect is only seen at high frequencies, above 100 Hz, where the tool is much less sensitive.

To improve performance, TMC engineers recommended a STACIS® active piezoelectric vibration cancellation system to support the entire Nanoform 250, including the embedded MaxDamp air isolators. STACIS cancels vibration down to extremely low frequencies, those often related to difficult-to-measure transient or random vibration, such as foot traffic or nearby machinery. The STACIS platform was initially tested beneath the Nanoform 250 Ultra at Precitech. Interestingly, test results for this application produced improved performance, even though the Precitech floor is extremely quiet.



Designed specifically as a second stage of vibration isolation, STACIS starts to isolate at 0.5 Hz and delivers a much higher level of performance than air isolators, particularly in less than optimal environments. Also, because the piezo technology is a “hard-mount,” STACIS can be “stacked” (placed beneath a tool with an internal vibration isolation system). Air isolators cannot be stacked without the detrimental effect of creating a “sprung-mass” and the corresponding resonant amplification.

The combined performance of the MaxDamp isolators supported by a STACIS platform system results in performance that is the sum of the two vibration isolation transfer functions. That is, the vibration isolation of the two systems is additive.

The Nanoform 250 was reinstalled on the STACIS platform system and the results were immediate and dramatic. Yield more than doubled. This STACIS retrofit was so successful that the manufacturer immediately purchased multiple additional Precitech Nanoform 250 Ultra diamond turning machines with corresponding TMC STACIS vibration isolation systems.



TMC, Precitech and Taylor Hobson are all brands/businesses under AMETEK Ultra Precision Technologies

www.techmfg.com www.precitech.com www.taylor-hobson.com