JINGDIAO | MoldMaking TECHNOLOGY

HOW TO MACHINE MICRON-LEVEL PRECISION MOLDS IN ONE TRY

On-machine measurement intelligence and modification technology helps mold builders overcome machining variables and quickly produce micron-level tolerances.

MR. HENG LI HE
DIRECTOR OF GLOBAL ENGINEERING, JINGDIAO GROUP

The precise fit of this part was possible with on-machine measurement and intelligent modification technology integrated into the control of a high-speed machining center.

Photos Credit: Jingdiao North America

Machining a micron-level precision mold on the first try is difficult to achieve. Machining the mold two or more times is often necessary to reach the required micron-level tolerance. Variables such as the machining environment, machine stability, cutting tool wear and accuracy and operator experience impact micron-level machining results.

The opening image shows a 300mm x 195 mm (M333, HRC50) part produced on a high-speed mill using a PCD cutting tool continuously for 80 hours. The tool wear was less than 0.8μm, which achieved a mirror Sa surface finish within 10 nanometers.

The precise fit of this machining sample begs three questions:

1. How were these parts machined?
2. How can they fit so perfectly together with a disappearing parting line?
3. How can this be done with no secondary operations?

On-machine measurement and intelligent modification technology integrated into the control of a high-speed machining center is one way to overcome these variables. These functions identify and eliminate any inherent deviations in key machining elements, which yields efficient, stable machining of micron-level precision molds.

On-machine measurement and intelligent modification produced this mirror Sa surface finish within 10 nanometers.

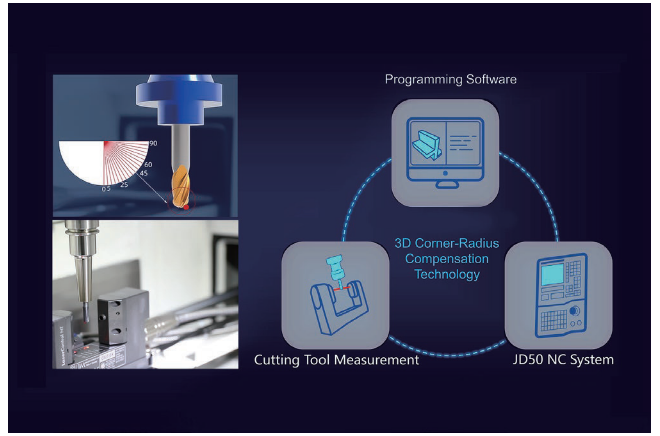
Here's how it works and what to consider.

Key Features and Functions

A high-speed precision machining center with **integrated on-machine measurement and intelligent modification technology** has a set of measurement systems in the machine's control. First, the measurement points are created in the CAM system. Then after the program is created, the NC code, measurement points and the part's solid model file are imported into the control. The operator machines the part and then selects the critical measurement points program. An accuracy heat map of the solid model file appears on the control, which visually indicates to the operator if the part is within tolerance.

On-machine measurement and intelligent modification technology turns traditional machining into digital control.

The **digital processing capability** of a high-speed machining center's CNC system makes machining micron-level precision molds in one pass possible. For example, the proper digital processing capability will acquire data acquisition from various measuring instruments and temperature sensors to form a closed-loop on-machine measurement and intelligent modification function, which efficiently and accurately carries out the measurement work on the CNC machine. It's like having a CMM built into your high-speed mill.

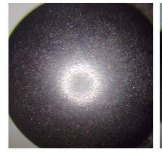


The on-machine measurement and intelligent modification control function permits contour measurement of the cutting tools.

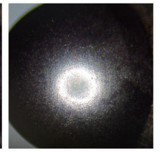
Regarding **part size measurement**, on-machine measurement and intelligent modification technology uses a probe that performs a preliminary inspection of the machined workpiece. Like a CMM, the control creates an accuracy heat map and informs the operator if the part is within spec. The operator can also export the measurement results and heat map image with the machining data.

Then there is the **cutting tool**, for which there can be an inherent deviation between the actual cutter size and the theoretical cutter data during manufacturing. Even the most accurate cutting tools have a tolerance. With on-machine measurement and intelligent modification technology in conjunction with the CNC system, the operator can use the laser tool calibrator to measure the inherent deviation of the cutting tool's radius and perform multi-point compensation according to the cutter's contour. After each tool is 3D measured, its actual value is automatically stored in the control, yielding more accurate machining results.

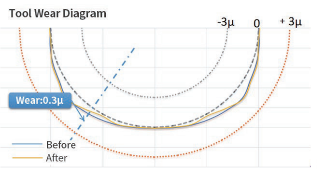
The operator can also measure **cutting tool wear** with on-machine measurement and intelligent modification technology using a laser tool calibrator to measure the change in cutting tool size due to wear. If wear exceeds a specific range – especially in the finishing process – it is necessary to carry out corresponding correction work to ensure that the following cutting tool removes the proper amount of material. For example, the control gives directions to measure the cutting tool after a specified time and if the wear is more significant than expected, the control changes to a new cutting tool.



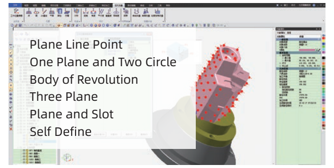
Before



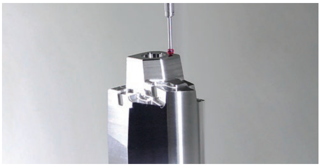
After



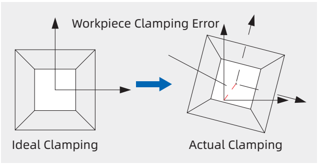
Another challenge is manually aligning a workpiece with an imprecise indicator or inexperienced operator that consumes labor time and produces inaccurate results. High-precision machining centers that **automatically align the workpiece** in X, Y and Z planes are more accurate and reduce setup time. For example, modeling features that define the workpiece coordinate system for the machined material improves high-speed machining accuracy.



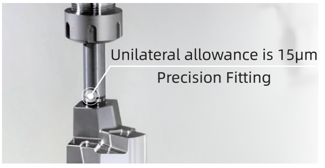
01-Support Multiple Workpiece Position Compensation Methods



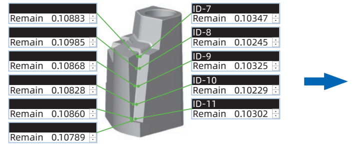
02-Obtain Actual Position on the Machine



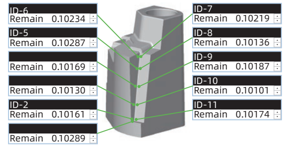
03-Workpiece Position Compensation



04-Verification of Position Compensation Accuracy



Before Modification: 7 μm



After Modification: 4 μm

Machine tools are very sensitive to heat when performing precise machining. On-machine measurement and intelligent modification technology can use a probe and standard ceramic ball to judge whether the current machine tool state is stable and make necessary corrections to adjust for a less desirable machining environment.

On-machine measurement and intelligent modification functions also monitor changes during processing by using various sensors built into the machine tool to detect problems and notify the operator. Alerts prevent the machine tool from working in an unstable state and preserve workpiece accuracy.

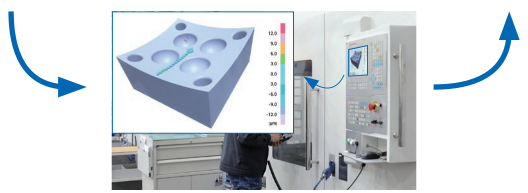
Mold Machining Advantages

High-precision machining centers with on-machine measurement and intelligent modification technology can achieve stable machining of micron-level molds by accurately judging, compensating and correcting inherent deviations such as tool errors and material deformation. It can also ensure long-term continuous processing of PCD cutting tools and produce surface finishes down to the nanometer level.

On-machine measurement and intelligent modification technology turns traditional machining into digital control that reduces quality problems caused by inexperienced operators, saves time when measuring parts on the machine and reduces the impact of external inherent deviations on production, improving a shop's overall machine tool utilization rate.

Inspect the Remaining Stock on the Machine

Achieve Stable Precision Machining



Real Time Display of CNC System

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